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August 1, 2013

Mark D. Marini, Secretary
Department of Public Utilities
One South Station, 5th Floor
Boston, Massachusetts 02110

Re: Western Massachusetts Electric, D.P.U. 13-**XX**
2012 Energy Efficiency Annual Report

Dear Secretary Marini:

On behalf of Western Massachusetts Electric (the "Company"), I enclose the Company's 2012 Energy Efficiency Annual Report for filing with the Department of Public Utilities (the "Department"). This report is being submitted pursuant to the Department's Order Adopting Energy Efficiency Annual Report Template, D.P.U. 08-50-C (2011).

Thank you for your attention to this matter. If you have any questions, please do not hesitate to contact me.

Very truly yours,

John K. Habib

John K. Habib

Enclosures

cc: Jeffrey Leupold, Department of Public Utilities
Matthew Saunders, Office of the Attorney General
Steven Venezia, Department of Energy Resources
Jerrold Oppenheim, Low-Income Energy Affordability Network
Members of the Energy Efficiency Advisory Council (via e-mail only)

2012

Western Massachusetts Electric

A Northeast Utilities Company

Energy Efficiency Annual Report

VOLUME 1

August 1, 2013

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Western Massachusetts Electric Company
2012 Energy Efficiency Annual Report

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I. INTRODUCTION

During program year 2012, the final year of implementation under the 2010-2012 three-year energy efficiency plans, the Massachusetts Energy Efficiency Program Administrators[1] (the "Program Administrators" or "PAs") continued to build on the nationally acclaimed successes of program years 2010 and 2011. Among the many awards and accomplishments achieved during program year 2012, the American Council for an Energy-Efficient Economy ("ACEEE") ranked Massachusetts number one in the nation for its energy efficiency efforts for the second year in a row.

Most notably in 2012, the PAs successfully delivered on their very ambitious goals for the program year, as reviewed and approved by the Massachusetts Department of Public Utilities (the "Department") in D.P.U. 09-116 through 09-127 and as submitted in each PA's 2012 Mid-Term Modification dated October 28, 2011.[2] The PAs were able to attain historic levels of energy savings while maintaining budgetary control and complying with the directive of the Green Communities Act to seek all cost-effective energy efficiency opportunities. The 2012 goals were intentionally designed to be very challenging stretch goals, and achievements in savings and benefits reached unprecedented levels in Massachusetts for residential, low-income, and commercial and industrial ("C&I") programs. The PAs successfully implemented their programs in the field while also continuing this unprecedented ramp up of spending and savings levels for energy efficiency programs to meet goals not just for program year 2012, but for the full life of the three-year plans, and to sow the seeds for additional savings going forward.

The accomplishments of 2012 were achieved despite a slower than expected recovery in the economy, low natural gas prices, and a significant increase in savings goals. In the wake of these challenges, the PAs continued to proactively work toward developing new delivery methods to reach more customers and to encourage customers to move forward with greater commitments and investments in energy efficiency. For example, during 2012, the PAs focused on refining their marketing approach to achieve deeper savings from participating customers, and worked diligently to reach a broader range of customers to implement all cost-effective program offerings. The PAs also continued to develop new technologies and new initiatives in 2012 in order to expand programming efforts and achieve their goals.

The Program Administrators also continued to engage in very high levels of integration, coordination and cooperation – all of which are hallmarks of the 2010-2012 three-year energy efficiency plans. Examples of this statewide coordination in 2012 include the establishment of consistent guidelines and protocols for delivery of the Voluntary Accelerated Rebate Pilot, which will be implemented in 2013, and continued expansion of upstream product offerings.

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[1] The Massachusetts Program Administrators are: Bay State Gas Company d/b/a Columbia Gas of Massachusetts, The Berkshire Gas Company, Blackstone Gas Company, Cape Light Compact, Fitchburg Gas and Electric Light Company d/b/a Unitil, National Grid, New England Gas Company, NSTAR Electric Company, NSTAR Gas Company, and Western Massachusetts Electric Company.

[2] Revisions to Western Massachusetts Electric Company's performance incentive model, D.P.U. 08-50 tables and screening model were submitted to the Department on February 15, 2013. See Western Massachusetts Electric Company, D.P.U. 11-112.

In 2012, the Program Administrators created the Evaluation Management Committee ("EMC") similar to the successful C&I and Residential Management Committees. The EMC, comprised of PA representatives and the Massachusetts Energy Efficiency Advisory Council ("EEAC" or "Council") consultants, serves as a steering committee for statewide evaluation issues. The EMC plans, prioritizes and delineates the research studies to be undertaken. The PAs worked together to engage in 25 studies across a wide span of program sectors in 2012, underscoring the fact that the evaluation, measurement and verification ("EM&V") of these program offerings remains a critical and vital tool for both Program Administrators and interested stakeholders in an ever changing marketplace.

The Program Administrators also continued to be actively engaged with the EEAC and worked collaboratively with the EEAC's consultants to meet detailed reporting and data collection deadlines in 2012. The PAs reviewed and expanded upon many areas of policy and reporting, including continuing accurate data development, evaluation and measurement of successes and areas in need of modification, transparent codes and standards, and building the framework necessary to ensure the ability to continue to offer successful and sustainable energy efficiency programs in the Commonwealth.

In addition, the PAs were also at the forefront of creating a culture of sustainability through public education. In May 2012, the PAs hosted an Appreciative Inquiry Summit, the first of its kind for energy efficiency in Massachusetts, which provided a venue for a diverse array of nearly 300 key stakeholders, including customers, civic leaders, contractors, key trade allies, energy efficiency experts, and others to provide the PAs with insights to guide efforts designed to continue to create a culture of sustainability in the Commonwealth. The PAs also hosted an Energy Efficiency Conference and Expo in 2012, which featured a full day of programming focused primarily on business and municipal customers.

Throughout 2012, the PAs continued their efforts to integrate gas and electric energy efficiency services and expand statewide marketing efforts, which, through the use of the Mass Save brand, continued to be an integral part of promoting energy efficiency programs in Massachusetts. The 2012 marketing campaign introduced a renewed, simplified Mass Save message.

Simultaneously with the activities and achievements noted above, the Program Administrators also devoted considerable time and effort in 2012 to developing their 2013-2015 energy efficiency plans. During the 2013-2015 planning process, each PA focused on increasing savings goals and reducing costs, streamlining the participation process in all sectors and realigning outreach and delivery efforts to be more customer-focused, all of which built on the achievements and lessons learned from 2010-2012.

Given the unprecedented nature of these efforts, and the ambitious goals established in the 2010-2012 plans, program year 2012 performance has been an outright success for energy efficiency in Massachusetts. Over the three years of the 2010-2012 energy efficiency plans, the Program Administrators have achieved unprecedented levels of savings and benefits within budget, and look forward to continuing these efforts and achieving additional successes going forward.

A. Purpose of Annual Report

Western Massachusetts Electric Company (the "Company") is pleased to provide its Energy Efficiency Annual Report ("Annual Report") for 2012. The purpose of the Annual Report is to:

- Provide a comparison of the Company's planned, preliminary year-end, and evaluated (where applicable) expenses, savings, and benefits at the portfolio, sector, and program levels for the program year.
- Identify significant[3] variances between the Company's planned and evaluated costs, savings, and benefits for the program year, and discuss reasons for such variances.
- Discuss how program performance during the program year informs the Company's proposed modifications to program implementation, if any, during upcoming years.
- Describe the EM&V activities undertaken by the Company that have not been included in previous Annual Reports, and explain how the results of the EM&V studies impact program cost-effectiveness.
- Describe the performance incentives that the Company proposes to collect.

B. Organization of Annual Report

The Company's 2012 Annual Report is organized as follows:

- Section I.C provides summary information on program performance at the portfolio and sector levels.
- Section II provides detailed information on program performance at the sector and program levels for the residential, low-income, and C&I sectors.
- Section III provides detailed information on the EM&V studies included in the Annual Report for each sector.
- Section IV addresses statutory budget requirements.
- Section V addresses the performance incentives the Company proposes to collect.
- Section VI addresses energy efficiency audits conducted during the past five years, where applicable.
- Section VII consists of Appendices A through F which provide further detailed supporting documentation for this report.

[3] Unless otherwise noted, "significant" variances are defined throughout this Annual Report as variances of +/-20 percent or more between the stated values.

C. Summary of Program Portfolio

The purpose of this section is to provide summary information on program performance at the portfolio and sector levels.

Tables[4] I.A and I.B provide summary information on program performance at the portfolio and customer sector levels, respectively.

Table I.A: Program Portfolio Summary

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	32,614,276			31,641,002		-3%
Performance Incentive	$	2,415,794			1,942,303		-19.6%
Savings & Benefits							
Energy							
Lifetime	MWh	911,217	757,354	-17%	746,144	-1%	-18%
Annualized	MWh	80,261	72,556	-10%	67,971	-6%	-15%
Demand							
Lifetime	kW	152,701	129,018	-16%	98,050	-24%	-36%
Annualized							
Summer	kW	11,646	10,972	-6%	8,676	-21%	-25%
Winter	kW	10,754	12,610	17%	11,556	-8%	7%
NEB (Lifetime)	$	59,453,545	52,378,196	-12%	51,287,620	-2%	-14%
Cost-Effectiveness							
TRC Benefits	$	181,161,453			144,374,596		-20%
TRC Costs	$	45,971,555			40,130,606		-13%
Net Benefits	$	135,189,898			104,243,990		-23%
BCR	n/a	3.94			3.60		-9%

Note: The Planned Values in Table I.A and all subsequent tables that contain Planned Values in this Annual Report (except as otherwise noted) were originally submitted to the Department on October 28, 2011 and revised on February 15, 2013 in Western Massachusetts Electric Company, D.P.U. 11-112.

As shown in Table 1.A above, significant variances exist at the portfolio level for lifetime kW between planned and preliminary year-end values and evaluated results. Additionally, there were variances between summer kW planned and preliminary year-end values and evaluated results. Both the C&I and residential sectors contributed to the variance in demand savings, due to new load shapes produced through evaluation activities.

TRC benefits and net benefits also had a variance between planned and evaluated values. TRC benefits are lower than expected due to lower energy savings in the C&I sector and lower NEB values in the residential sector. Net benefits are lower because overall TRC benefits are lower.

For a more detailed discussion of the cause of variances in each sector please refer to section II.A.1 for residential results, section II.B.1 for low-income results; and section II.C.1 for C&I results.

[4] The Company is also providing the Department with working Microsoft Excel spreadsheets for all of the tables included in this Annual Report. Such tables include all formulas and functions used in each table.

Table I.B: Customer Sector Summary				
Sector	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Residential				
TRC Benefits	$	79,839,934	54,954,121	-31%
TRC Costs	$	12,920,535	14,908,676	15%
Net Benefits	$	66,919,399	40,045,444	-40%
BCR	n/a	6.18	3.69	-40%
Low-Income				
TRC Benefits	$	13,204,268	15,670,157	19%
TRC Costs	$	4,570,715	4,840,416	6%
Net Benefits	$	8,633,553	10,829,741	25%
BCR	n/a	2.89	3.24	12%
C&I				
TRC Benefits	$	88,117,250	73,750,319	-16%
TRC Costs	$	28,480,304	20,381,513	-28%
Net Benefits	$	59,636,946	53,368,806	-11%
BCR	n/a	3.09	3.62	17%
TOTAL				
TRC Benefits	$	181,161,453	144,374,596	-20%
TRC Costs	$	45,971,555	40,130,606	-13%
Net Benefits	$	135,189,898	104,243,990	-23%
BCR	n/a	3.94	3.60	-9%

As shown in Table I.B above, significant variances exist at the sector level between planned and evaluated values for the following categories: Residential TRC benefits, net benefits and BCR; Low-Income net benefits; and C&I TRC costs.

- In the residential sector both TRC benefits and net benefits decreased due to lower than expected participation in the Mass Save program, reduced air sealing and insulation savings in the Multi-Family retrofit program, and lower than expected per participant savings in the behavioral program. Please refer to section II.A.2 for a more detailed discussion of the cause of the variances by program within this sector.

- Within the low-income sector, net benefits increased due to an increase in NEBs associated with increased oil savings. Please refer to section II.B.2 for a more detailed discussion of the cause of the variances by program within this sector.

- In the C&I sector reduced participation and spending in the Large Retrofit and New Construction programs was the primary factor leading to reduced TRC costs. Please refer to section II.C.2 for a more detailed discussion of the cause of the variances by program within this sector.

II. PROGRAM PERFORMANCE

A. Residential Sector Programs

1. Summary

During 2012, the Company implemented the following residential programs and residential pilots:

Residential Programs

- Residential New Construction and Major Renovation
- Residential Cooling and Heating Equipment
- Residential Multi-Family Retrofit
- Residential Mass Save
- Behavior Feedback
- Residential ENERGY STAR® Lighting
- Residential ENERGY STAR® Appliances

Residential Pilots

- Deep Energy Retrofit

Tables II.A.1 through II.A.3 provide summary information on the performance of the residential programs at the sector, end use, and program levels, respectively.

Sections II.A.2 and II.A.3 provide detailed information on the performance of each residential program and pilot program, respectively.

Table II.A.1: Residential Sector Summary							
Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	9,760,079			10,619,614		9%
Performance Incentive	$	1,085,533			776,900		-28%
Savings & Benefits							
Energy							
Lifetime	MWh	167,743	206,167	23%	199,282	-3%	19%
Annualized	MWh	24,880	29,204	17%	25,625	-12%	3%
Demand							
Lifetime	kW	41,200	49,341	20%	22,701	-54%	-45%
Annualized							
Summer	kW	3,409	4,490	32%	2,644	-41%	-22%
Winter	kW	5,246	7,341	40%	6,012	-18%	15%
NEB (Lifetime)	$	56,631,176	46,029,851	-19%	32,176,441	-30%	-43%
Cost-Effectiveness							
TRC Benefits	$	79,839,934			54,954,121		-31%
TRC Costs	$	12,920,535			14,908,676		15%
Net Benefits	$	66,919,399			40,045,444		-40%
BCR	n/a	6.18			3.69		-40%

As shown in Table II.A.1 above, significant variances exist at the residential sector level for lifetime MWh between planned and preliminary year-end values; demand values between planned, preliminary year-end, and evaluated results; NEB values between planned, preliminary year-end, and evaluated results; and TRC benefits, TRC costs, net benefits, and BCR values between planned and evaluated results. The reasons for such variances are described below

- The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

- The increase in lifetime MWh was caused by a combination of higher lifetime savings in the Residential New Construction & Major Renovation, Residential Cooling & Heating Equipment, ENERGY STAR Lighting, and ENERGY STAR Appliances programs.

- The variances in demand values were caused by differing levels of participation, differences in measure mix, and new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section3.

- NEB values declined due to fewer participants than expected, lower participation in certain measures with especially high NEBs, and the application of *2012 Residential Heating, Water Heating and Cooling Equipment Evaluation: Net-to-Gross, Market*

Effects, and Equipment Replacement Timing study reduced NEBs in the Residential Cooling & Heating Equipment program.

- TRC benefits decreased due to the lower demand savings and NEB values outlined above, while TRC costs increased due to higher than expected participation in certain programs with higher cost measures such as the Residential Cooling & Heating Equipment program.

- The changes in net benefits are a mathematical result of the changes in the TRC benefits and TRC costs.

A more detailed program-level discussion can be found in Section II.A.2.

Table II.A.2: Residential Sector Summary of End Uses				
End Uses	Units (lifetime)	Preliminary Year-End Results	Evaluated Results	% Change from Preliminary to Evaluated
Lighting				
Energy	MWh	164,744	165,274	0%
Demand	kW	17,347	14,497	-16%
NEB	$	1,363,510	1,334,850	-2%
HVAC				
Energy	MWh	8,940	10,407	16%
Demand	kW	1,845	2,123	15%
NEB	$	6,339,775	4,135,718	-35%
Motors				
Energy	MWh	0	0	0%
Demand	kW	0	0	0%
NEB	$	0	0	0%
Refrigeration				
Energy	MWh	3,892	3,815	-2%
Demand	kW	483	476	-1%
NEB	$	37,456	37,456	0%
Hot Water				
Energy	MWh	6,844	6,646	-3%
Demand	kW	8,318	615	-93%
NEB	$	917,949	1,053,375	15%
Behavior				
Energy	MWh	5,189	2,127	-59%
Demand	kW	325	133	-59%
NEB	$	0	0	0%
Process				
Energy	MWh	3,849	3,968	3%
Demand	kW	414	733	77%
NEB	$	0	0	0%
Envelope				
Energy	MWh	12,709	7,045	-45%
Demand	kW	20,609	4,123	-80%
NEB	$	37,371,162	25,615,042	-31%
Total				
Energy	MWh	206,167	199,282	-3%
Demand	kW	49,341	22,701	-54%
NEB	$	46,029,851	32,176,441	-30%

The variances in Table II.A.2 are categorized by end use. It is difficult to isolate the reason for the change from planed values to evaluated values by end use because end uses stretch across many different programs that have various delivery methods, savings, NTG factors, NEBs, and

costs. Therefore, these variances are explained in the context of program variances. See Section II.A.2 for further information.

Table II.A.3: Residential Program Summary

Sector	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Residential New Construction & Major Renovation				
TRC Benefits	$	2,543,842	2,499,949	-2%
TRC Costs	$	865,065	1,495,352	73%
Net Benefits	$	1,678,777	1,004,598	-40%
BCR	n/a	2.94	1.67	-43%
Residential Cooling & Heating Equipment				
TRC Benefits	$	531,336	1,394,710	162%
TRC Costs	$	406,140	1,225,575	202%
Net Benefits	$	125,197	169,134	35%
BCR	n/a	1.31	1.14	-13%
Multi-Family Retrofit				
TRC Benefits	$	3,154,404	788,414	-75%
TRC Costs	$	572,660	710,618	24%
Net Benefits	$	2,581,744	77,796	-97%
BCR	n/a	5.51	1.11	-80%
MassSAVE				
TRC Benefits	$	60,480,194	32,040,924	-47%
TRC Costs	$	7,160,507	5,549,102	-23%
Net Benefits	$	53,319,688	26,491,822	-50%
BCR	n/a	8.45	5.77	-32%
Behavior/Feedback Program				
TRC Benefits	$	558,177	202,741	-64%
TRC Costs	$	273,277	186,383	-32%
Net Benefits	$	284,900	16,358	-94%
BCR	n/a	2.04	1.09	-47%
ENERGY STAR Lighting				
TRC Benefits	$	11,898,874	17,054,703	43%
TRC Costs	$	2,423,644	4,383,496	81%
Net Benefits	$	9,475,230	12,671,207	34%
BCR	n/a	4.91	3.89	-21%

ENERGY STAR Appliances				
TRC Benefits	$	673,106	972,679	45%
TRC Costs	$	338,730	531,917	57%
Net Benefits	$	334,376	440,762	32%
BCR	n/a	1.99	1.83	-8%
Deep Energy Retrofit				
TRC Benefits	$	0	0	n/a
TRC Costs	$	118,949	44,657	-62%
Net Benefits	$	0	0	n/a
BCR	n/a	0	0	n/a
Residential New Construction & Major Renovation - Major Renovation statewide				
TRC Benefits	$	0	0	n/a
TRC Costs	$	0	0	0%
Net Benefits	$	0	0	n/a
BCR	n/a	0	0	n/a
Residential New Construction Multi Family (4-8 story) statewide pilot				
TRC Benefits	$	0	0	n/a
TRC Costs	$	0	0	0%
Net Benefits	$	0	0	n/a
BCR	n/a	0	0	n/a
Residential New Construction Lighting Design statewide pilot				
TRC Benefits	$	0	0	n/a
TRC Costs	$	0	0	0%
Net Benefits	$	0	0	n/a
BCR	n/a	0	0	n/a
Community Based Pilot				
TRC Benefits	$	0	0	n/a
TRC Costs	$	0	0	0%
Net Benefits	$	0	0	n/a
BCR	n/a	0	0	n/a
Hard-to-Measure Initiatives				
TRC Costs	$	761,564	781,576	3%
TOTAL				
TRC Benefits	$	79,839,934	54,954,121	-31%
TRC Costs	$	12,920,535	14,908,676	15%
Net Benefits	$	66,919,399	40,045,444	-40%
BCR	n/a	6.18	3.69	-40%

The variances in Table II.A.3 are by program and are discussed in more detail in Section II.A.2 for programs and in Section II.A.3 for pilots.

Residential Sector Performance Highlights

During 2012, the Program Administrators built upon existing residential programs and significantly expanded initiatives to increase participation in all residential programs. Selected highlights are presented below:

- Residential New Construction and Major Renovation[5] - In 2012, with 121 communities adopting the Stretch Energy Code, this program faced a market in which energy codes continued to change. Single family development picked up from previous years, but opportunities to capture future energy savings became increasingly difficult due to evolving code requirements. To address these barriers, the Program Administrators offered technical assistance as well as incentives to exceed the baseline. The PAs also increased market penetration while providing energy savings for residents. During 2012, the Program Administrators provided multiple trainings and participated in several recruitment events targeted at builders and trade allies new to performance-based construction. The PAs continued to participate in three pilots (multi-family new construction, major renovations, and lighting design) to aid in identifying the next generation of energy savings opportunities. It is expected that builders will continue to look to the Program Administrators to provide training, technical assistance and incentives to meet the new energy code. As of the end of 2012, over 40 Home Energy Rating System ("HERS") companies participated in the program. Finally, the Program Administrators in western Massachusetts continued to participate in the *Western Massachusetts Storm Recovery Program*. The storm recovery program contacted all of the communities affected by the 2011 tornado and distributed thousands of flyers to builders, building code offices, homeowners, tornado relief centers, town meetings/events and churches.

- Residential Cooling and Heating Equipment – In 2012, the Program Administrators exceeded their annual statewide goals for cooling equipment, duct sealing and the early replacement of old, inefficient equipment in the Residential Cooling and Heating Equipment program, also known as the COOL Smart℠ program. PAs held quality installation training sessions, including trainings on system design, duct diagnostics, brushless fan motors and ENERGY STAR Heating, Ventilation and Air Conditioning ("HVAC") quality installation. A customer incentive for specified eligible energy efficient Heat Pump Water Heaters ("HPWH") installed to replace an existing electric water heater, or for new construction was introduced in 2012. Over 2100 HPWHs were installed in 2012, with retail stores stocking and heavily promoting this energy-saving measure. In October, the Program Administrators held their annual COOL Talk meeting. This event is a forum for the PAs to share the program offerings, as well as a chance for contractors to articulate their own experiences with the program. The PAs also continued to offer technical support to contractors engaged in quality efforts, and continued to participate in joint electric and gas integration at

[5] Prior to 2012 the program was called Massachusetts New Construction with ENERGY STAR®.

events such as the Plumbing Heating Cooling Contractors Annual Trade Show and the annual GasNetworks® fall conference.

- Multi-Family Retrofit – At the conclusion of 2012, most PAs were close to or exceeded program goals. Energy efficient lighting, instant savings measures, and weatherization continued to be in high demand. The multi-family working group, consisting of representatives from both residential and C&I, coordinated between the two sectors to deliver comprehensive, whole facility, energy efficiency services.

  The Multi-Family Market Integrator continued to be an invaluable resource to the multi-family program in 2012, as illustrated in a year-over-year increase of 25 percent in incoming calls for multi-family services. This trend of successfully enrolling facilities can be credited to capitalizing on previously established relationships with facility owners/ property managers, as well as the increased effort to create brand recognition through statewide marketing efforts.

- Mass Save – Program Year 2012 was the first full year of the market model. Two groups of Mass Save participating contractors, Home Performance Contractors ("HPCs") and Independent Installation Contractors ("IICs"), with over 90 contractor companies statewide, provided services in addition to those offered by the lead vendor.

  The Contractors Best Practices Working Group continued to highlight the PAs' commitment to ongoing communication with participating contractors in the program. The group served as a forum to provide an open line of communication between HPCs, IICs, lead vendors and PAs to discuss any matters related to the program with an independent third-party facilitator.

  In 2012, the HEAT Loan program continued to offer loans ($500-$25,000), and the offerings were expanded to include central air conditioning and residential electric customers in individually metered condominium units. The PAs saw an increase in both the average loan amount and the number of customers financing multiple measures. In addition, the PAs implemented various initiatives throughout the year, including pre-weatherization and early boiler replacement incentives, sales and technical trainings, and marketing bonuses.

- ENERGY STAR Lighting - In 2012, the ENERGY STAR Lighting program produced strong results, with all the PAs meeting or exceeding savings goals. The ENERGY STAR qualification of new light-emitting diodes ("LED") products sparked new manufacturer interest in the Program Administrators' residential programs. Manufacturing partners were eager to create and enhance LED Negotiated Cooperative Promotions with new and existing retail partners. As a result of increased LED product availability, the Massachusetts Program Administrators were able to surpass their statewide LED bulb goal by 362 percent and their LED fixture goal by 98 percent.

- ENERGY STAR Appliances – The ENERGY STAR Appliances program results varied by Program Administrator and measure. ENERGY STAR qualified refrigerators and freezers, as well as the second refrigerator and freezer recycling program, were once again strong performers for this program. Pool pumps, computers, and ENERGY STAR televisions also performed well. Other measures, like advanced power strips, LCD monitors, and room air cleaners, lagged behind expectations. The PAs introduced a short-term mark down of ENERGY STAR room air conditioners with an Energy Efficiency Rating of 10.8 or higher through independent retailers.

A more detailed discussion of each of the above programs follows.

2. Residential Programs

a. Residential New Construction and Major Renovation

Purpose/Goal: The purpose of the Residential New Construction and Major Renovation program was to capture lost opportunities, encourage the construction of energy-efficient homes, and drive the market to one in which new homes are moving towards net-zero energy.

Targeted Customers: The target market for this program included homebuilders, contractors, architects/designers, trade allies, Home Energy Rating System ("HERS") raters, homebuyers, realtors, developers, low-income and affordable housing developers, code officials, and consumers in the market for new homes or major renovations.

Definition of Program Participant: A participant is defined as a unique electric account served under this program. For residential new construction the account represents a newly constructed dwelling unit.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- HVAC
- Hot Water
- Envelope
- Refrigeration

Delivery Mechanism: The program was administered by each Program Administrator in its service territory and coordinated regionally through the Joint Management Committee ("JMC"). The JMC contractor was responsible for tracking and reporting program activity and advised the JMC on necessary program changes and enhancements. A separate third-party vendor conducted quality assurance/quality control of field activities. The JMC utilized a market-based network of trained contractors who offered energy efficiency and rating services to homebuilders.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program was discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 121-130 (bates numbering 00127-00136). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.A.4[6] provides information on the performance of the Residential New Construction and Major Renovation program.

Table II.A.4: Residential New Construction & Major Renovation

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	601,119			779,658		30%
Performance Incentive	$	28,020			26,808		-4%
Participants	unique accts	141			156		11%
Program Cost / Participant	$	4,263			4,998		17%
Savings & Benefits							
Energy							
Lifetime	MWh	2,556	4,803	88%	4,933	3%	93%
Annualized	MWh	249	414	66%	425	3%	71%
Average Measure Life	yrs	10.3	11.6	13%	11.6	0%	13%
Demand							
Lifetime	kW	500	823	64%	815	-1%	63%
Annualized							
Summer	kW	35	56	61%	59	5%	70%
Winter	kW	48	87	83%	100	15%	110%
Average Measure Life	yrs	14.4	14.6		13.7		
NEB (Lifetime)	$	2,215,964	1,838,372	-17%	1,897,471	3%	-14%
Cost-Effectiveness							
TRC Benefits	$	2,543,842			2,499,949		-2%
TRC Costs	$	865,065			1,495,352		73%
Net Benefits	$	1,678,777			1,004,598		-40%
BCR	n/a	2.94			1.67		-43%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Total program costs were higher than expected due to higher than expected participation in the program. Participant incentive costs were higher than planned program costs due to customer participation in higher tiers of savings which offer a larger incentive per unit.

Savings and Benefits - Preliminary year-end and evaluated lifetime and annual energy savings are higher than planned values due to more units participating in the Residential New Construction & Major Renovation program. Those units averaged more indoor lighting fixtures than anticipated, adding to the increased

[6] For each program and pilot program, the Company has defined "participant", and updated the "units" column in the program or pilot program table to be consistent with that definition.

savings seen between planned values and preliminary year-end and evaluated values.

Variances in lifetime and annual demand are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual.* See Appendix B, Section 3. Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

Cost Effectiveness - TRC costs are higher than expected due to the higher participation outlined above. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are the:

- *MA RNC Program Incremental Cost Report*
  This report provides estimates of the incremental costs per square foot involved in building high efficiency homes that meet the criteria of the MA RNC program. Incremental costs (costs above those of typical homes built outside the program) are estimated for single family, low-rise multi-family buildings of three or fewer stories, and mid- to high-rise multi-family buildings of four stories or more for each incentive option offered by the program. The study had no impact on savings. The study is discussed in more detail in Section III, Study 1.

- *Lighting Onsite Inventory and Saturation Study*
  The objective of this study was to perform lighting inventories and estimate socket saturations in Massachusetts homes. The study also examined lighting purchase behavior and searched for evidence of incandescent bulb stockpiling. Saturation of all energy-efficient light bulbs, including CFLs, LEDs, and fluorescent tubes, increased to 39 percent statewide in 2013. The results of this study will increase energy savings by increasing the number of bulbs found in indoor fixtures. The study is discussed in more detail in Section III, Study 7.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Residential New Construction program is cost-effective with a BCR of 1.67.

b. Residential Cooling and Heating Equipment

Purpose/Goal: The purpose of the Residential Cooling and Heating Equipment ("COOL Smart") program was to raise residential consumer awareness and market share of properly installed high-efficiency cooling equipment and systems, and increase market share of ENERGY STAR furnaces equipped with an electronically commuted motor.

Targeted Customers: The program targeted residential customers in the market to purchase new or replacement HVAC equipment, including: new systems in existing and new homes (new systems); replacement systems in existing homes (new equipment/old systems), including the early retirement of existing equipment; and improvements in operational systems in existing homes (new equipment/old systems). The program also targeted: HVAC contractors and technicians; suppliers, manufacturers, and distributors of HVAC equipment; new-home builders; and remodeling contractors.

Definition of Program Participant: A participant is defined as a unique electric account served under this program.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses: HVAC

Delivery Mechanism: The program was administered by each Program Administrator in its service territory. Delivery was through a common vendor selected through a common RFP. Whenever possible, there was coordination with the related gas Program Administrator's initiatives. To this end, the COOL Smart and Gas Networks' High Efficiency Heating and Hot Water programs worked to procure a single, joint circuit rider to support both programs in the field. Program initiatives were also piggybacked onto the Residential New Construction and Mass Save/Home Energy Services ("HES") programs:

- Participating residential new construction program builders and their HVAC contractors were referred to the COOL Smart program for training and Quality Installation Verification ("QIV"). Whenever appropriate, these training were jointly provided with GasNetworks.

- HES participants were referred to COOL Smart for HVAC measures using COOL Smart literature, which is part of the standard HES information package.

Quality control follow-up inspections were performed by independent inspectors on up to 10 percent of installations to verify equipment installation and performance.

The program continued to use equipment distributors to assist customers with filling out their rebate forms, sell high-efficiency and QIV-related technology, and to provide indoor training labs for HVAC contractors.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 135-145 (bates numbering 00141-00151). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.A.5 provides information on the performance of the Residential Cooling and Heating Equipment program.

Table II.A.5: Residential Cooling & Heating Equipment

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	369,213			879,894		138%
Performance Incentive	$	18,274			11,049		-40%
Participants	unique accts	711			1,323		86%
Program Cost / Participant	$	519			665		28%
Savings & Benefits							
Energy							
Lifetime	MWh	2,948	12,339	319%	11,462	-7%	289%
Annualized	MWh	169	972	475%	924	-5%	446%
Average Measure Life	yrs	17.4	12.7	-27%	12.4	-2%	-29%
Demand							
Lifetime	kW	506	9,483	1774%	1,641	-83%	224%
Annualized							
Summer	kW	34	898	2573%	123	-86%	266%
Winter	kW	59	1,258	2029%	235	-81%	297%
Average Measure Life	yrs	15.1	10.6		13.4		
NEB (Lifetime)	$	158,308	159,956	1%	13,690	-91%	-91%
Cost-Effectiveness							
TRC Benefits	$	531,336			1,394,710		162%
TRC Costs	$	406,140			1,225,575		202%
Net Benefits	$	125,197			169,134		35%
BCR	n/a	1.31			1.14		-13%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Total program costs were driven higher by greater than expected participation in the program, resulting in participant incentives being nearly three times higher than expected. High interest in heat pump water heaters, mini splits, warm air furnaces, and rightsizing primarily drove the increase in participation. Due to the fact that total program costs increased more rapidly than the number of participants, the average program cost per participant rose as well.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector.

These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits - Preliminary year-end and evaluated lifetime and annual energy savings were much higher than planned due to the increase in participation in certain high savings measures outlined above.

Variances in lifetime and annual demand are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3. Differences in participation levels and measure mix also contributed to the variations seen in the demand values. Better information lead to a change in the load shape for heat pump water heaters and as they are a large part of this program it caused a significant change in the demand savings.

The *2012 Residential Heating, Water Heating and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing* study is the basis for the reduction of NEB resources from planned and preliminary year-end values to evaluated results due to the fact that certain non-energy benefits are not applicable depending on whether the equipment was replaced on failure or retired early.

Cost-Effectiveness - TRC benefits are higher due to the higher electric savings from increased participation from the measures outlined above. Correspondingly, there are higher TRC costs from the increased participation. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are as follows:

- *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*
  The study updated Net-to-Gross ("NTG") ratios for certain prescriptive equipment available in the Residential Heating & Water Heating and Residential Cooling & Heating Equipment programs. It also analyzed net market effects ("NME") and looked into the timing of equipment replacement. Results indicate that NTG ratios are slightly higher than previously estimated for many measures. Further, NME analyses and data provide qualitative evidence to support this finding. The study also found program induced accelerated replacement of equipment that was not being captured in savings estimates; however the level of replacement varied by equipment being installed. The net effect for the Company was to increase energy savings and decrease benefits for the 2012 evaluated results. The study is discussed in more detail in Section III, Study 2.

- *Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure*
  This memorandum provides adjusted deemed NEI values that address the differences in NEIs for residential heating, cooling, and water heating equipment that is early replacement compared to replace on failure. These deemed NEIs update the NEIs provided in the residential NEI report submitted by the PAs to the Department on August 15, 2011 in their 2010 Energy Efficiency Annual Reports in D.P.U. 11-63 through 11-73, 11-126. The results of this study decreased net lifetime benefits for 2012 evaluated results. The study is discussed in more detail in Section III, Study 25.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Residential Cooling and Heating program is cost-effective with a BCR of 1.14.

c. Residential Multi-Family Retrofit

Purpose/Goal: The purpose of the Residential Multi-Family Retrofit program was to address the energy efficiency retrofit opportunities in facilities with five or more residential dwelling units in the market rate sector.

Targeted Customers: Residential multi-family facilities with five or more dwelling units were targeted by this program.

Definition of Program Participant: A participant is defined as a unit served under this program.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- HVAC
- Motors and Drives
- Refrigeration
- Domestic Hot Water

- Building Envelope
- End Use Behavior

Delivery Mechanism: The program was administered cooperatively by the gas and electric Program Administrators. The Multi-Family Market Integrator was responsible for facilitating the delivery of program services as well as acting as the conduit for participant inquiries to ensure that participants were not inconvenienced by having to contact multiple parties directly during the project lifecycle.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 181-195 (bates numbering 00187-00201). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.A.6 provides information on the performance of the Residential Multi-Family Retrofit program.

Table II.A.6: Multi-Family Retrofit

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	476,533			573,555		20%
Performance Incentive	$	38,038			6,040		-84%
Participants	# of units	530			1,135		114%
Program Cost / Participant	$	899			505		-44%
Savings & Benefits							
Energy							
Lifetime	MWh	12,553	3,894	-69%	5,295	36%	-58%
Annualized	MWh	784	520	-34%	599	15%	-24%
Average Measure Life	yrs	16.0	7.5	-53%	8.8	18%	-45%
Demand							
Lifetime	kW	157	325	107%	614	89%	291%
Annualized							
Summer	kW	20	28	38%	99	254%	389%
Winter	kW	34	49	45%	229	363%	570%
Average Measure Life	yrs	7.8	11.6		6.2		
NEB (Lifetime)	$	1,975,205	602,081	-70%	185,628	-69%	-91%
Cost-Effectiveness							
TRC Benefits	$	3,154,404			788,414		-75%
TRC Costs	$	572,660			710,618		24%
Net Benefits	$	2,581,744			77,796		-97%
BCR	n/a	5.51			1.11		-80%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Total program costs were higher than expected mostly due to slightly higher expenditures in participant incentives and higher expenditures in the Sales, Technical Assistance & Training ("STAT") budget category. The higher spending in participant incentives and STAT was a direct result of greater participation than planned as well as larger quantities of common area fixtures installed, and the installation of electric thermostats. The large increase in participants was due to a positive response to the program and more units than originally planned participated in the program.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits - The variance between preliminary year-end and planned values in lifetime and annual energy savings was due to lower than expected installations of refrigerators, insulation, and air sealing. Despite increased participation, there were fewer conversions in these categories. Given that these are very high savings measures, the reduction in installation of these measures has a significant impact on program wide savings. The variance between preliminary year-end and evaluated results is due to new measure savings values from the *Massachusetts Multifamily Program Impact Analysis* study filed in the Company's 2011 Energy Efficiency Annual Report. There was also an increase in evaluated savings due to this study which increased kWh savings values associated with programmable thermostats.

The increases in lifetime and annual demand factors are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3. Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

Lower NEBs between planned values and preliminary year-end values were due to the lower number of insulation and air sealing measures mentioned above. The additional, decrease in evaluated lifetime NEBs is due to fewer audit conversions resulting in less NEI allocated to participants from insulation and air sealing installations from planned.

Cost Effectiveness - TRC benefits went down as the result of lower participation in envelope measures with the highest savings and benefit values, while TRC costs increased because of increased participation in lower savings measures. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V study included in the Company's 2012 Annual Report that applies to this program is the:

- *Lighting Onsite Inventory and Saturation Study*
  The objective of this study was to perform lighting inventories and estimate socket saturations in Massachusetts homes. The study also examined lighting purchase behavior and searched for evidence of incandescent bulb stockpiling. Saturation of all energy-efficient light bulbs, including CFLs, LEDs, and fluorescent tubes, increased to 39 percent statewide in 2013. The results of this study will increase energy savings by increasing the number of bulbs found in indoor fixtures. The study is discussed in more detail in Section III, Study 7.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Multi-Family Retrofit program is cost-effective with a BCR of 1.11.

d. Residential Mass Save/Home Energy Services ("HES")

Purpose/Goal: The purpose of the Mass Save/HES program was to provide residential customers with energy efficiency recommendations that enable them to identify and initiate the process of installing cost-effective energy efficiency improvements.

Targeted Customers: The HES target market is all non-low-income residential customers living in single-family houses or one- to-four-unit buildings that are not part of a larger site where an association exists (such as a condominium association with multiple four-unit buildings). The program aims to reach the aforementioned customers who are interested in making their homes more energy efficient. The HES program is fuel-blind.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Definition of Program Participant: A participant is defined as a unique electric account served under this program. For this program a unique electric account is equal to a residential audit.

Targeted End-Uses:

- Lighting
- HVAC
- Hot Water
- Envelope
- Refrigeration

Delivery Mechanism: Mass Save/HES was implemented by each PA's competitively procured lead vendor.

The program was delivered by lead vendors selected through a competitive bidding process. Lead vendors were responsible for managing and training market-based participants such as participating IICs and HPCs. Additional lead vendor responsibilities included:

- Consistent statewide training
- Data reporting
- Achieving aggressive savings
- Customer satisfaction
- Quality control standards
- Scheduling requirements
- Technical assistance
- Maintaining and reporting health and safety information

Two groups of Mass Save participating contractors, HPCs and IICs, provided services in addition to those services offered by the lead vendor. All participating contractors had to meet program eligibility and requirements. HPCs independently recruited customers, provided Home Energy Assessments ("HEAs") and implemented weatherization measures. IICs provided installation of weatherization measures for those customers who received an HEA from the lead vendor. IICs also had the opportunity to independently recruit customers and refer them to the lead vendor for the HEA.

In order to receive incentives or program rebates, customers were required to have an HEA through either the PA's lead vendor or via a participating HPC to identify and prioritize all cost-effective energy efficiency improvements. Insulation work, whether performed by an HPC or IIC, is subject to quality control inspection(s) performed by the PA-vendor or third-party vendor. This ensured that high quality was maintained, and that installations met Building Performance Institute standards or similar standards set by the PAs.

The gas and electric PAs remained under contract with Competitive Resources, Inc., a third-party Quality Control ("QC") vendor responsible for performing QC inspections of program implementation vendors and participating contractors. The QC vendor provided valuable information and feedback to the Program Administrators on program successes and identified areas of possible improvement.

The Program Administrators are working together toward a "best practices" approach to provide a more coordinated statewide training to reinforce quality installation techniques for the HES program. It is expected that training requirements for contractors to retain their status as a HES participating contractor will increase over time. Additionally, contractors must maintain a high level of customer satisfaction to continue in the program.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009 and the Company's 2012 RCS Budget Petition, filed November 1, 2011. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 146-157 (bates numbering 00152-00163) and Western Massachusetts Electric Company, D.P.U. 11-RCS-05, respectively. The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118 and on December 27, 2011 in Western Massachusetts Electric Company, D.P.U. 11-RCS-05, respectively.

Table II.A.7 provides information on the performance of the residential Mass Save program.

Table II.A.7: MassSAVE

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	4,785,891			4,333,236		-9%
Performance Incentive	$	847,161			479,585		-43%
Participants	unique accts	5,597			4,095		-27%
Program Cost / Participant	$	855			1,058		24%
Savings & Benefits							
Energy							
Lifetime	MWh	40,279	35,509	-12%	23,333	-34%	-42%
Annualized	MWh	3,707	3,938	6%	2,692	-32%	-27%
Average Measure Life	yrs	10.9	9.0	-17%	8.7	-4%	-20%
Demand							
Lifetime	kW	28,688	23,012	-20%	4,998	-78%	-83%
Annualized							
Summer	kW	1,450	1,247	-14%	292	-77%	-80%
Winter	kW	616	734	19%	818	11%	33%
Average Measure Life	yrs	19.8	18.5		17.1		
NEB (Lifetime)	$	51,343,525	42,275,342	-18%	28,926,131	-32%	-44%
Cost-Effectiveness							
TRC Benefits	$	60,480,194			32,040,924		-47%
TRC Costs	$	7,160,507			5,549,102		-23%
Net Benefits	$	53,319,688			26,491,822		-50%
BCR	n/a	8.45			5.77		-32%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Participation in the Mass Save program decreased from planned values due to fewer than expected customers requesting audits as well as fewer customers submitting applications for rebates for qualifying measures in 2012. Cost per participant increased as total program costs decreased less rapidly than the number of participants.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits - The variance in lifetime demand between planned and preliminary year-end results is attributable to differences in participation. Variances between planned and evaluated values showed a significant difference due to the inclusion of a new realization rate necessitated by a change in implementation vendor software. This study is outlined in the *HES Realization Rate Results Memo*. See Appendix C, Study 3. This study is also responsible for the decreases in NEBs between planned and preliminary year-end values and evaluated values.

Evaluated values for lifetime and annual energy savings declined due to the application of *The Home Energy Services Impact Evaluation study* which decreased the NTG ratio for CFL bulbs, and lowered the overall savings per bulb due to a billing analysis. These values are referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3.

Additional variances in lifetime and annual demand are also due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

Cost effectiveness - TRC benefits decreased as a result of lower electric savings due to the lower realization rate described above. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are the:

- *HES Realization Rate Results Memo*
  This study produced PA-specific realization rates (the ratio of ex ante to ex post savings) used to adjust insulation and air-sealing savings. The study decreased program savings for the Company's 2012 evaluated results. The study is discussed in more detail in Section III, Study 3.

- *2012 Home Energy Services Pre-Weatherization Initiative Evaluation*
  This evaluation assessed the impact of additional incentives on a customer's decision to overcome pre-weatherization barriers (overcoming these barriers make them eligible to install certain recommended HES measures). The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 9.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Mass Save program is cost-effective with a BCR of 5.77.

e. Behavior Feedback Program

Purpose/Goal: The purpose of the Behavior Feedback program was to lower residential customer energy consumption by educating and motivating customers to take energy saving actions and modify their behaviors.

Targeted Customers: The program targeted single-family residential customers regardless of their energy usage.

Definition of Program Participant: A participant is defined as one residential household. During the course of the year a large cohort of participants was added to this program. The number of participants reflected in the Table II.A.8 is a weighted average of the number of participants that participated in the program over the course of the year.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses: The program targeted all residential end-uses.

Delivery Mechanism: "Passive" participants received information on their household energy consumption compared to similar households through quarterly Home Energy Reports while "active" participants (accounts linked to the web portal) received monthly electronic reports. The program was administered by WMECo. The vendor was C3 Energy.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program was proposed in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011. See Western Massachusetts Electric Company, D.P.U. 11-106.

Table II.A.8 provides information on the performance of the Behavior Feedback program.

Table II.A.8: Behavior Feedback

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	267,678			184,859		-31%
Performance Incentive	$	5,599			1,524		-73%
Participants	est. # of hhlds	25,000			71,031		184%
Program Cost / Participant	$	11			3		-76%
Savings & Benefits							
Energy							
Lifetime	MWh	5,844	5,189	-11%	2,127	-59%	-64%
Annualized	MWh	5,844	5,189	-11%	2,127	-59%	-64%
Average Measure Life	yrs	1.0	1.0	0%	1.0	0%	0%
Demand							
Lifetime	kW	376	325	-14%	133	-59%	-65%
Annualized							
Summer	kW	376	325	-14%	133	-59%	-65%
Winter	kW	1,500	1,297	-14%	532	-59%	-65%
Average Measure Life	yrs	1.0	1.0		1.0		
NEB (Lifetime)	$	0	0	0%	0	0%	0%
Cost-Effectiveness							
TRC Benefits	$	558,177			202,741		-64%
TRC Costs	$	273,277			186,383		-32%
Net Benefits	$	284,900			16,358		-94%
BCR	n/a	2.04			1.09		-47%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Total program costs were lower than expected due to lower marketing and advertising dollars spent on the program. The number of participants increased dramatically due a programmatic decision to include a new cohort of participants in July 2012 to build off the program's prior success. Due to the fact that total program costs were lower than expected and participants were higher than expected, the program cost per participant declined.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances

in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits - The decline in lifetime and annual energy savings between planned and preliminary year-end values and evaluated values was due to the *Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report* which can be found in Appendix C, Study 22. This study revealed that original planning estimates were based on early adopters in the program, which had unique characteristics and high savings rates. Subsequent participants were discovered to be saving at a lower level.

Variances in lifetime and annual demand are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3. Differences in participation levels also contribute to the variations seen in the demand values.

Cost effectiveness - TRC benefits were lower due to the lower electric savings described above while TRC costs were lower due to the lower spend on marketing also described above. The changes in net benefits and BCR were a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V study included in the Company's 2012 Annual Report that applies to this program is the:

- *Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report*
  This report includes impact findings of behavior/feedback programs and pilots administered by National Grid, NSTAR, Western Massachusetts Electric Company and Cape Light Compact during the 2012 program year. It also includes process findings for CLC's Smart Home Energy Monitoring Pilot ("SHEMP") from 2009-2012. The study also established savings estimate ratios to adjust implementer estimates in order to report savings in future years. The net effect of the study was to decrease savings for the Company. The full report is included in Section III Study 22.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Behavior Feedback program is cost-effective with a BCR of 1.09.

f. Residential ENERGY STAR Lighting

Purpose/Goal: The purpose of the ENERGY STAR Lighting program was to increase consumer awareness of the importance and benefits of purchasing ENERGY STAR-qualified lighting products and expand the availability, consumer acceptance, and use of high-quality energy-efficient lighting technologies and controls.

Targeted Customers: All residential electric customers were targeted by this program.

Definition of Program Participant: A participant is defined as a unique electric account served under this program. In the case of upstream lighting, participants are determined by dividing units by an agreed upon factor per measure, as set forth below.

Residential Lighting Assumptions

2012 Lighting program	Widget per Participant
Screw-in Bulbs	8
Screw-in Bulbs - Hard to reach	4
Screw-in Bulbs (Specialty bulbs)	8
LEDs	1
Indoor Fixture (incl. Torchieres)	2
Outdoor Fixture	2
LED Fixtures	1
Screw-in Bulbs - School Fundraiser	4

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses: Residential lighting

Delivery Mechanism: This program utilizes upstream incentives and an online catalog channel, which dramatically increased sales and lowered costs of product for the customer.

A manufacturer/retailer outreach contractor recruited and trained retailers to participate in the program, placed point-of-purchase materials and rebate coupons in participating retail stores, oversaw the Negotiated Cooperative Promotions ("NCP") process, and acted as a liaison for Program Administrators, manufacturers, and retailers.

A rebate fulfillment contractor collected data and payment requests from manufacturers, retailers, and consumers, processed rebate coupons and NCPs, and provided documentation to the Program Administrators for program tracking and evaluation purposes.

An Internet/mail-order sales channel contractor purchased and stocked products offered through the catalog and the Mass Save website, staffed a toll-free line for customers, and processed catalog and website purchases.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 164-172 (bates numbering 00170-00178). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.A.9 provides information on the performance of the Residential ENERGY STAR Lighting program.

Table II.A.9: ENERGY STAR Lighting

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	2,074,834			2,521,719		22%
Performance Incentive	$	141,750			240,966		70%
Participants	est. # of hhlds	108,375			135,204		25%
Program Cost / Participant	$	19			19		-3%
Savings & Benefits							
Energy							
Lifetime	MWh	98,343	136,820	39%	144,400	6%	47%
Annualized	MWh	13,514	17,138	27%	17,806	4%	32%
Average Measure Life	yrs	7.3	8.0	10%	8.1	2%	11%
Demand							
Lifetime	kW	10,351	14,483	40%	13,282	-8%	28%
Annualized							
Summer	kW	1,422	1,814	28%	1,754	-3%	23%
Winter	kW	2,897	3,696	28%	3,869	5%	34%
Average Measure Life	yrs	7.3	8.0		7.6		
NEB (Lifetime)	$	870,631	1,116,644	28%	1,116,066	0%	28%
Cost-Effectiveness							
TRC Benefits	$	11,898,874			17,054,703		43%
TRC Costs	$	2,423,644			4,383,496		81%
Net Benefits	$	9,475,230			12,671,207		34%
BCR	n/a	4.91			3.89		-21%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

> Expenses - The ENERGY STAR Lighting program experienced an increase in actual versus planned levels of program costs as the purchase of higher cost specialty and LED bulbs along with fixtures greatly exceed planned values. The participation shown above follows the increase in program cost and was also caused by the increased sales of specialty and LED bulbs.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits: Higher actual values than planned levels of specialty bulbs, indoor fixtures, and LED bulbs drove the increase in annual energy savings, lifetime NEBs, lifetime demand savings, and both annual summer and winter demand savings. In addition, LEDs and LED fixtures have long measure lives which increased both preliminary year-end lifetime kWh savings and lifetime Demand savings. There was no significant change due to evaluation results.

Cost-Effectiveness - Both TRC benefits and TRC costs increased due to the higher participation in the lighting program. Total TRC costs increased at a higher ratio than benefits due to higher cost of LED bulbs compared to planned TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are the:

- *Massachusetts Consumer Survey Results Winter-2012*
  This consumer survey was performed in December 2012 and January 2013 with the objective of tracking key lighting market indicators and understanding likely and actual consumer responses to the increased lighting efficiency standards mandated by the Energy Independence and Security Act of 2007 ("EISA"). The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III Study 4.

- *Residential Lighting Shelf Survey and Pricing Analysis*
  This evaluation included a light bulb shelf-stocking survey and a hedonic pricing regression analysis. The results of the shelf-stocking survey demonstrated that participating stores carry a greater proportion of energy-efficient CFLs and LEDs than incandescent or halogen bulbs. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 5.

- *Lighting Retailer, Supplier Perspectives on the Massachusetts ENERGY STAR Lighting Program*
  The study performed in-depth interviews with lighting manufacturers and high-level buyers and conducted surveys with store managers in order to understand their perceptions of the current impacts of EISA on the lighting market as well as to explore the perspectives on the growing LED market and program impacts on the lighting market. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 6.

- *Lighting Onsite Inventory and Saturation Study*
  The objective of this study was to perform lighting inventories and estimate socket saturations in Massachusetts homes. The study also examined lighting purchase behavior and searched for evidence of incandescent bulb stockpiling. Saturation of all energy-efficient light bulbs, including CFLs, LEDs, and fluorescent tubes, increased to 39 percent statewide in 2013. The results of this study will increase energy savings by increasing the number of bulbs found in indoor fixtures. The study is discussed in more detail in Section III, Study 7.

- *Massachusetts ENERGY STAR® Lighting Program: Early Impacts of EISA*
  The objective of this study was to interpret the results and effects of the first full-year of implementation of the increased lighting efficiency standards mandated by EISA on the Massachusetts residential lighting market. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 8.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Residential ENERGY STAR Lighting program is cost-effective with a BCR of 3.89.

g. Residential ENERGY STAR Appliances

Purpose/Goal: The purpose of the Residential ENERGY STAR Appliances program was to increase consumer awareness of the importance and benefits of purchasing ENERGY STAR-qualified appliances and electronic products, and expand the availability, consumer acceptance, and use of high-quality energy-efficient technologies.

Targeted Customers: All residential electric customers were targeted by this program.

Definition of Program Participant: A participant is defined as a unique electric account served under this program. For the upstream component of this program, a one-for-one assumption is made for television products and a two-for-one assumption is made for smart strips.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Refrigeration
- Process

Delivery Mechanism: The program utilizes upstream incentives and mail-in rebates, which dramatically increased sales and lowered costs of product for customers.

A manufacturer/retailer outreach contractor recruited and trained retailers to participate in the program, placed point-of-purchase materials and rebate forms in participating retail stores, oversaw the NCP process for televisions, and acted as a liaison for Program Administrators, manufacturers, and retailers.

A rebate fulfillment contractor collected data and payment requests from manufacturers, retailers and consumers, processed rebate applications and NCPs, and provided documentation to the Program Administrators for program tracking and evaluation purposes.

For recycling, the customer contacted a vendor either via internet or telephone to schedule a pick-up. The vendor then issued an incentive payment to the customer and properly disposed of the appliance.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 173-178 (bates numbering 00179-00184). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.A.10 provides information on the performance of the Residential ENERGY STAR Appliances program.

Table II.A.10: ENERGY STAR Appliances							
Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	304,298			520,460		71%
Performance Incentive	$	6,691			10,928		63%
Participants	unique accts	3,643			7,095		95%
Program Cost / Participant	$	84			73		-12%
Savings & Benefits							
Energy							
Lifetime	MWh	5,221	7,613	46%	7,731	2%	48%
Annualized	MWh	612	1,032	69%	1,052	2%	72%
Average Measure Life	yrs	8.5	7.4	-14%	7.3	0%	-14%
Demand							
Lifetime	kW	621	889	43%	1,217	37%	96%
Annualized							
Summer	kW	72	122	68%	184	51%	154%
Winter	kW	92	219	138%	229	5%	149%
Average Measure Life	yrs	8.6	7.3		6.6		
NEB (Lifetime)	$	67,543	37,456	-45%	37,456	0%	-45%
Cost-Effectiveness							
TRC Benefits	$	673,106			972,679		45%
TRC Costs	$	338,730			531,917		57%
Net Benefits	$	334,376			440,762		32%
BCR	n/a	1.99			1.83		-8%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - The higher than anticipated participation and total program costs were caused by all measure categories exceeding planned values except for refrigerator recycling. In addition, a higher than expected actual production of the smart strips measure increased the participation count over the planned value.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits - Annual and lifetime energy as well as demand savings were also impacted by the high number of participants. The smart strips measure has a shorter measure life compared to other planned measures in the program, and this causes a decline is average lifetime. This decline leads to higher increase in annual savings compared to lifetime savings. The program saw a decline in benefits because the lack of refrigerators recycled from planned, which was the primary source of lifetime NEBs.

Variances in evaluated lifetime and annual demand are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3. Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

Cost-Effectiveness - The program's TRC benefits and costs were also impacted by the higher than planned program participation. Net benefits also increased, but the product mix of actual measures versus planned measures impacted both TRC categories proportionately.

There were no evaluation studies pertaining to this program during 2012.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The residential ENERGY STAR Appliance program is cost-effective with a BCR of 1.83.

3. Residential Pilots

a. Deep Energy Retrofit

Description of Pilot/Specific Activities Intended to Study: The Deep Energy Retrofit pilot was implemented to investigate the potential for energy savings of at least 50 percent of total on-site energy use through deep retrofits of existing residential buildings and to identify incremental savings and how to reduce the costs and challenges associated with deep retrofits.

Why Implemented on Pilot Basis rather than as a Full Program: This initiative was offered as a pilot in order for the Program Administrators to study a new approach to achieving energy savings. The Program Administrators will analyze the information gathered from the pilot to determine market viability, cost-effectiveness, and, if applicable, adoption rates. Following completion of the pilot, the Program Administrators will utilize these pilot results to determine the future of the pilot and whether it will be adopted either as a stand alone program or as an additional measure offering within an existing program.

Targeted Customers: The pilot targeted home owners, property owners, and property managers considering renovations and willing to invest in extensive carbon reductions. In addition, the pilot targeted advanced building remodelers, architects, designers, trade allies, and others involved in renovation or restoration of residential buildings.

Definition of Program Participant: A participant is defined as a unique electric account served under this program.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- HVAC
- Hot Water
- Envelope
- End Use Behavior

Delivery Mechanism: Project design details and assistance to the Deep Energy Retrofit contractors performing the work the work was handled through technical specialist contractor, program manager and organizations under contract and/or utilizing Department of Energy Building America funds.

Significant Differences in Actual Program Design from Approved Program Design: None.

How Achievement of the Pilot's Stated Goal was Measured: The overall goal of the pilot was to attract participants into this "broader and deeper" energy-savings initiative, knowing that costs and project complexities can be barriers to deep energy retrofit participation. Ultimately, achievement of this goal is measured by the pilot's cost-effectiveness. Based on data collected and evaluated, the Deep Energy Retrofit pilot was not deemed to be cost effective. Thus, in 2012, WMECo discontinued the pilot. However, the Company did fulfill financial commitments for those projects that began in 2011 and were completed in 2012. Going forward, the Company is exploring ways to incorporate deeper measures into the HES program on a more prescriptive basis as a result of experience gained from the pilot. The PAs are currently investigating the cost effectiveness of three different DER packages and will incorporate them into the 2014 HES offering if proven to be cost effective. Due to the high costs of DER projects and the lengthy amount of time needed to complete the project, the Company believes that developing packages that address shell improvements which can be done in stages over a period of years may make the most sense.

Docket/Exhibit where the Program is Discussed and Approved: The pilot is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 158-163 (bates numbering 00164-00169). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.A.11 provides information on the performance of the Deep Energy Retrofit pilot. Because of the nature of pilot programs, the table for this pilot program is incomplete with regard to savings and benefits. The Company has provided all information that is available.

Table II.A.11: Deep Energy Retrofit							
Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	118,949			44,657		-62%
Participants	unique accts	n/a			1		n/a
Program Cost / Participant	$	n/a			44,657		n/a
Savings & Benefits							
Energy							
Lifetime	MWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized	MWh	n/a	n/a	n/a	n/a	n/a	n/a
Average Measure Life	yrs	n/a	n/a	n/a	n/a	n/a	n/a
Demand							
Lifetime	kW	n/a	n/a	n/a	n/a	n/a	n/a
Annualized							
Summer	kW	n/a	n/a	n/a	n/a	n/a	n/a
Winter	kW	n/a	n/a	n/a	n/a	n/a	n/a
Average Measure Life	yrs	n/a	n/a	n/a	n/a	n/a	n/a
NEB (Lifetime)	$	n/a	n/a	n/a	n/a	n/a	n/a
Cost-Effectiveness							
TRC Benefits	$	n/a			n/a		n/a
TRC Costs	$	118,949			44,657		-62%
Net Benefits	$	n/a			n/a		n/a
BCR	n/a	n/a			n/a		n/a

There was no EM&V study for this pilot in 2012.

As noted above, the Deep Energy Retrofit pilot was not cost-effective and the Company discontinued the pilot in 2012.

B. Low-Income Sector Programs

1. Summary

During 2012 the Company implemented the following low-income programs and associated initiatives: [7]

- Low-Income Residential New Construction
- Low-Income Retrofit[8]
  - Low-Income 1-4 Family
  - Low-Income Multi-Family

[7] The Company did not offer any pilot programs in the low-income sector during 2012. However, low-income new construction customers were eligible for the residential Multi-Family 4-8 story pilot. Please see the residential pilot descriptions.

[8] In their 2012 Mid-Term Modification filings the Program Administrators proposed a consolidation of the low-income single-family retrofit and low-income multi-family retrofit programs in order to form one low-income retrofit program, noting the expected benefits of increasing flexibility to meet customer needs.

Tables II.B.1 through II.B.3 provide summary information on the performance of the low-income programs at the sector, end use, and program/initiative levels, respectively.

Table II.B.1: Low-Income Sector Summary

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	4,355,186			4,519,790		4%
Performance Incentive	$	236,549			274,468		16%
Savings & Benefits							
Energy							
Lifetime	MWh	37,088	31,959	-14%	34,982	9%	-6%
Annualized	MWh	3,507	3,625	3%	3,378	-7%	-4%
Demand							
Lifetime	kW	3,896	2,974	-24%	3,917	32%	1%
Annualized							
Summer	kW	350	285	-19%	313	10%	-10%
Winter	kW	763	611	-20%	928	52%	22%
NEB (Lifetime)	$	9,079,841	8,475,049	-7%	11,713,495	38%	29%
Cost-Effectiveness							
TRC Benefits	$	13,204,268			15,670,157		19%
TRC Costs	$	4,570,715			4,840,416		6%
Net Benefits	$	8,633,553			10,829,741		25%
BCR	n/a	2.89			3.24		12%

As shown in Table II.B.1 above, significant variances exist at the low-income sector level for lifetime kW between planned values and preliminary year-end and evaluated values; Winter kW between planned, preliminary year-end, and evaluated values; NEBs between planned and preliminary year-end values and evaluated values; and TRC benefits, net benefits, and BCR between planned and evaluated values. The reasons for such variances are described below:

- Variances in lifetime kW and winter kW are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3. Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

- The variances seen in the NEBs category was due to a change in the rate differential between low-income and market rate residential customers, and an increase in oil savings from the *Low Income Single Family Program Impact Evaluation* submitted in the Company's 2011 Annual Report.

- The changes in net benefits are a mathematical result of the changes in the TRC benefits and TRC costs.

A more detailed program-level discussion can be found in Section II.B.2.

Table II.B.2: Low-Income Sector Summary of End Uses				
End Uses	Units (lifetime)	**Preliminary Year-End Results**	**Evaluated Results**	**% Change from Preliminary to Evaluated**
Lighting				
Energy	MWh	11,836	12,508	6%
Demand	kW	959	582	-39%
NEB	$	244,780	435,311	78%
HVAC				
Energy	MWh	585	404	-31%
Demand	kW	24	22	-7%
NEB	$	1,139,560	1,600,843	40%
Behavior				
Energy	MWh	1,801	235	-87%
Demand	kW	174	37	-79%
NEB	$	10,769	319,639	2868%
Refrigeration				
Energy	MWh	14,885	10,036	-33%
Demand	kW	1,781	1,245	-30%
NEB	$	154,190	571,082	270%
Hot Water				
Energy	MWh	282	270	-4%
Demand	kW	27	38	40%
NEB	$	267,288	258,098	-3%
Envelope				
Energy	MWh	2,570	11,529	349%
Demand	kW	10	1,994	20409%
NEB	$	6,658,462	8,528,521	28%
Total				
Energy	MWh	31,959	34,982	9%
Demand	kW	2,974	3,917	32%
NEB	$	8,475,049	11,713,495	38%

The variances in Table II.B.2 are categorized by end use. It is difficult to isolate the reason for the change from planed values to evaluated values by end use because end uses stretch across many different programs that have various delivery methods, savings, NTG factors, NEBs, and costs. Therefore, these variances are explained in the context of program variances. See Section II.B.2 for further information.

Table II.B.3: Low-Income Program Summary				
Sector	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Low-Income Residential New Construction				
TRC Benefits	$	517,391	120,189	-77%
TRC Costs	$	152,397	88,893	-42%
Net Benefits	$	364,994	31,296	-91%
BCR	n/a	3.40	1.35	-60%
Low-Income Retrofit				
TRC Benefits	$	12,686,877	15,549,968	23%
TRC Costs	$	4,351,407	4,692,470	8%
Net Benefits	$	8,335,470	10,857,498	30%
BCR	n/a	2.92	3.31	14%
Hard-to-Measure Initiatives				
TRC Costs	$	66,911	59,053	-12%
TOTAL				
TRC Benefits	$	13,204,268	15,670,157	19%
TRC Costs	$	4,570,715	4,840,416	6%
Net Benefits	$	8,633,553	10,829,741	25%
BCR	n/a	2.89	3.24	12%

In the Low-Income Residential New Construction program there were significant variances in nearly all categories in both preliminary year-end and evaluated results, which triggers the variance in TRC benefits and TRC costs. This was predominantly driven by lower than expected participation in the program. Please reference section II.B.4 for a more detailed discussion of the cause of the variances in this program.

In the Low-Income Retrofit program, there were variances in TRC benefits due to higher than expected NEBs and demand savings which also affected the net benefits and BCR of the program. Please refer to section II.B.5 for a more detailed discussion of the cause of the variances in this program.

Low-Income Sector Performance Highlights

Low-Income Residential New Construction

The Low-Income Residential New Construction Program provided incentives to low-income low-rise and high-rise projects. Incentives were based on final achieved and verified performance of the participating project. The program also provided additional incentives for high efficiency gas and cooling equipment, along with compact fluorescent lamps and appliance rebates.

Low-Income Retrofit

In 2012, the Program Administrators continued to leverage funds from the Department of Energy's Weatherization Assistance Program that is administered by the Department of Community Development for their low-income energy efficiency programs. This approach provided simplicity through a seamless, integrated experience for the participants, deeper efficiency penetration consistent with a whole house/building approach, as well as the ability to reach as many low-income residents as practicable with the greatest amount of eligible services.

In addition to public housing authorities and non-profit facilities, "for profit" multi-family facilities were also eligible to participate in the Low-Income Multi-Family Retrofit initiative in 2012, as long as 50 percent of the occupants qualified as low-income, and provided that the PA had budget dollars to serve this new market in its territory.

A more detailed discussion of each of the above programs follows.

2. Low-Income Programs

a. Low-Income New Construction

Purpose/Goal: The purpose of the Low-Income New Construction program was to encourage the construction of energy-efficient homes, and drive the market to one in which new homes are moving towards near-zero energy.

Targeted Customers: The target market for this program included homebuilders, contractors, architects/designers, trade allies, HERS raters, homebuyers, realtors, developers, low-income and affordable housing developers, code officials, and consumers in the market for new homes and/or major renovations.

Definition of Program Participant: A participant is defined as a unique electric account served under this program. For the low-income new construction program, the account represents a newly constructed dwelling unit.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- HVAC
- Refrigeration
- Hot Water
- Envelope

Delivery Mechanism: The program is administered by each Program Administrator in its service territory and coordinated regionally through the JMC.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 202-208 (bates numbering 00208-00214). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.B.4 provides information on the performance of the Low-Income New Construction program.

Table II.B.4: Low-Income Residential New Construction

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	144,260			41,468		-71%
Performance Incentive	$	8,137			1,266		-84%
Participants	unique accts	26			15		-42%
Program Cost / Participant	$	5,548			2,765		-50%
Savings & Benefits							
Energy							
Lifetime	MWh	568	146	-74%	147	1%	-74%
Annualized	MWh	76	19	-75%	19	1%	-75%
Average Measure Life	yrs	7.5	7.9	5%	7.8	-1%	4%
Demand							
Lifetime	kW	105	35	-67%	35	0%	-67%
Annualized							
Summer	kW	10	3	-72%	3	1%	-72%
Winter	kW	16	4	-76%	5	22%	-70%
Average Measure Life	yrs	10.7	12.7		12.6		
NEB (Lifetime)	$	445,606	97,981	-78%	100,071	2%	-78%
Cost-Effectiveness							
TRC Benefits	$	517,391			120,189		-77%
TRC Costs	$	152,397			88,893		-42%
Net Benefits	$	364,994			31,296		-91%
BCR	n/a	3.40			1.35		-60%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - The variance in total program costs was caused by less than expected expenditures on participant incentives. Participation, and by extension participant incentive, in this program was significantly lower than had been planned due to a delay in a large project that was expected to be finished by the end of the year but was not completed. Program cost per participant was lower than expected due to the significantly lower overall program costs.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive

allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings & Benefits - Variances in lifetime and annual energy savings between planned values and preliminary year-end and evaluated values were caused by the lower than anticipated participation in the program.

Variances in lifetime and annual demand are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Appendix B, Section 3. Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

Variances in NEB values between planned values and preliminary year-end and evaluated values were also caused by the lower than anticipated participation in the program described above.

Cost-Effectiveness - TRC benefits and costs were both driven lower by decreased participation in the program. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are the:

- *Lighting Onsite Inventory and Saturation Study*
  The objective of this study was to perform lighting inventories and estimate socket saturations in Massachusetts homes. The study also examined lighting purchase behavior and searched for evidence of incandescent bulb stockpiling. Saturation of all energy-efficient light bulbs, including CFLs, LEDs, and fluorescent tubes, increased to 39 percent statewide in 2013. The results of this study will increase energy savings by increasing the number of bulbs found in indoor fixtures. The study is discussed in more detail in Section III, Study 7.

- *Status of Ongoing Low Income Lighting and Heating Metering Study*
  This study assesses lighting hours of use and the prevalence of secondary heating in low-income households in Massachusetts. The two overarching objectives of the study are to determine a daily low income-specific lighting hours-of-use ("HOU") value to replace the current assumption, and to determine the prevalence of low-income customers who use a secondary heating source to warm their homes (and how best to incorporate secondary heating usage into future evaluations). These results are preliminary; the study is ongoing and will be finalized by early September. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study11.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan.

With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Low-Income New Construction program is cost effective with a BCR of 1.35.

b. Low-Income Retrofit Program

Purpose/Goal: Two initiatives, the Low-Income 1-4 Family Retrofit initiative and the Low-Income Multi-Family ("LIMF") Retrofit initiative, were incorporated in the Low-Income Retrofit program in 2012.

The purpose of the Low-Income 1-4 Family Retrofit initiative was to increase energy efficiency and reduce the energy cost burden for income-eligible customers through the installation of electric, oil, and propane energy efficiency measures to achieve deeper and broader energy savings consistent with a comprehensive, whole house approach.

The purpose of Low-Income Multi-Family Retrofit was to deliver energy efficient products and services directly to income-eligible residential customers living in multi-family facilities with five or more dwelling units.

Targeted Customers: The Low-Income 1-4 Family Retrofit initiative targeted residential customers living in one- to four-unit dwellings who were at or below 60 percent of the state median income level and who qualified to receive fuel assistance and/or utility discount rate(s). For two- to four-unit dwellings, 50 percent of the occupants had to qualify as low-income.

The LIMF Retrofit initiative targeted public housing authorities, non-profit housing developers, for-profit housing developers, landlords, property managers, and residential customers at, or below, 60 percent of median income living in multi-family properties consisting of five or more units.

Definition of Program Participant: A participant is defined as a unique electric account served under this initiative. The unique account is tied to the low-income audit.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- Heating and Ventilation
- Refrigeration
- Hot Water
- Envelope

Delivery Mechanism: PAs used a lead vendor and/or worked closely with their respective Community Action Program ("CAP") agencies on all aspects of the program design and implementation. All PAs worked in conjunction with the Low Income Energy Affordability Network ("LEAN"). The Multi-Family Advisory Committee was tasked with prioritizing low-income multi-family projects for each PA, using benchmarking software called WegoWise. The lead vendor/CAP agencies were responsible for providing coordination of energy efficiency services to the customers, working with installation contractors to ensure that the proper initiative guidelines were enforced, ensuring that the customers met the eligibility requirements for program participation, and providing the CAP and/or PA with the required documentation of all work performed.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 209-230 (bates numbering 00215-00236). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.B.5 provides information on the performance of the Low-Income Retrofit program.

Table II.B.5: Low-Income Retrofit

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	4,144,015			4,419,268		7%
Performance Incentive	$	228,412			273,202		20%
Participants	# of audits	2,970			2,610		-12%
Program Cost / Participant	$	1,395			1,693		21%
Savings & Benefits							
Energy							
Lifetime	MWh	36,520	31,813	-13%	34,834	9%	-5%
Annualized	MWh	3,431	3,607	5%	3,359	-7%	-2%
Average Measure Life	yrs	10.6	8.8	-17%	10.4	18%	-3%
Demand							
Lifetime	kW	3,791	2,939	-22%	3,882	32%	2%
Annualized							
Summer	kW	340	282	-17%	311	10%	-9%
Winter	kW	747	607	-19%	923	52%	24%
Average Measure Life	yrs	11.2	10.4		12.5		
NEB (Lifetime)	$	8,634,235	8,377,068	-3%	11,613,424	39%	35%
Cost-Effectiveness							
TRC Benefits	$	12,686,877			15,549,968		23%
TRC Costs	$	4,351,407			4,692,470		8%
Net Benefits	$	8,335,470			10,857,498		30%
BCR	n/a	2.92			3.31		14%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Cost per participant increased because costs were slightly higher but with somewhat fewer participants to spread those costs over.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings & Benefits - Variances in lifetime and annual demand are due to new load shapes referenced in the *2012 Program Year - Report Version of the Massachusetts Technical Reference Manual*. See Differences in participation levels and measure mix also contribute to the variations seen in the demand values.

The increase in NEB values between planned and preliminary year-end values and evaluated values was due to a change in rate differentials between low-income and market rate customers as a result of recent regulatory proceedings. Additionally, an increase in oil savings from the *Low Income Single Family Program Impact Evaluation* submitted in the Company's 2011 Annual Report contributed to higher NEBs.

Cost Effectiveness - The increase in TRC benefits is attributable to the increase in NEBs and demand savings highlighted above. The changes in net benefits are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V study included in the Company's 2012 Annual Report that applies to this program is the:

- *Status of Ongoing Low Income Lighting and Heating Metering Study*
  This study assesses lighting hours of use and the prevalence of secondary heating in low-income households in Massachusetts. The two overarching objectives of the study are to determine a daily low income-specific lighting HOU value to replace the current assumption, and to determine the prevalence of low-income customers who use a secondary heating source to warm their homes (and how best to incorporate secondary heating usage into future evaluations). These results are preliminary; the study is ongoing and will be finalized by early September. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study11.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The Low-Income Retrofit program is cost effective with a BCR of 3.31.

C. Commercial and Industrial Sector Programs

1. Summary

During 2012 the Company implemented the following Commercial and Industrial ("C&I") programs:

- C&I New Construction and Major Renovation
- C&I Large Retrofit
- C&I Small Retrofit

The Company did not offer any C&I pilots in 2012.

Tables II.C.1 through II.C.3 provide summary information on the performance of the C&I programs at the sector, end use, and program levels, respectively.

Table II.C.1: C&I Sector Summary

Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	18,499,010			16,501,597		-11%
Performance Incentive	$	1,093,712			890,935		-19%
Savings & Benefits							
Energy							
Lifetime	MWh	706,386	519,229	-26%	511,880	-1%	-28%
Annualized	MWh	51,875	39,727	-23%	38,969	-2%	-25%
Demand							
Lifetime	kW	107,605	76,703	-29%	71,432	-7%	-34%
Annualized							
Summer	kW	7,887	6,197	-21%	5,719	-8%	-27%
Winter	kW	4,745	4,659	-2%	4,616	-1%	-3%
NEB (Lifetime)	$	(6,257,471)	(2,126,705)	-66%	7,397,684	448%	218%
Cost-Effectiveness							
TRC Benefits	$	88,117,250			73,750,319		-16%
TRC Costs	$	28,480,304			20,381,513		-28%
Net Benefits	$	59,636,946			53,368,806		-11%
BCR	n/a	3.09			3.62		17%

As shown in Table II.C.1 above, significant variances exist at the C&I sector level in the Savings & Benefits, and Cost-Effectiveness categories. The reasons for such variances between planned, preliminary year-end, and evaluated values are described below.

- Lower lifetime and annual MWh savings were driven mostly by reduced participation in the C&I New Construction & Major Renovation program and the C&I Retrofit program. The C&I New Construction & Major Renovation program experienced decreases in participation and associated savings as difficult economic conditions persisted, especially in the western part of the state which is heavily dependent on industrial production.

- Differences in demand savings were attributable to changes in anticipated participation and changes in load shapes due to updated evaluation studies.

- Decreases in negative NEBs values are largely the result of differences in gas/oil resource NEI mix and the results of impact evaluations like the *Impact Evaluation of 2011 Prescriptive Lighting Installations* and *C&I Non-Energy Impacts Study*.

- Decreases in TRC costs are primarily the result of lower than anticipated participant incentives from lower participation.

Table II.C.2: C&I Sector Summary of End Uses				
End Uses	Units (lifetime)	**Preliminary Year-End Results**	**Evaluated Results**	**% Change from Preliminary to Evaluated**
Lighting				
Energy	MWh	272,031	288,613	6%
Demand	kW	55,672	53,757	-3%
NEB	$	-1,881,797	3,967,160	-311%
HVAC				
Energy	MWh	120,857	111,237	-8%
Demand	kW	11,412	10,533	-8%
NEB	$	-244,908	1,546,943	732%
Motors				
Energy	MWh	70,268	53,612	-24%
Demand	kW	2,047	2,041	0%
NEB	$	0	0	0%
Refrigeration				
Energy	MWh	39,010	45,567	17%
Demand	kW	4,474	3,113	-30%
NEB	$	0	1,874,826	0%
Hot Water				
Energy	MWh	0	0	0%
Demand	kW	0	0	0%
NEB	$	0	0	0%
Process				
Energy	MWh	0	0	0%
Demand	kW	0	0	0%
NEB	$	0	0	0%
Compressed Air				
Energy	MWh	6,418	6,316	-2%
Demand	kW	1,502	973	-35%
NEB	$	0	8,755	0%
CHP				
Energy	MWh	0	0	0%
Demand	kW	0	0	0%
NEB	$	0	0	0%
Total				
Energy	MWh	508,584	505,345	-1%
Demand	kW	75,106	70,416	-6%
NEB	$	-2,126,705	7,397,684	448%

The variances in Table II.C.2 are categorized by end use. It is difficult to isolate the reason for the change from planed values to evaluated values by end use because end uses stretch across many different programs that have various delivery methods, savings, NTG factors, NEBs, and costs. Therefore, these variances are explained in the context of program variances. See Section II.C.2 for further information.

Table II.C.3: C&I Program Summary				
Sector	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
C&I New Construction and Major Renovation				
TRC Benefits	$	28,050,504	24,014,032	-14%
TRC Costs	$	5,568,040	5,445,024	-2%
Net Benefits	$	22,482,464	18,569,007	-17%
BCR	n/a	5.04	4.41	-12%
C&I Large Retrofit				
TRC Benefits	$	43,943,369	27,846,831	-37%
TRC Costs	$	15,044,503	7,393,337	-51%
Net Benefits	$	28,898,866	20,453,494	-29%
BCR	n/a	2.92	3.77	29%
C&I Small Retrofit				
TRC Benefits	$	16,123,376	21,889,456	36%
TRC Costs	$	7,668,569	7,391,620	-4%
Net Benefits	$	8,454,807	14,497,836	71%
BCR	n/a	2.10	2.96	41%
Hard-to-Measure Initiatives				
TRC Costs	$	199,192	151,531	-24%
TOTAL				
TRC Benefits	$	88,117,250	73,750,319	-16%
TRC Costs	$	28,480,304	20,381,513	-28%
Net Benefits	$	59,636,946	53,368,806	-11%
BCR	n/a	3.09	3.62	17%

The variances in Table II.C.3 are by program and are discussed in more detail in Section II.C.2.

C&I Sector Performance Highlights

During 2012, the Program Administrators built upon existing C&I programs and significantly expanded initiatives to increase participation across all C&I programs. Selected highlights are presented below:

- **Proactive Research of Emerging Technologies** – In 2012, the Massachusetts Technical Advisory Committee ("MTAC"), the entity designed to field inquiries on the appropriateness of new technologies to be offered under the Massachusetts programs, achieved several key milestones. First, discussions were initiated in 2012 regarding the merger of the separate residential and C&I committees in order to evaluate promising new technologies in a consistent statewide manner. These committees merged in 2013. Second, in 2012, the MTAC reviewed 18 commercial natural gas and electric technologies and approved three as eligible

for energy efficiency incentives under the Mass Save program.[9] Third, the energy use of major medical equipment in the healthcare sector, such as Magnetic Resonance Imaging (MRI) machines and other energy intensive medical equipment was evaluated. The MTAC provided the vehicle for investigating opportunities for this sector and contracted with the Fraunhofer Center for Sustainable Energy Systems for this analysis in 2012. [10]

Another important technology evaluated by the MTAC was rooftop unit controls for existing packaged cooling and heating equipment. C&I buildings typically have multiple packaged units with no control communication between these units. The potential for both natural gas and electric savings appears very promising, and initial inquiries indicate that there are thousands of applicable units in the Commonwealth that could benefit from this technology. Cape Light Compact provided an initial test site in 2012 and the MTAC has hired an independent consulting engineer to perform before and after monitoring of this site. (A report was issued in the first quarter of 2013 and this technology went on to be approved for implementation later in 2013.)

- **Refinements to Upstream Lighting Initiative** – 2012 was the first full year of operation for the Upstream Lighting Initiative, known to customers as "Bright Opportunities." After a dramatic customer response upon roll out in late 2011, the initiative continued to garner high volume throughout 2012, yielding over 21,000 participants and more than $18 million in buy downs paid statewide for high efficiency linear fluorescents and LED lamps. During 2012, a number of new LED lamp types were added to the initiative, substantially expanding the variety of possible applications for participating customers to use this technology. By the second quarter, the LED product selection had been expanded to include A-lamps, PAR Lamps in three sizes, MR16s, and decorative fixture lamps for chandeliers.

  As part of the initiative's early success, program LED lamp prices dropped sufficiently that the PAs lowered incentives for certain lamps and enacted a minimum threshold customer contribution to ensure that the discounted product held value for participants, as manufacturers and distributors were able to lower their margins with increased volumes. Additionally, the PAs proactively addressed the rare earth shortage and the subsequent material price increases that impacted the lighting industry in late 2011 and 2012. By monitoring market pricing changes, the PAs increased incentives for eligible linear fluorescent lamps to reduce the incremental cost between standard and high-efficiency lamps.

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[9] Of the other 15 technologies considered by MTAC in 2012, three were denied approval; the remaining 12 were continued into 2013 for additional evaluation – either in field monitoring studies or because the MTAC was awaiting additional documentation from applicants.

[10] The final Fraunhofer report, presented in early 2013, demonstrated savings opportunities exist primarily in powering down machinery between uses rather than making changes to equipment specifications for lower energy use during operation. Such changes to hospital operating protocols would require recertification of equipment operators and procedures, thus limiting the accessibility of such savings.

The high participation levels experienced in 2012 were the result of a number of promotional efforts undertaken by the PAs. A special college LED promotion led to 75,000 LED lamps being installed in college dorm rooms across Massachusetts. Another effort targeted state and municipal facilities and yielded more than 120,000 reduced wattage T8 lamps. *Preferred Distributor* recognition, along with higher incentives, was also developed to stimulate demand for the program's linear fluorescent products, resulting in an increase of 1 million units in Q3/Q4 of 2012.

Quality control and quality assurance ("QA/QC") was another key component of this initiative in 2012. The PAs issued an RFP for a QA/QC vendor in early 2012 and awarded contract to CRI. Starting in the third quarter of 2012, CRI began inspecting five percent of participant sites on a monthly basis to verify the installation of lamps purchased through the program, as well as to gather field data on wattage of lamps replaced and customer satisfaction with the upstream products, particularly with regard to LEDs installed in dimming applications.

- **Development of Upstream HVAC** – In 2012, the PAs began development work to expand the upstream program to also include HVAC measures in 2013. The development team researched existing programs around the country, including having in depth discussions with administrators in California who have a long standing successful upstream HVAC program. The team then decided to proceed with a concept that would take Mass Save's existing Cool Choice program completely upstream, so that C&I customers seeking packaged HVAC or heat pump units could find higher efficiency units available at their distributor without having to pay a premium for that efficiency. A full scale C&I program RFP was issued in November 2012 (with the option to add a residential program at a later date), and bid proposals were received from three prospective suppliers. (Contract award and program launch occurred in the first half of 2013.)

- **Market Characterization and Segmentation** – NU and National Grid led an effort to characterize the market for energy efficiency for the term of the 2013-2015 Plan, through a study performed by the consulting firm Point 380 in 2012. The Point 380 study results are, and will continue to be, used to inform the PAs "go-to-market" strategies by identifying the industries, building types and end uses representing greater efficiency opportunities and thus warranting relatively greater attention and allocation of resources. The results also greatly support sales force planning, while enabling more relevant and effective value propositions to better meet specific customers' needs. The Point 380 materials were shared with all Program Administrators, who have each benefited from this effort. NU and National Grid made a joint presentation to the Council summarizing the Point 380 study, which is available at http://www.ma-eeac.org.

  In order to achieve greater participation and savings, the Program Administrators have increasingly used market segmentation to inform go-to-market strategies. Based on the specific characteristics of defined segments, marketing approaches, delivery systems, value propositions and offerings can be customized to better

meet the needs and interests of individual companies in those segments. For example, the PAs began developing specific offerings and marketing collateral to better serve the needs of grocers.

Appreciative Inquiry Summit – In May 2012, the PAs hosted an Appreciative Inquiry Summit, the first of its kind for energy efficiency in Massachusetts, which provided a venue for a diverse array of nearly 300 key stakeholders in attendance. Many C&I customers, contractors and experts participated in this event and provided insight into their view of the programs and recommendations to improve the delivery of energy efficiency in Massachusetts.

- **Development of the 2013-2015 Three-Year Energy Efficiency Plan** - Throughout much of 2012, the PAs were actively involved in developing the 2013-2015 three-year plan. Two primary focal points of the 2013-2015 three-year plan were reviewed during this process in 2012, including: new strategies to increase breadth of participation, as well as the comprehensiveness of efficiency projects.

  The strategies explored included: expanded service offerings targeted at smaller customers to enable self-service participation options; community-based engagement built upon the Main Streets model; expanding the upstream delivery model to non-lighting technologies; greater use of segmentation approaches to develop customized offerings to encourage greater comprehensiveness among specific subsets of customers such as hospitals and municipalities; an accelerated rebate pilot for the top five electric and gas customers; and exploration of options for inclusion of utility-owned LED street lighting in programs.

A more detailed program-level discussion can be found in the following sections.

2. C&I Programs

a. C&I New Construction and Major Renovation

Purpose/Goal: The C&I New Construction and Major Renovation program was designed to optimize the efficiency of equipment, building design and systems in new construction and renovation of commercial, industrial, institutional and government facilities. Focusing on offering a comprehensive set of electric and gas efficiency options specific to the needs unique to each customer, the program also targeted the brief window of opportunity to install premium grade replacements when equipment fails or is near the end of its useful life. In doing so, the Program Administrators worked to ensure that the best practices propagated by the program are ultimately built into the evolution of better building requirements.

Targeted Customers: The target market for this program was all time-dependent gas and electric energy efficiency opportunities in the C&I sector including commercial, industrial, institutional, and government customers.

Definition of Program Participant: A program participant is defined as an individual project undertaken by a customer who has received a financial incentive for the completed implementation of one or more time- dependent electric energy efficiency measures. One customer may undertake multiple projects at different locations during the program year. Each project is therefore counted as an individual participant.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- Motors & Drives
- HVAC
- Refrigeration
- Envelope
- Compressed Air
- Hot Water
- Process

Delivery Mechanism: The Program Administrators worked together to market and implement the program as a unitary statewide effort to maximize the acquisition of potential energy savings (gas and electric) in the ongoing market for new facilities and replacement equipment in the Commonwealth.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where the Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 243-254 (bates numbering 00249-00260). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.C.4 provides information on the performance of the C&I New Construction and Major Renovation program.

Table II.C.4: C&I New Construction and Major Renovation							
Performance Category	**Units**	**Planned Value**	**Preliminary Year-End Results**		**Evaluated Results**		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	5,018,787			4,133,453		-18%
Performance Incentive	$	364,861			298,656		-18%
Participants	# of projects	138			98		-29%
Program Cost / Participant	$	36,368			42,178		16%
Savings & Benefits							
Energy							
Lifetime	MWh	208,871	206,182	-1%	180,192	-13%	-14%
Annualized	MWh	15,315	15,458	1%	13,405	-13%	-12%
Average Measure Life	yrs	13.6	13.3	-2%	13.4	1%	-1%
Demand							
Lifetime	kW	33,607	35,701	6%	30,388	-15%	-10%
Annualized							
Summer	kW	2,351	2,907	24%	2,465	-15%	5%
Winter	kW	1,615	2,384	48%	2,064	-13%	28%
Average Measure Life	yrs	14.3	12.3		12.3		
NEB (Lifetime)	$	-467,790	-300,398	36%	-195,099	35%	58%
Cost-Effectiveness							
TRC Benefits	$	28,050,504			24,014,032		-14%
TRC Costs	$	5,568,040			5,445,024		-2%
Net Benefits	$	22,482,464			18,569,007		-17%
BCR	n/a	5.04			4.41		-12%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows:

Expenses - Participation variance in this program is largely attributed to fewer than expected new construction and time dependent projects as a result of economic conditions, which has uniquely affected the western part of Massachusetts.

Savings and Benefits - Variances in demand savings are due to a variety of factors including: changes in participation, a project mix more heavily weighted in peak oriented kW savings, and new demand savings factors and coincident factors from a series of impact evaluations. These evaluations include those impact evaluations listed below in the next section, as well as the *Impact Evaluation of 2010 Custom Process and Compressed Air Installations* and *Impact Evaluation of 2010 Custom Lighting Installations*.

The variance in NEBs from planned values to preliminary year-end values is due to differences between the planned and actual gas/oil negative resource NEI mix. Differences in the evaluated results are largely the result of revised heating penalty values produced by *The Impact Evaluation of 2010 Prescriptive Lighting Installations*, which were less than the values previously carried due to a lower market presence of heat producing products like incandescent bulbs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are as follows:

- *Impact Evaluation of 2011-2012 Prescriptive VSDs*
  This study produced realization rates for annual kWh for prescriptive Variable Speed Drives ("VSDs"). The study decreased program savings for the Company's 2012 evaluated results. This study is discussed in more detail in Section III, Study 13.

- *Impact Evaluation of 2010 Prescriptive Lighting Installations*
  This study evaluated the large C&I prescriptive lighting end-use, which includes all lighting systems and controls, Advanced Lighting Design or performance lighting, and refrigerated LED case lights. The study presents realization rates for gross energy savings, on-peak and seasonal summer and winter demand savings, and coincidence factors at the statewide level using 12 months of metered data. The net effect for the Company was to increase energy savings for this program. The study is discussed in more detail in Section III, Study 14.

- *Impact Evaluation of 2011 Custom Refrigeration, Motor and Other Installations*
  This study produces realization rates for annual kWh, summer and winter peak kW, and percent on peak for the large C&I custom electric component of refrigeration, motors, and "other" measure types. The net effect for the Company was to decrease energy savings for this program. This study is discussed in more detail in Section III, Study 15.

- *Process Evaluation of the 2012 Bright Opportunities Program*
  This study was a process evaluation of the Bright Opportunities initiative which provides "upstream" incentives to distributors of energy efficient lamps and bulbs. The evaluation studied the design and delivery of the initiative, barriers to the adoption of efficient lighting technologies under this design, advantages of an "upstream" design versus a "downstream" design, and provided an estimated net-to-gross ratio based on free-ridership and spillover. The net-to-gross ratio impacted the 2012 savings and resulted in an overall decrease in savings for the Company. The study is discussed in more detail in Section III, Study 16.

- *C&I Customer Profile Project*
  This study characterizes the Massachusetts energy efficiency market by analyzing recent customer usage and program participation data. The study relied on comprehensive billing and tracking data for all C&I customers to estimate the extent to which customers of various sizes and types participated in energy efficiency programs in 2011. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 17.

- *Mid-Sized Customer Needs Assessment - Interim Results*
  The study is investigating the extent to which current program offerings effectively serve the needs of mid-sized customers by conducting interviews with PAs and implementation contractors and analyzing available customer billing and tracking data to examine differences in participation rates across customer size groups. The interim results of this study do not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 18.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The C&I New Construction and Major Renovation program is cost-effective with a BCR of 4.41.

b. C&I Large Retrofit

Purpose/Goal: The C&I Large Retrofit program focused on comprehensive gas and electric energy efficiency opportunities associated with mechanical, electrical, and thermal systems in existing commercial, industrial, governmental and institutional buildings. Through this program, technical assistance and incentives were provided to encourage retrofitting of equipment that continued to function, but was outdated and inefficient, and could be replaced with a premium efficient product. In addition, this program helped participants identify specific peak load management opportunities and assisted occupants in improving their ongoing operation and maintenance practices.

Targeted Customers: The target market for this program was all non-residential customers – commercial, industrial, governmental, and institutional.

Definition of Program Participant: A program participant is defined as an individual project undertaken by a customer who has received a financial incentive for the completed implementation of one or more electric energy efficiency measures. One customer may undertake multiple projects at different locations during the program year. Each project is therefore counted as an individual participant.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- Motors and Drives
- HVAC
- Compressed Air and Processes
- Envelope
- Water Heating
- Combined Heat & Power

Delivery Mechanism: Program Administrator staff, trade allies and project administrators performed most sales, marketing, program administration, and implementation functions, while outside contractors were retained for technical review of applications, on-site energy analysis, technical and design assistance for comprehensive projects, project commissioning services, and the actual measure installations, including turn-key services.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 231-242 (bates numbering 00237-00248). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.C.5 provides information on the performance of the C&I Retrofit program.

Table II.C.5: C&I Large Retrofit							
Performance Category	**Units**	**Planned Value**	**Preliminary Year-End Results**		**Evaluated Results**		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	7,774,063			5,671,598		-27%
Performance Incentive	$	533,868			338,237		-37%
Participants	# of projects	248			146		-41%
Program Cost / Participant	$	31,347			38,847		24%
Savings & Benefits							
Energy							
Lifetime	MWh	367,097	191,383	-48%	187,394	-2%	-49%
Annualized	MWh	26,186	14,552	-44%	14,146	-3%	-46%
Average Measure Life	yrs	14.0	13.2	-6%	13.2	1%	-6%
Demand							
Lifetime	kW	52,085	21,938	-58%	17,915	-18%	-66%
Annualized							
Summer	kW	3,796	1,776	-53%	1,423	-20%	-63%
Winter	kW	2,286	1,505	0%	1,375	0%	0%
Average Measure Life	kW	13.7	12.4		12.6		
NEB (Lifetime)	yrs	-4,154,196	-834,929	80%	5,040,601	704%	221%
Cost-Effectiveness							
TRC Benefits	$	43,943,369			27,846,831		-37%
TRC Costs	$	15,044,503			7,393,337		-51%
Net Benefits	$	28,898,866			20,453,494		-29%
BCR	n/a	2.92			3.77		29%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses – Planned participation was misaligned for the customer demographics in the commercial and industrial sector. Total program costs declined as a result of lower participant incentive, which is in line with lower overall program participation. Program cost per participant increased because costs declined at a slower rate than participation.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances.

Savings and Benefits - Lower than expected participation in the program explains the variance in energy between planned values and preliminary year-end and evaluated values. Fewer projects led to fewer savings.

Variances in demand savings in the evaluated results were largely caused by revised demand impact factors from those impact evaluations listed below in the next section as well as the *Impact Evaluation of 2010 Custom Lighting Installations* and *Impact Evaluation of 2010 Custom Process and Compressed Air Installations*.

The variance in NEBs from planned values to preliminary year-end values is due to significantly lower participation than planned and also due to differences between the planned and actual gas/oil negative resource NEI mix. Differences in the evaluated results are largely the result of revised heating penalty values produced by *The Impact Evaluation of 2010 Prescriptive Lighting Installations*, which were less than the values previously carried due to a lower market presence of heat producing products like incandescent bulbs. Additionally, the *C&I Non-Energy Impact Study* produced non-resource related NEI values, mostly in the form of O&M benefits, which also had significant effect on benefits as well.

Cost-Effectiveness - TRC benefits are lower than expected due to lower energy and demand savings. TRC costs are lower than expected due to lower than expected participation and costs associated with participant incentives. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are as follows:

- *Impact Evaluation of 2011-2012 Prescriptive VSDs*
  This study produced realization rates for annual kWh for prescriptive VSDs. The study decreased program savings for the Company's 2012 evaluated results. This study is discussed in more detail in Section III, Study 13.

- *Impact Evaluation of 2010 Prescriptive Lighting Installations*
  This study evaluated the large C&I prescriptive lighting end-use, which includes all lighting systems and controls, Advanced Lighting Design or performance lighting, and refrigerated LED case lights. The study presents realization rates for gross energy savings, on-peak and seasonal summer and winter demand savings, and coincidence factors at the statewide level using 12 months of metered data. The net effect for the Company was to increase energy savings for this Program. The study is discussed in more detail in Section III, Study 14.

- *Impact Evaluation of 2011 Custom Refrigeration, Motor and Other Installations*
  This study produces realization rates for annual kWh, summer and winter peak kW, and percent on peak for the large C&I custom electric component of refrigeration, motors, and "other" measure types. The net effect for the Company was to decrease energy savings for this program. This study is discussed in more detail in Section III, Study 15.

- *C&I Customer Profile Project*
  This study characterizes the Massachusetts energy efficiency market by analyzing recent customer usage and program participation data. The study relied on comprehensive billing and tracking data for all C&I customers to estimate the extent to which customers of various sizes and types participated in energy efficiency programs in 2011. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 17.

- *Mid-Sized Customer Needs Assessment - Interim Results*
  The study is investigating the extent to which current program offerings effectively serve the needs of mid-sized customers by conducting interviews with PAs and implementation contractors and analyzing available customer billing and tracking data to examine differences in participation rates across customer size groups. The interim results of this study do not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 18.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The C&I Large Retrofit program is cost-effective with a BCR of 3.77.

c. C&I Small Retrofit

Purpose/Goal: The primary objective of the C&I Small Retrofit Program was to provide cost-effective, comprehensive electric and gas retrofit services to business customers on a turnkey basis using the same delivery model throughout the Commonwealth.

Targeted Customers: The target market for this program included direct install retrofit business customers below 300kW.

Definition of Program Participant: A Program Participant is defined as a customer below 300kW in usage who has received turnkey retrofit services and incentive dollars through the C&I Small Retrofit Program. One customer may undertake multiple projects at different locations during the program year. Each project is, therefore, counted as an individual participant.

Beginning in 2013, the Program Administrators will use consistent participant definitions, as set forth in Appendix M to the 2013-2015 Three-Year Plan in D.P.U. 12-100 through 12-111.

Targeted End-Uses:

- Lighting
- HVAC
- Hot Water
- Motors & Drives
- Refrigeration
- Envelope

Delivery Mechanism: Vendors were selected through a competitive bidding process to implement the program. These vendors marketed the program, performed facility audits, and offered recommendations to customers while completing audit forms and questionnaires. In addition, the same vendors purchased materials, installed measures, loaded data into a database, and prepared progress reports for the Program Administrators on a regular basis.

Significant Differences in Actual Program Design from Approved Program Design: None.

Docket/Exhibit where Program is Discussed and Approved: The program is discussed in detail in the Company's 2010-2012 Three-Year Electric Energy Efficiency Plan, filed October 30, 2009. See Western Massachusetts Electric Company, D.P.U. 09-118, Exhibit WMECo-1, pages 255-259 (bates numbering 00261-00265). The program was approved by the Department on January 28, 2010 in Western Massachusetts Electric Company, D.P.U. 09-118.

Table II.C.6 provides information on the performance of the C&I Small Retrofit Program.

Table II.C.6: C&I Small Retrofit							
Performance Category	Units	Planned Value	Preliminary Year-End Results		Evaluated Results		
			Value	% Change from Planned	Value	% Change from Preliminary	% Change from Planned
Expenses							
Total Program Costs	$	5,506,967			6,545,015		19%
Performance Incentive	$	194,983			254,042		30%
Participants	# of projects	512			639		25%
Program Cost / Participant	$	10,756			10,243		-5%
Savings & Benefits							
Energy							
Lifetime	MWh	130,418	121,664	-7%	144,294	19%	11%
Annualized	MWh	10,373	9,717	-6%	11,417	17%	10%
Average Measure Life	yrs	12.6	12.5	0%	12.6	1%	1%
Demand							
Lifetime	kW	21,913	19,064	-13%	23,129	21%	6%
Annualized							
Summer	kW	1,740	1,514	-13%	1,830	21%	5%
Winter	kW	844	769	-9%	1,177	53%	40%
Average Measure Life	yrs	12.6	12.6		12.6		
NEB (Lifetime)	$	-1,635,485	-991,378	39%	2,552,182	357%	256%
Cost-Effectiveness							
TRC Benefits	$	16,123,376			21,889,456		36%
TRC Costs	$	7,668,569			7,391,620		-4%
Net Benefits	$	8,454,807			14,497,836		71%
BCR	n/a	2.10			2.96		41%

An explanation of significant variances between planned, preliminary year-end, and evaluated values follows.

Expenses - Planned participation was misaligned for the customer demographics in the commercial and industrial sector. The net result was an increase in customer participation in this program.

The Company's methodology allocated performance incentives achieved at the sector level to individual programs based on benefits and net benefits. Any variance in actual performance incentive allocations is directly linked to variances in evaluated benefits and net benefits in individual programs within a sector. These variances are not attributable to a change in performance incentive allocation methodology. In order to explain program performance incentive variance, please refer to the explanation of benefits and net benefits variances above.

Savings and Benefits - Variances in demand savings in the evaluated results were largely caused by revised demand impact factors from the *Massachusetts Small Business Direct Install: 2010-2012 Impact Evaluations*.

The variance in NEBs from planned values to preliminary year-end values is due to differences between the planned and actual gas/oil negative resource NEI mix. Differences in the evaluated results are largely the result of revised heating penalty values produced by *Massachusetts Small Business Direct Install: 2010-2012 Impact Evaluations*, which were less than the values previously carried due to a lower market presence of heat producing products like incandescent bulbs.

Additionally, the *C&I Non-Energy Impact Study* produced significant non-resource related NEI values, mostly in the form of O&M benefits, which also had significant affect on benefits as well.

Cost-effectiveness - The increase in TRC benefits is a result of the increases in NEBs outlined above. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

The EM&V studies included in the Company's 2012 Annual Report that apply to this program are as follows:

- *Massachusetts Small Business Direct Install: 2010-2012 Impact Evaluations*
  This report produced lighting fixture and lighting control measure realization rates for annual kWh and summer and winter peak kW, as well as on-peak coincidence factors. The net effect of these evaluations decreased energy and demand savings for these measures. The full report is discussed in Section III, Study 12.

- *C&I Customer Profile Project*
  This study characterizes the Massachusetts energy efficiency market by analyzing recent customer usage and program participation data. The study relied on comprehensive billing and tracking data for all C&I customers to estimate the extent to which customers of various sizes and types participated in energy efficiency programs in 2011. The results of this study did not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 17.

- *Mid-Sized Customer Needs Assessment - Interim Results*
  The study is investigating the extent to which current program offerings effectively serve the needs of mid-sized customers by conducting interviews with PAs and implementation contractors and analyzing available customer billing and tracking data to examine differences in participation rates across customer size groups. The interim results of this study do not impact the 2012 evaluated results. The study is discussed in more detail in Section III, Study 18.

The Company regularly reviews best available information to adjust strategies in order to achieve energy efficiency goals. With respect to 2012 program performance information, the Company incorporated the best available information into its 2013-2015 energy efficiency plan. With respect to the results of EM&V studies that were completed for 2012, the Company will review those results and make any necessary adjustments to ensure it remains on track to achieve its goals for 2013-2105. The Company will continue to monitor program performance to determine if any evaluation is significant enough to trigger a modification under the new MTM guidelines established in D.P.U. 11-120-A (Phase II) (2013).

The C&I Small Retrofit Program is cost-effective with a BCR of 2.96.

III. EVALUATION MEASUREMENT AND VERIFICATION ACTIVITIES

A. Summary

The Massachusetts Program Administrators completed 25 evaluation studies for the 2012 Energy Efficiency Annual Report. The studies that had the most significant influence on the final evaluated data for electric Program Administrators were the:

- C&I Customer Profile Project study
- HES Realization Rate Results evaluation
- 2012 Residential Heating, Water Heating and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing study
- Massachusetts ENERGY STAR® Lighting Program: Early Impacts of EISA study
- Process Evaluation of the 2012 Bright Opportunities Program

The C&I Customer Profile Project sought to characterize the Massachusetts energy efficiency market by looking at past customer participation, billing data, and customer usage. Overall, the study found the vast majority of savings in 2011 came from custom projects in the custom end-use, which supports a continuation of impact evaluation work to verify these savings. In addition, the study made several other key observations. One, there is an indication of opportunity for more savings in some customer sectors, for example the health care sector where the percent of participating customers is low (1.8 percent of electric and 3 percent of gas) while the savings achieved by participating customers is higher than average. However, while the study identified areas which appear to represent opportunity, it did not seek to answer why participation was low in the sectors. Two, participation rates appeared to increase as account size increased for both gas and electric, reflecting the individualized attention paid to these customers by PA account managers. However, the average savings percent was found to be highest for small gas and electric customers. Finally, the participation rate for gas customers with the same electric PA was found to be 2.6 percent, which was higher than the 1.6 percent participation rate for those with different electric PAs. Additional information on this process evaluation is discussed in more detail in Appendix C, Study 17.

The HES Realization Rate study is a supplemental evaluation following up on the larger 2011 HES Impact Study, which was completed in 2012. This evaluation was needed to provide specific PA realization rates and account for improvements in some vendor software. The HES Realization Rate study targeted two measures: insulation and air sealing. As a background, the savings for these measures are provided by the vendor, who utilizes proprietary software to calculate savings based on the existing conditions compared to the upgraded conditions. The study compared the vendor calculated savings with calibrated engineering models developed by the evaluation team in order to calculate realization rates. The study results showed overall higher savings and higher realization rates when compared with the 2011 impact study. This is due in part to increased adoption of recommended weatherization measures by study participants. This study is discussed in more detail in Appendix C, Study 3.

The 2012 Residential Heating, Water Heating and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing Study sought to determine net-to-gross ("NTG") ratios and early replacement timing for measures in the Residential Heating and Water Heating and Cool Smart programs. The results indicated that the NTG ratios are slightly higher than previously estimated for many measures. Further the Net Market Effects ("NME") analyses and data show evidence that the primary cause of improved NTG ratios is the strong equipment rebate levels that moved the market towards higher tiered efficiency. The study also examined if the program incentives are causing the early replacement of existing equipment prior to failure, thus taking an inefficient equipment offline before the end of its useful life. While the study showed program induced early replacement occurring, the levels of such early replacement were not aligned with the non-energy impacts ("NEIs") assigned to various measures. Overall, this resulted in a modest increase in savings from early replacement, but a sharp decrease in NEIs associated with several measures. This study is discussed in more detail in Appendix C, Study 2. The NEI application is discussed in more detail in Appendix C, Study 25.

The electric PAs conducted a process evaluation of the 2012 Bright Opportunities Program, which is a C&I upstream lighting program. The preponderance of the evidence indicates that the Bright Opportunities Program is a well-designed and well-run program. The study showed generally high program satisfaction levels from end users and participating trade allies, lack of barriers to program participation, generally high program net-to-gross ratios, and also lack of significant complaints from program implementers. Interim gross impact evaluation results suggest that gross savings are being forecasted accurately. Additional information on this process evaluation and the updated NTG values are discussed in more detail in Appendix C, Study 16.

The Massachusetts ENERGY STAR® Lighting Program: Early Impacts of EISA Study sought to synthesize the results from the four lighting evaluation tasks reported separately (consumer survey, onsite saturation, shelf-stocking survey, and supplier interviews) as well as highlight the effects of the first full-year of implementation of the increased lighting efficiency standards mandated by the Energy Independence and Security Act ("EISA") on the Massachusetts residential lighting market. Through consumer and supplier surveys, the study found that consumers and suppliers report an increased availability of CFLs and LEDs on store shelves, and a decreased availability of filament incandescent bulbs. The various results did not provide full clarity on how EISA has changed the availability of A-line halogen incandescent bulbs, but the study speculates that most likely the availability increased in 2012. Another interesting finding of the study was regarding 100-watt incandescent bulbs. Even though their manufacture and import was banned in January 2012, a dwindling but still sizable number of these bulbs remained on store shelves throughout 2012, well after their EISA phase out. Finally, the sixty-watt incandescent bulbs fill 22 percent of all sockets in Massachusetts homes, making it the most popular bulb in homes. Therefore, the full impact of EISA will not be understood on the lighting market—including on consumer lighting purchases and stockpiling behavior—until after the January 2014 phase-out of this bulb. This study is discussed in more detail in Appendix C, Study 8.

Table III.A summarizes the EM&V studies that have not been included in previous Annual Reports. Please note: studies 19, 20, and 21 apply to gas energy efficiency programs only and are, therefore, not included in the table below.

Table III.A: Evaluation Studies in Annual Report			
Studies	Location of Complete Study in Annual Report	Docket & Exhibit Approving Planned Evaluation Studies	Implemented as Approved? (yes/no)
Residential Program Studies			
MA RNC Program Incremental Cost Report	App. C, Study 1	Study was approved in January 2013 with the 2013-2015 Three-Year Plan, D.P.U. 12-100 through D.P.U. 12-111	All studies are implemented as planned
2012 Residential Heating, Water Heating and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing	App. C, Study 2		
HES Realization Rate Results Memo	App. C, Study 3		
Massachusetts Consumer Survey Results Winter-2012	App. C, Study 4		
Residential Lighting Shelf Survey and Pricing Analysis	App. C, Study 5		
Lighting Retailer, Supplier Perspectives on the Massachusetts ENERGY STAR Lighting Program	App. C, Study 6		
Results of the Massachusetts Onsite Lighting Inventory	App. C, Study 7		
Massachusetts ENERGY STAR® Lighting Program: Early Impacts of EISA	App. C, Study 8	Study not submitted for approval	
Residential Pilot Studies			
2012 Home Energy Services Pre-Weatherization Initiative Evaluation	App. C, Study 9	Study was approved in January 2013 with the 2013-2015 Three-Year Plan, D.P.U. 12-100 through D.P.U. 12-111	All studies are implemented as planned
Residential Lighting Controls Initiative Evaluation	App. C, Study 10		
Low-Income Program Studies			
Status of Ongoing Low Income Lighting and Heating Metering Study	App. C, Study 11	Study was approved in January 2013 with the 2013-2015 Three-Year Plan, D.P.U. 12-100 through D.P.U. 12-111	All studies are implemented as planned

Table IIIA (continued)

Commercial & Industrial Program Studies			
Massachusetts Small Business Direct Install: 2010-2012 Impact Evaluations	App. C, Study 12	Study was approved in January 2013 with the 2013-2015 Three-Year Plan, D.P.U. 12-100 through D.P.U. 12-111	All studies are implemented as planned
Impact Evaluation of 2011-2012 Prescriptive VSDs	App. C, Study 13		
Impact Evaluation of 2010 Prescriptive Lighting Installations	App. C, Study 14		
Impact Evaluation of 2011 Custom Refrigeration, Motor and Other Installations	App. C, Study 15		
Process Evaluation of the 2012 Bright Opportunities Program	App. C, Study 16		
Customer Profile Project	App. C, Study 17		
Mid-Sized Customer Needs Assessment - Interim Results	App. C, Study 18		
Special & Cross Sector Studies			
Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report	App. C, Study 22	Study was approved in January 2013 with the 2013-2015 Three-Year Plan, D.P.U. 12-100 through D.P.U. 12-111	All studies are implemented as planned
2012 Massachusetts Statewide Marketing Campaign Evaluation Report	App. C, Study 23		
2013 Massachusetts Statewide Marketing Campaign: Pre-Campaign Snapshot	App. C, Study 24		
Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating and Cooling Equipment that is Early Replacement Compared to Replace on Failure	App. C, Study 25	Study not submitted for approval	

B. Residential Program Studies

1. MA RNC Program Incremental Cost Report

Type of Study: Technology Evaluation
Evaluation Conducted by: NMR Group
Date Evaluation Completed: 6/11/2013

Evaluation Objective and High Level Findings: This report provides estimates of the incremental costs per square foot involved in building high efficiency homes that meet the criteria of the 2013 MA Residential New Construction (RNC) Program. Incremental costs above the costs of typical homes being built outside the program are estimated for single family (SF), low-rise multifamily buildings of three or fewer stories (MF 1-3), and mid- to high-rise multifamily buildings of four stories or more (MF 4+) for each of the incentive options offered by the program.

The evaluation provides the following incremental cost per square foot for homes built through the program.

MA RNC Single Family Incremental costs	Prescriptive		Performance		
	I	II	Tier I	Tier II	Tier III
Single Family Detached	$ 1.54	$ 6.39	$ 1.19	$ 4.57	$ 9.33

MA RNC Multi-family 1-3 story Incremental Costs	Prescriptive		Performance	
	I	II	Tier I	Tier II
Single Family Attached	$ 1.38	$ 5.61	$ 1.03	$ 1.27
Multifamily 1-3 No Master Meter	$ 0.10	$ 1.50	$ 0.65	$ 1.18
Multifamily 1-3 Master Meter Gas	$ 0.08	$ 1.48	$ 0.79	$ 1.35
Multifamily 1-3 story Overall	$ 0.60	$ 3.10	$ 0.86	$ 1.29

MA RNC Multi-family 4+ Story Incremental Costs	Residential In-unit Prescriptive	Whole bldg Simple Prescriptive	Whole bldg Interactive Prescriptive
Multifamily 4+ story	$ 0.14	$ 1.21	$ 1.65

MA RNC Incremental Costs By Sector	Single Family	Multi-Family 1-3 story	Multi-Family 4+ story
Overall Incremental cost/SF	$ 2.31	$ 0.95	$ 1.00

Programs to which the Results of the Study Apply:

- Residential New Construction and Major Renovation (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: No recommendations were offered.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: No recommendations were offered.

Savings Impact: The study had no impact on savings.

Formulas Used in Impact Analysis: Historical RNC program participant data was used to inform differential pricing estimates and weighting.

Application of Results: Retroactively

How the Study Came to the Recommended Conclusions: No recommendations were offered.

A copy of the complete study can be found in Appendix C, Study 1.

2. 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing

Type of Study: Market Assessment, Market Characterization
Evaluation Conducted by: Navigant, ODC, and Cadmus
Date Evaluation Completed: 6/19/2013

Evaluation Objective and High Level Findings: The objectives of this evaluation were to:

1. Determine free-ridership (FR), spillover (SO), and net-to-gross (NTG) values by program measure,

2. Estimate the net market effects (NME) for each measure, and

3. Estimate the timing of equipment replacement (ER) across early replacement, replace on failure (ROF), and "in-between" categories. There is also a fourth category ("new") which is either a first-time installation of the end-use or new construction.

The high level findings are as follows:

FR, SO, and NTG estimates for Cool Smart and Residential Heating and Water Heating (HEHE) equipment measures are shown in Table 1. The results indicated that the NTG ratios are slightly higher than previously estimated for many measures. Further, the NME analyses and data provide qualitative evidence supporting this finding, and that the primary cause of improved NTG results is a better alignment of equipment efficiency tiers and associated rebate levels – and appropriate changes over time – to move the market.

Table 1: Average FR, SO, and NTG Estimates

Measure	FR	SO	NTG
Boilers, AFUE 90-95.9%	0.32	0.08	**0.76**
Boilers, AFUE ≥96%	0.31		**0.77**
Boilers, Overall	0.31		**0.77**
Furnaces, AFUE ≥95%	0.41	0.22	**0.81**
Central Air Conditioners/Heat Pumps, SEER 14.5-14.9	0.35	0.28	**0.93**
Central Air Conditioners, SEER ≥16	0.42		**0.86**
Central Air Conditioners, Overall	0.40		**0.88**
Ductless Mini-Splits	0.45	0.07	**0.62**
Storage Water Heaters, Energy Factor ≥0.67	0.13	0.13	**1.00**
Tankless Water Heaters, Energy Factor ≤0.94	0.37	0.26	**0.89**
Tankless Water Heaters, Energy Factor ≥0.95	0.28		**0.98**
Tankless Water Heaters, Overall	0.32		**0.93**
Integrated Space Heaters/Water Heaters with a Condensing Boiler	0.34	0.08	**0.74**

This study also addressed the Quality Installation Verification components of the Cool Smart Program. Table 2 provides a summary of the QIV FR, SO, and NTG values as follows:

Table 2: Quality Installation Verification NTG

Measure	Average FR	Average SO	NTG
Manual J Central Air Conditioners and Heat Pumps	0.38	0.16	0.78
Manual J Heating	NA	0.15	NA
Airflow Testing/Duct Sealing	0.15	0.07	0.92
Refrigerant Testing	0.22	0.24	1.02
Overall QIV	**0.25**	**0.16**	**0.91**

The measures responsible for the majority of savings due to equipment installations in the HEHE and Cool Smart programs are central HVAC systems: natural gas boilers, natural gas furnaces, central air conditioning, and heat pumps. As shown in Table 1, participants replacing equipment early (4 or more years of remaining life) represent more than 30% of boiler and 23% of furnace installations, but just 8% of central air conditioner and heat pump installations. Early replacement shares among integrated boiler/hot water units, storage water heaters, and tankless water heaters range from 20 to 33%. There is virtually no early replacement among ductless mini-split installations. More than 95% of these are either first-time cooling installations or are replacing window air conditioners. There are also a significant number of HEHE participants who are neither early nor replace-on-failure (ROF). These in-between installation estimates range from 15 to 25% across all of the program's major equipment measures.

Table 1. Equipment Replacement Timing in HEHE and Cool Smart Programs

Equipment Replacement Timing Shares				
Measure	**Early**	**New**	**ROF**	**In-Between**
Boiler	30.6%	0.0%	44.9%	24.5%
Furnace	23.1%	0.0%	61.5%	15.4%
Central Air Conditioner / Heat Pump	8.0%	50.4%	29.2%	12.4%
Ductless Mini-Split	2.5%	95.1%	0.0%	2.5%
Integrated Boiler / Water Heater	20.0%	0.0%	55.7%	24.3%
Storage Water Heater	33.3%	0.0%	50.0%	16.7%
Tankless Water Heater	28.0%	0.0%	54.8%	17.2%

Programs to which the Results of the Study Apply:

- Residential Cooling and Heating Equipment (CoolSmart) (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Company to these recommendations is summarized below.

> **Recommendation 1:** The evaluators want to acknowledge the lack of consensus on NTG algorithms, and recommend that the PAs and EEAC develop clear protocols across all residential and non-residential program categories to look at NTG issues more holistically.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations. The PAs are considering undergoing an initiative in the Cross Cutting Sector to encourage methodological consensus.

Application of Results: Retroactively

How the Study Came to the Recommended Conclusions: The evaluators estimated measure-specific FR, SO and NTG via what is commonly referred to as the Self-Report Approach (SRA). The SRA method was also used to estimate the NME and ER estimates. The evaluators relied on surveys with heating, cooling and water heating distributors and contractors, as well as surveys with program participants.

A copy of the complete study can be found in Appendix C, Study 2.

3. Home Energy Services Realization Rate Calibration

Type of Study: Impact Evaluation
Evaluation Conducted by: The Cadmus Group, Inc.
Date Evaluation Completed: 6/28/2013

Evaluation Objective and High Level Findings: The objective of the evaluation was to develop realization rates (the ratio of *ex ante* and *ex post* savings) that each Program Administrator (PA) could use to adjust insulation and air-sealing savings, as estimated by the most recent home auditing software employed by each HES implementer, to more closely reflect evaluated savings.

The evaluation yielded the following realization rates by PA (where appropriate and when sufficient data were available) for each of the four assessed heating fuel types.

Natural Gas

PA	n	Model Precision (at 90% confidence)	*Ex Ante*	*Ex Post*	Realization Rate
Berkshire Gas	182	±17%	161	137	0.85
Columbia Gas	294	±10%	209	131	0.63
National Grid	2,889	±4%	188	140	0.74
New England Gas	18	±83%	107	119	1.11
NSTAR	1,344	±5%	165	139	0.84
Unitil	22	±21%	256	175	0.68
Commonwealth-wide	**4,749**	**±3%**	**183**	**139**	**0.76**

Electric

PA	n	*Ex Ante*	*Ex Post*	Realization Rate
Cape Light Compact	101	2,693	1,360	0.51
National Grid	383	2,423	1,459	0.60
NSTAR	124	2,712	1,468	0.54
Commonwealth-wide	**608**	**2,527**	**1,445**	**0.57**

Heating Oil

PA	n	*Ex Ante*	*Ex Post*	Realization Rate
Cape Light Compact	748	16.4	16.4	1.00
National Grid	5,365	18.9	16.7	0.88
NSTAR	4,192	19.8	16.8	0.85
Unitil	128	38.6	13.9	0.36
WMECo	329	34.7	19.0	0.55
Commonwealth-wide	**10,762**	**19.8**	**16.8**	**0.85**

Propane

PA	n	*Ex Ante*	*Ex Post*	Realization Rate
Cape Light Compact	70	14.3	12.2	0.86
National Grid	216	14.3	12.6	0.88
NSTAR	91	14.2	13.5	0.95
Unitil	5	63.2	12.7	0.20
WMECo	10	33.4	14.6	0.44
Commonwealth-wide	**391**	**15.4**	**12.8**	**0.83**

Programs to which the Results of the Study Apply:

- Residential Mass Save (Home Energy Services) (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: No recommendations were offered.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: No recommendations were offered.

Savings Impact: The PAs will use the results of this evaluation to retroactively adjust vendor provided *ex ante* savings estimates for insulation and air sealing measures.

Formulas Used in Impact and Process Analysis: The evaluation assessed *ex post* savings for both measures using two approaches: a billing analysis and an engineering analysis. A brief description of each follows:

- ***Billing Analysis.*** The evaluators developed a fixed-effects conditional savings regression model, using paired pre- and post-participation months to estimate savings for insulation and air sealing installed in homes heated by natural gas. The analysis utilized participation records from the High Efficiency Heating and Water Heating, Cool Smart, and Opower programs to ensure it did not misattribute the efficiency measures installed or behavioral changes resulting from those programs to the two HES measures.

- ***Engineering Analysis.*** For homes heated by electricity, heating oil, or propane, the evaluators estimated savings using PA- and fuel-specific U.S. Department of Energy (DOE-2) based simulation models, calibrated using each PA's average observed pre-program energy consumption. The simulation models were updated using detailed measure data and home characteristics recorded by HES implementers as well as a variety of weather files selected to best represent each PAs service territory.

Application of Results: Retroactively

How the Study came to the Recommended Conclusions: No recommendations were offered.

A copy of the complete study can be found in Appendix C, Study 3.

4. Massachusetts Consumer Survey Results Winter-2012

Type of Study: Market Assessment
Evaluation Conducted by: NMR Group
Date Evaluation Completed: 5/30/2013

Evaluation Objective and High Level Findings: This consumer survey was performed in December 2012 and January 2013 with the objective of tracking key lighting market indicators and understanding likely and actual consumer responses to the increased lighting efficiency standards mandated by the Energy Independence and Security Act of 2007 (EISA).

Key findings include the following:

Conclusion 1: Customer satisfaction with CFLs remains steady, with roughly one-half of respondents being "very satisfied" with the bulbs, and three out of four being "very or somewhat" satisfied. A persistent concern with CFLs in Winter 2012 relates to their mercury content and disposal issues.

Conclusion 2: The study results show that those households using many CFLs (experts) demonstrated a high level of lighting "savvy" compared to those households using few or none of the bulbs (novices).

Conclusion 3: Consumers seem to like the idea of LED bulbs but remain concerned about the high price point. Consumers seem particularly optimistic about the LED's lack of mercury and better dimming performance compared to CFLs.

Conclusion 4: No bulb stands out as the likely "standard" replacement to the incandescent being phased out by EISA, but consumers tended to prefer a "higher wattage" incandescent for replacement of 75 Watt incandescents over other bulb types.

Conclusion 5: Consumers remain relatively unaware of A-line CFLs.

Conclusion 6: About one-fifth of consumers say they would consider stockpiling bulbs, but only 9% admit to stockpiling 100 Watt incandescents in 2012.

Conclusion 7: Consumers are becoming more familiar with the term "lumens" and understand that it means light output or brightness, but they still buy bulbs based on wattage or wattage equivalence.

Programs to which the Results of the Study Apply:

- Residential ENERGY STAR® Lighting (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Recommendation 1: The evaluators suggest continued tracking of CFL satisfaction throughout future consumer surveys in order to see if satisfaction remains stable in the post-EISA period, when CFLs will face serious competition from less efficient screw-in halogen bulbs and very efficient and long-lasting screw-in LED bulbs.

Recommendation 2: Despite evidence that some consumers are having difficulties finding 100-Watt incandescent bulbs on store shelves, one-half of shoppers for these bulbs were able to buy them. Therefore, if they are not already doing so, when developing energy and demand savings assumptions post-EISA, the PAs should consider assuming that the former "baseline" incandescent bulbs will remain available for at least one year and not adjust their delta Watts to account for lower energy use of halogens or other bulb types until after that year.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations. The PAs will continue to track the lighting market to evaluate the impact of EISA.

Savings Impact: There are no savings impacts.

Formulas Used in Impact Analysis: There are no savings impacts.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: The study relied on a telephone survey of randomly selected customers of each program administrator in Massachusetts. The evaluators surveyed a total of 600 customers. The study used the Statistical Package for Social Sciences (SPSS) to analyze the data, yielding descriptive statistics to summarize survey responses.

A copy of the complete study can be found in Appendix C, Study 4.

5. Residential Lighting Shelf Survey and Pricing Analysis

Type of Study: Market Assessment
Evaluation Conducted by: NMR Group
Date Evaluation Completed: 6/8/2013

Evaluation Objective and High Level Findings: This evaluation involved the performance of a light bulb shelf-stocking survey and a hedonic pricing regression analysis. The results of the shelf-stocking survey demonstrated that participating stores carry a greater proportion of energy-efficient CFLs and LEDs over incandescent or halogen bulbs. Moreover, the proportion of shelf space devoted to energy-efficient bulbs has increased in partner stores since 2010. Program incentives serve to reduce the price of specialty and standard CFLs by about $1.00 to $2.00, but there is evidence that the program partners are not passing along the full incentive to consumers. The report suggests supplementary approaches for estimating the impact of the program on in-store prices that could be implemented early in the next evaluation cycle.

Programs to which the Results of the Study Apply:

- Residential ENERGY STAR® Lighting (Electric)

Evaluation Recommendations and Program Administrator Response: This study did not offer any recommendations.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: This study did not offer any recommendations.

Savings Impact: There are no savings impacts.

Formulas Used in Impact Analysis: There are no savings impacts.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: No recommendations were offered.

A copy of the complete study can be found in Appendix C, Study 5.

6. Retailer, Supplier Perspectives on the Massachusetts ENERGY STAR Lighting Program

Type of Study: Technology Evaluation
Evaluation Conducted by: NMR Group
Date Evaluation Completed: 6/12/2013

Evaluation Objective and High Level Findings: The objective of this study was to perform in-depth interviews with lighting manufacturers and high-level buyers and conduct surveys with store managers in order to understand their perceptions of the current impacts of EISA on the lighting market as well as to explore the perspectives on the growing LED market and program impacts on the lighting market.

Major conclusions of this extensive research effort included the following, but additional important findings can be found in the full report:

- **Impacts of EISA of Bulb Stocking and Sales**: Participating suppliers and store managers generally believed that their stocking and sales of CFLs and LEDs had increased since EISA while those of incandescent bulbs had decreased. Most also thought that the stocking and sales of halogen bulbs had remained about the same.

- **Stockpiling of Incandescent Bulbs**: The suppliers did not all agree on whether stockpiling was a concern. Only 107 of the 240 store managers thought EISA had changed consumers' bulb purchasing habits and, of these 107, just 22% noted stockpiling behavior among these habits. Suppliers who had noted stockpiling argued that both consumers and retailers exhibited the behavior and that it applied more to 60-Watt bulbs than to 75-Watt or 100-Watt.

- **Concerns about Halogen Market Share**: Suppliers believed that the removal of program supports for CFLs and LEDs would increase the likelihood that consumers would choose halogen bulbs instead of CFLs and LEDs to replace incandescent bulbs. They even feared that some consumers may backslide from CFLs and LEDs to halogens, as halogens are being promoted as "energy efficient."

- **Sales of LED bulbs**: Over one-half of store managers said they sold LEDs bulbs (although some may have sold non-ENERGY STAR® models), with A-line, spot/reflectors, and nightlights being the most commonly sold styles. About one-half of

the managers characterized LED sales as either good or excellent. General purpose bulbs tended to be the best sellers.

- **Barriers to LED sales**: Both stores that currently carry and those that have decided not to carry LEDs cite the high price of the bulbs as the greatest barriers to increased sales. However, they also remained optimistic about future LED sales based on the expectation that prices would continue to fall and the technology would continue to improve.

Programs to which the Results of the Study Apply:

- Residential ENERGY STAR® Lighting (Electric)

Evaluation Recommendations and Program Administrator Response: The study did not offer any recommendations.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: The study did not offer any recommendations.

Savings Impact: There are no savings impacts.

Formulas Used in Impact Analysis: There are no savings impacts.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: Although there are no recommendation conclusions, the study relied on ten in-depth interviews with lighting manufacturers and high-level retail buyers as well as telephone surveys with 240 participating store managers. Interviewees and survey respondents were asked questions about the lighting market, their experience with the program, changing lighting technology, and their estimation of the impacts of EISA.

A copy of the complete study can be found in Appendix C, Study 6.

7. Lighting Onsite Inventory and Saturation Study

Type of Study: Technology Evaluation
Evaluation Conducted by: NMR Group
Date Evaluation Completed: 6/7/2013

Evaluation Objective and High Level Findings: The objective of this study was to perform lighting inventories and estimate socket saturations in Massachusetts homes. The study also examined lighting purchase behavior and searched for evidence of incandescent bulb stockpiling.

The main conclusions of the study are as follows:

- Most households used at least one CFL in 2013, even if some of them were dissatisfied with the products or not even aware they were using CFLs.

- The percentage of sockets filled with CFLs in 2013 was 28%, which was statistically similar to the 26% observed in 2009. The stagnation in CFL saturation can in part be explained by households replacing burned out CFLs with newly purchased CFLs.

- Saturation of all energy-efficient light bulbs, including CFLs, LEDs, and fluorescent tubes, increased to 39% in 2013.

- LED saturation remained low, at 2% of the total, but doubled from Spring 2012 to Spring 2013. Most LEDs were the under-the-cabinet type, not A-shaped bulbs.

- About 61% of sockets remaining in homes could theoretically be filled with an energy efficient light bulbs; about 57% of the remaining potential rests with standard bulbs, while the other 43% rests with specialty applications (i.e., dimmable or three-way control or does not have the A-shape).

- Households stored about two CFLs on average in 2013.

- The average onsite household bought about three CFLs in 2012—two of them were standard CFLs and one was a specialty CFL.

- The evaluators found evidence of stockpiling of incandescent bulbs; households stored an average of four incandescent bulbs, particularly 60-Watt bulbs. However, none of the onsite participants tied this behavior to EISA but instead explained that they just like to have extra bulbs on hand.

Programs to which the Results of the Study Apply:

- Residential ENERGY STAR Lighting® (Electric)

- Residential New Construction (Both)

- Low Income Residential New Construction (Electric)

- Multi-Family Retrofit (Both)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Recommendation 1: Continue tracking the Massachusetts lighting market through regular consumer surveys, onsite saturation studies, shelf stocking surveys, and supplier interviews.

Recommendation 2: The PAs should perform a net-to-gross study as one has not been performed since 2010. This study will help to clarify whether current program-supported

sales are helping to prevent backsliding to incandescents or incandescent halogen bulbs or whether they represent a high amount of free ridership.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

The PAs will continue to track the lighting market to evaluate the impact of EISA. The PAs will also continue to work within the EMC to determine the correct timing to conduct a NTG study on the evolving lighting market.

Savings Impact: The report estimated the number of bulbs in indoor fixtures for all bulb types to be 1.49.

Formulas Used in Impact Analysis: There are no savings impacts, but PAs will update the assumed number of bulbs for indoor fixtures to be 1.49.

Application of Results: Retroactively

How the Study Came to the Recommended Conclusions: The study involved performing onsite visits to 150 homes in Massachusetts. Trained technicians took detailed notes about all lighting sockets and light bulbs found in the home, including bulbs found in storage. Households also provided information on when and where they purchased bulbs, why they stored bulbs, and the intended use of bulbs found in storage. The evaluators analyzed the data in Excel spreadsheets and in the Statistical Package for Social Sciences (SPSS) to arrive at the study conclusions.

A copy of the complete study can be found in Appendix C, Study 7.

8. Massachusetts ENERGY STAR® Lighting Program: Early Impacts of EISA

Type of Study: Technology Evaluation
Evaluation Conducted by: NMR Group
Date Evaluation Completed: 6/12/2013

Evaluation Objective and High Level Findings: The objective of this study was to identify what the results from the four lighting evaluation tasks reported separately (consumer survey, onsite saturation, shelf-stocking survey, and supplier interviews) tell us about the effects of the first full-year of implementation of the increased lighting efficiency standards mandated by the Energy Independence and Security Act (EISA) on the Massachusetts residential lighting market.

The key conclusions of the study include the following:

- **Awareness of EISA:** Fewer than one-half of consumers were aware of the increased lighting efficiency standards mandated by EISA; about two-third of program participating store managers were aware of EISA.

- **Bulb Availability:** Consumers and suppliers report—and the shelf-stocking survey confirms—an increased availability of CFLs and LEDs on store shelves. At the same time, the availability of filament incandescent bulbs has decreased. The various results did not provide clarity on how EISA has changed the availability of A-line halogen incandescent bulbs, but it is most likely that it has also increased. Even though their manufacture and import was banned in January 2012, a dwindling but still sizable number of 100-Watt incandescent bulbs remained on store shelves throughout 2012.

- **Bulb Purchase Behavior:** The onsite saturation study conducted in early 2013 did not show significant changes in the types of bulbs observed in Massachusetts household when compared to 2012. In general, the consumer survey and the supplier interviews point to increased purchases of CFLs and LEDs, decreased purchases of incandescents, and stable purchases of halogen bulbs.

- **Stockpiling of Incandescents:** The evaluators did not find evidence of widespread stockpiling of incandescent bulbs, but there were indications that some households—and retailers—had engaged in the behavior. The limited stockpiling that is occurring tends to be focused on 60-Watt incandescent bulbs and not on the already phased-out 75-Watt and 100-Watt incandescents.

- **Big Unknown – 60-Watt Incandescent Phase-out:** Sixty-Watt incandescent bulbs fill 22% of all sockets in Massachusetts homes, making this the most popular bulb in use in homes. Hence we will not be able fully to understand the effect of EISA on the lighting market—including on consumer lighting purchases and stockpiling behavior—until after the January 2014 phase-out of this bulb.

Programs to which the Results of the Study Apply:

- Residential ENERGY STAR Lighting (Electric)
- Residential New Construction and Major Renovation (Electric)
- Residential Mass Save (Home Energy Services) (Electric)
- Multifamily Retrofit (Electric)
- Low-Income Residential New Construction and Major Renovation (Electric)
- Low-Income 1-4 Family Retrofit (Electric)
- Low-Income Multifamily Retrofit (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

These recommendations are in addition to the ones submitted in individual task reports.

Recommendation 1: The PAs should track the lighting markets in select comparison areas with varying levels and models of residential lighting programs.

Recommendation 2: The PAs should continue rebates for standard CFLs and LEDs at least through 2015 (one year after 40- and 60-Watt incandescent phase-out) in order to keep more energy-efficient bulbs on shelves and prevent backsliding of the market to halogen incandescents.

Recommendation 3: The PAs should continue efforts to educate consumers about new lighting terminology such as lumens and light temperature, how to select the best bulb, and the variety of highly energy-efficient light bulbs available to meet residential lighting needs.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

The PAs have, however, committed to increase education efforts to improve consumer education, as stated in their approved 2013-2015 three-year plan.

Savings Impact: There are no savings impacts

Formulas Used in Impact Analysis: There are no savings impacts

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: The evaluators performed telephone surveys, in-home onsite lighting inventories, in-store shelf-stocking studies, and in-depth interviews and surveys with suppliers to arrive at these conclusions. More detail on each of these methods can be found in their individual report templates.

A copy of the complete study can be found in Appendix C, Study 8.

C. Residential Pilot Studies

9. 2012 Home Energy Services Pre-Weatherization Initiative Evaluation

Type of Study: Process Evaluation
Evaluation Conducted by: The Cadmus Group, Inc.
Date Evaluation Completed: 4/19/2013

Evaluation Objective and High Level Findings: The objective of the evaluation was to assess the impact of initiative additional incentives on customer's decision to overcome pre-weatherization barriers (which then made them eligible to install certain recommended HES measures). The initiative targeted three common, low-cost pre-weatherization barriers: evidence of knob and tube wiring, general combustion safety, and improper dryer venting. The evaluation also assessed the delivery of the initiative itself. Key conclusions included:

Conclusion 1: The initiative data did not show a significant change in the measure adoption rate for National Grid and NSTAR customers who faced the knob and tube wiring barrier. Although these findings suggest that the initiative may not have influenced the measure adoption rate, it is important to remember that the provided data only represent a subset of HES customers, and the evaluators' analysis was limited to two PAs and only one barrier.

Conclusion 2: While the turnkey option offers customers easy access to approved contractors, the PAs and lead vendors that offered the turnkey option were uncertain of the delivery option's long-term viability. These PAs and lead vendors cited difficulties identifying and enrolling contractors given the limited financial opportunities for these contractors. In other words, the level of work for contractors generated by the initiative (to inspect knob and tube wiring and clear other pre-weatherization barriers) was not substantial enough to interest and enlist a sufficient number of approved turnkey contractors. PAs and lead vendors also cited the administrative burden, such as managing and updating the list of qualified contractors willing to participate in the program, as a challenge to turnkey viability. Further, according to Phase 2 participant survey respondents, only a small number of participants used this delivery option.

Conclusion 3: Non-participants indicated confusion about what the initiative actually covered for knob and tube wiring. During the survey, even after being told the incentive was only to check the wiring, non-participants still wanted a higher incentive: they were not able to differentiate between the cost of the inspection and the cost of potentially replacing the knob and tube wiring (if live).

Conclusion 4: PA stakeholders and customers that employed a 30-day deadline for initiative enrollment indicated that additional time would have helped. Specifically, survey respondents that were given the 30-day deadline indicated that the timeframe presented a challenge for addressing the initiative barriers (12%, n=13). However, an analysis of acceptance rates revealed that customers who were given a 30-day deadline had higher acceptance rates than those offered the 90-day deadline.

Conclusion 5: Interviews with PAs and lead vendors indicate that elements of the initiative's design and delivery varied across PAs. Examples of variation included marketing materials, participant forms, incentive amounts, and the timing of when participants received the rebate for clearing a barrier.

Programs to which the Results of the Study Apply:

- Residential Mass Save (Home Energy Services) (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The evaluators suggest that the PAs should work closely with their lead vendors to determine the long-term viability and effectiveness of the turnkey option.

Recommendation 2: The evaluators suggest that the PAs identify ways to better communicate what the cost of checking knob and tube actually covers and how it differs from the cost to actually replace the knob and tube wiring.

Recommendation 3: The evaluators suggest that the PAs consider a compromise deadline of 45 or 60 days that keeps some of the benefits of the immediacy of the deadline, but makes it more realistic for customers to meet the deadline.

Recommendation 4: While some variation may be necessary, the evaluators suggest that the PAs should discuss these variations, determine best practices, and standardize design and delivery as much as possible across the state.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: In an effort to standardize design and delivery, the PAs have adopted a 60 day deadline for acceptance of the incentive. All other recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any of the other recommendations that require changes to program design and operations.

Savings Impact: There are no savings impacts.

Formulas Used in Impact and Process Analysis: There are no savings impacts.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: The Pre-Weatherization Initiative evaluation included PA program manager interviews, program vendor staff interviews, 118 participant and nonparticipant customer surveys, and a review of pilot and historical program data. Based on information obtained through these data collection methods, the evaluators used their professional judgment and experience evaluating energy efficiency programs to offer recommendations aimed at improving program processes where appropriate.

A copy of the complete study can be found in Appendix C, Study 9.

10. Residential Lighting Controls Initiative Evaluation

Type of Study: Process Evaluation
Evaluation Conducted by: The Cadmus Group, Inc.
Date Evaluation Completed: 6/5/2013

Evaluation Objective and High Level Findings: This evaluation was performed between August 2012 and May 2013. The objectives of the evaluation were to analyze the energy-saving potential of replacing traditional dimming switches with advanced dimming controls and to investigate the compatibility of those controls with efficient bulb technologies. Key conclusions included:

Conclusion 1: The compatibility of dimming controls and LEDs was an issue. Participants, implementation staff, and program managers all noted difficulties finding working combinations of dimmers and bulbs.

Conclusion 2: Survey and metering data revealed that some participants operated their lights more after installation of the new dimmers and bulbs; however, savings still resulted since savings were largely driven by the lamp replacement.

Conclusion 3: In order for an impact evaluation of lighting use with dimmer replacements to be successful, it is important to have detailed tracking of implementation activities, including an equipment inventory with product specifications; a time-stamped contact log of all customer interactions; and a dated tracking matrix showing what equipment was replaced or adjusted at each appointment.

Programs to which the Results of the Study Apply:

- N/A (Study results not applied to any program)

Evaluation Recommendations and Program Administrator Response: Due to the inconclusive findings, the evaluation did not include formal recommendations.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: There are no recommendations for the PA to adopt.

Savings Impact:

Savings Category	Total Verified Gross Impacts	Average Impact per Site
Demand Impacts	2.11 kW	0.26 kW
Energy Savings	1,987 kWh/yr	248 kWh/yr

Formulas Used in Impact Analysis: A combined approach of field data collection and laboratory testing was used to estimate energy and demand savings.

- **On-site inventory:** Pre- and post-installation information was collected for the fixtures and controls in each participant's room or area of interest.
- **Pre- and post-metering:** Meters were deployed at participant sites prior to the installation of dimmer controls and bulbs. These loggers recorded illuminance levels from the lamps controlled by the dimmers for six to eight weeks before and after measure installation.

- **Lab testing of dimmer controls:** Laboratory testing was used to analyze the relationship between power and illuminance (lumens per square foot) and the dimmer switch settings.

- **Analysis:** The illuminance field data, the laboratory power data, and other supporting information were synthesized to analyze the energy impacts of the initiative. Operating hours for each group of bulbs attached to a lighting control were calculated, both at a gross, on-off level, as well as at each discrete dimmable level. Gross energy savings were calculated by aggregating metered hours of use at each dimmable level with the laboratory-tested energy used at that level. The reported demand impacts are the difference between the pre- and post-install maximum wattage values. Coincident peak demand impacts were not estimated or reported.

Application of Results: Results from the initiative will not be applied because results were inconclusive and because the initiative was not associated with an existing program.

How the Study Came to the Recommended Conclusions: The study included 16 participants who agreed to have their existing dimming controls and bulbs exchanged for new controls and LED bulbs through the initiative. Meters were installed on the affected controls and bulbs for six weeks before and after the installation of new measures. Data collected from these meters were mapped to laboratory testing data that triangulated illuminance, power, and dimmer position for each dimmer/bulb combination. Results from the mapping were used to calculate energy and demand savings.

A copy of the complete study can be found in Appendix C, Study 10.

D. Low-Income Program Studies

11. Low Income Hours of Use and Heating Study

Type of Study: Impact Evaluation
Evaluation Conducted by: The Cadmus Group, Inc.
Date Evaluation Completed: 6/28/2013

Evaluation Objective and High Level Findings: The objective of the study is to assess lighting hours of use (HOU) and the prevalence of secondary heating among low income customers. The study is currently underway and will be completed by September 6, 2013.

While the study is ongoing, the evaluators can offer the following preliminary findings at this time:

- The preliminary low income-specific HOU of 2.66 is slightly less than the current program assumption of 2.8 hours/day.

- Low income seniors use their lights less (2.12 hours per day) than low income non-senior (2.88).

- Homes with secondary heating sources appear to supplement their primary heating when heating their home. As a result, future evaluations should consider the impact of program measures on both primary and secondary heating.

The following caveats are important to consider given the study's status:

- The study is ongoing and all preliminary findings are subject to change. The evaluators do not anticipate significant changes to the key results presented in this memo, but acknowledge these results may shift slightly following a complete review process.

- The preliminary findings may also change based on agency's bulb installation practices. Discussions to date indicate that some agencies may install efficient lighting in any available sockets, while others may target specific high-use room or fixture types. The agency's collective installation practices have ramifications on the appropriateness of the preliminary HOU of 2.66, which represents average usage across all sockets in low income homes.

Programs to which the Results of the Study Apply:

- Low-Income New Construction (Electric)

- Low-Income 1-4 Family Retrofit (Electric & Gas)

- Low-Income Multi-Family Retrofit (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: No recommendations were offered, but the status memo does state that future low income impact evaluations should include secondary heating fuels when estimating total program savings.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: The PAs will include secondary heating fuels where appropriate in future low income impact evaluations.

Savings Impact: No savings impacts are offered at this time.

Formulas Used in Impact and Process Analysis: The preliminary study findings are based on analysis of 261 site visits at randomly sampled low income customer homes across the Commonwealth of Massachusetts.

At each home, trained technicians completed a whole-home lighting inventory and installed up to 10 lighting loggers per home. The technicians also installed a meter that assesses thermostat usage (for both manual and programmable thermostats) and meters that monitored heating equipment. In total, more than 2,000 lighting loggers and 800 meters were installed on heating equipment and collected usage information from November 29, 2012, through May 2, 2013.

The raw data collected through this robust metering process were reviewed, weighted, and annualized to estimate annual usage.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: No formal recommendations were offered.

A copy of the complete study can be found in Appendix C, Study 11.

E. C&I Program Studies

12. Massachusetts Small Business Direct Install: 2010-2012 Impact Evaluations

Type of Study: Impact Evaluation
Evaluation Conducted by: The Cadmus Group, Inc. and Navigant
Date Evaluation Completed: 1/29/2013

Evaluation Objective and High Level Findings: The Cadmus Group and Navigant Consulting prepared this summary evaluation report. This summary evaluation report compares the results of two previously filed impact evaluations with a billing analysis conducted in 2012 for the C&I Small Retrofit program, and recommends the appropriate program impact factors for future years. The objectives from each evaluation were:

Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study. This study was conducted during 2010-2011 and filed with the 2011 annual report. The impact evaluation was conducted to provide independent estimates of annual energy savings and peak demand impacts for the retrofit installation of high-efficiency lighting fixtures through the C&I Small Retrofit programs. The impact evaluation focused on savings due to the equipment change only and does not include savings due to the installation of lighting controls.

The study showed a statewide combined energy realization rate (included HVAC interaction) of 102%, combined summer coincidence factor of 72%, and combined winter coincidence factor of 44% for non-controlled lighting fixture retrofit projects.

Small Business Direct Install Program**:** Pre/Post Lighting Controls Study. This study was conducted during 2011-2012 and filed with the 2013-2015 three-year plan. The impact evaluation was conducted to provide independent estimates of annual energy savings and peak demand impacts for the retrofit installation of lighting control installations through the C&I Small Retrofit programs. The impact evaluation focused on savings due to the installation of lighting controls only and does not include savings due to the retrofit of associate lighting fixtures.

The study showed a statewide combined energy realization rate (included HVAC interaction) of 42%, combined summer coincidence factor of 17%, and combined winter coincidence factor of 11% for retrofit lighting occupancy sensor installations.

Billing Analysis. This study's goal was to assess the overall energy impact of all C&I Small Retrofit program projects, including non-lighting projects, implemented in 2010 and 2011.

The study found a statewide program energy realization rate of 66%. However, through internal consultation and further analysis, the evaluators concluded that the result was influenced by exogenous factors for which the study could not control, and that the true realization rate was higher than 66%.

The summary report recommended the program use the evaluation results based on the metering study results: statewide combined energy realization rate for lighting fixtures of 102% and statewide combined energy realization rate for lighting controls of 42% (see Table below). For non-lighting measures, it was recommended to maintain existing evaluation results.

Programs to which the Results of the Study Apply:

- C&I Small Retrofit (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from Program Administrators to these recommendations is summarized below.

Note: The recommendations from the Multi-Season study were included in the evaluation summary for that report, filed with the 2011 annual report. This evaluation summary includes only the recommendations from the Pre/Post Lighting Controls Study and the Billing Analysis.

Recommendation 1: Based on the Pre- and Post-Installation Lighting Occupancy Sensor study: the wide-ranging patterns of pre-installation HOU, including some lighting systems that operated less frequently before the controls were installed, were a surprise to the PAs and the evaluators, and were only detected with pre-installation metering. For future evaluations of control-based efficiency measures, the PAs should continue to perform pre- and post-installation metering studies in order to capture the true impacts.

Recommendation 2: Based on the Billing Analysis: If the PAs are to continue using billing analysis as a method for estimating savings achieved by the SBDI Program, we strongly recommend that more detailed information be collected from program participants, particularly building occupancy and vacancy. If obtaining such data is not feasible, the evaluators recommends that the PAs consider only using billing analyses in cases where it is highly unlikely that any exogenous factors correlate with the implementation of energy conservation measures. In practice, billing analyses would likely only be appropriate in cases where participants are highly homogenous and have consistent patterns of consumption (e.g., all participant buildings are government offices).

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

Future evaluations of the types described above may incorporate these recommendations, based on the types of customers being studied, uncertainty around existing equipment and operations, and the additional cost and time necessary to collect more detailed information.

Savings Impact: The evaluation results for lighting fixture installations are similar to previous evaluations, which have consistently verified energy and demand realization rates close to 100%. The summer and winter peak coincidence factors were also similar to previous years.

The evaluation results for lighting control installations are much lower than previously estimated, primarily due to findings regarding the pre-retrofit operating hours. However, these results had poor precision due to the variation in the site-level realization rates.

Formulas Used in Impact Analysis: Program adjusted gross impacts are calculated by applying the total combined energy and demand realization rates to the program gross energy and demand tracking estimates:

Adjusted gross energy impacts are calculated by applying the kWh Realization Rate (kWh_{RR}) and the HVAC electric interaction factor ($HVAC_{ELEC}$) to the tracking gross energy savings.

Summer and winter peak demand impacts are calculated by applying the connected demand realization rate (kW_{RR}), peak coincidence factor (CF_{SP} for summer, CF_{WP} for winter) and HVAC demand interaction factor ($HVAC_{SP}$ for summer, $HVAC_{WP}$ for winter) to the tracking connected kW savings

Application of Results: Retroactively

How the Study Came to the Recommended Conclusions: The billing analysis was conducted for all projects implemented in 2010 and 2011, using participant tracking and usage data provided by each PA and performing data screening and analysis methods to estimate the program realization rate for the statewide program, each measure category, and each PA.

During the analysis, the evaluators identified irregularities in the participant billing data and identified potential sources of bias in the results due to omitted variables. The team surmised that the most likely drivers of drivers of the unexpectedly low realization rates were (1) changes in economic activity, (2) changes in facility occupancy rates, and/or (3) changes in the program participant and/or project characteristics. The team determined that appropriate data to control for these effects were not available and would be difficult and expensive to research.

The team conducted additional research to explain the results and concluded that there was sufficient rationale to reject the results of the billing analysis. These findings included:

(1) Evidence of increases in commercial vacancies in Massachusetts over the past four years, including the program years of interest for the evaluation,

(2) Observed correlations between building vacancies and participation in commercial retrofit efficiency programs, based on contemporaneous research performed in California by the Cadmus Group, and

(3) Demonstration that the absence of participant-specific details on vacancies (and thus not being able to control for it within the model) results in biased parameter estimates in this study.

Based on these findings and additional discussions with the Program Administrators and EEAC Consultants, the evaluators recommended rejecting the billing analysis results and maintaining the results of the metering studies.

A discussion of these findings and the final recommendation is documented in the memorandum "2012 Billing Analysis Findings and Recommendations," dated October 24, 2012.

A copy of the complete study can be found in Appendix C, Study 12.

13. Prescriptive VSD Impact Evaluation

Type of Study: Impact Evaluation
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 5/9/2013

Evaluation Objective and High Level Findings: This report presents the results of the Impact Evaluation of Prescriptive Variable Speed Drives (VSD) conducted by DNV KEMA and DMI between 2011 and 2012. The objective of this impact evaluation is to begin to quantify how well prescriptive VSD installations are performing and to estimate the energy and demand savings resulting from a sample of (26) VSDs installed in Massachusetts between 2011 and 2012 using both pre- and post-installation metering. Data collected as part of this evaluation is intended to be used to help inform the savings factors used in future updated TRMs.

Key findings include the following:

- Annual kWh realization rate was 94% with a relative precision of +/- 23% at the 80% confidence interval.
- Failure to install controls or configure manual VSD speeds is the most common reason for a poor realization ratio.
- Automatic controls are required by the prescriptive VSD applications but are infrequently installed.
- VSD installations were observed to replace existing and failed VSDs and received incentives.
- A small number of motor types are miscategorized. For example, a swimming pool circulation pump was categorized as a hot water circulating pump.
- Manually set fixed VSD speeds are common. This results in constant post-retrofit power demand and very high summer demand reduction realization ratios.
- In some cases comparable energy savings could have been achieved through proper balancing and without a VSD installation. This approach would be less costly and achieve faster payback periods.

- The TRM assumes that hot water pumps will operate during summer months and chilled water pumps operate during winter months. In most cases, these seasonal motor types were shut down and did not operate during the off seasons.

- Summer kW reductions were significantly higher than predicted by the TRM due to the post-retrofit motor operating with manual controls at constant input kW.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Electric)

- C&I Large Retrofit (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Recommendation 1: Many VSDs are installed but never utilized. The motors were observed to operate at 60 Hz after the installation. Post-inspections should be performed to ensure that automatic controls are installed as required by the prescriptive applications.

Recommendation 2: VSD installation dates were found to vary significantly from installation of control sequences. In the majority of installations, the VSD was installed several weeks or months before any type of control sequence was implemented. During this period VSDs would typically operate at 60 Hz. The standard protocol for this evaluation was to await confirmation of the controls installation rather than encourage the installation by calling for updates. In some cases DMI installed kW meters for the pre-retrofit condition, but VSDs were never installed. It is recommended that a six-month follow-up is performed before the full incentive is paid so that proper operation can be confirmed.

Recommendation 3: Multiple instances were observed in which the VSD retrofit was replacing an existing drive. In all of these cases, the facility operator reported that the existing drives were failing and had operational issues. It appeared that these failing VSDs were approximately 15 years old or more. The prescriptive VSD application states that incentives are not available to VSDs replacing existing drives. Evaluated savings for two of these installations were found to be small or even zero based on metering data. It is recommended that a pre-inspection is done to identify whether or not an existing VSD is being replaced.

Recommendation 4: In at least one case energy savings resulted primarily due to proper balancing rather than VSD control of the motor. Prior to the VSD retrofit, a chilled water pump was providing an excess of water to end users and the motor was observed to operate at over 100% load. The VSD installation was used to essentially balance the chilled water flow. This resulted in significant energy savings, the majority of which could have been achieved simply through balancing and without installation of a VSD. It is recommended that a pre-inspection be done to identify cases in which a VSD might not be the most economical solution.

Recommendation 5: Even though the energy realization rate of 94% was good for a program like this, the individual metered VSD energy realization rates varied from -2% to 407%. The -2% case was the only one that was negative, but 15 drives had a realization rate less than 100%. The remaining 10 drives had a realization rate greater than 100%, and in most cases, they were significantly greater. It is recommended that this realization rate be applied to the TRM energy savings estimates as an immediate step.

Recommendation 6: The MA PAs and EEAC should also look to improve upon the motor level savings assumptions following the completion of the current Northeast Energy Efficiency Partnerships (NEEP) VSD Load Shape study expected to be completed in late 2013. This study includes post-installation metering on hundreds of drives, which would help to refine the TRM savings assumptions for certain motor, and possibly building types.

Recommendation 7: The TRM claims summer kW reductions for hot water pumps and winter kW reductions for chilled water pumps. In most cases, hot water pumps were observed to be shut down for the summer months and chilled water pumps shut down for winter months. It is not expected that this would apply to all of these motor types, but based on the sample observed in this evaluation, it appears that the TRM should be adjusted downwards. Currently, it appears that the TRM assumes 100% of these motors will operate during their off-seasons. It is recommended that the TRM be reviewed, and appropriate adjustments be made to ensure that demand savings are realistic for certain measure types. Consider near-zero summer kW reduction for hot water pumps and near-zero winter kW reduction for chilled water pumps

Recommendation 8: Summer On-Peak kW reductions in the TRM are generally very close to zero for motor types not related to heating. This seems to be a reasonable assumption for motors with automatic controls as it would be expected that an appropriately-sized motor would operate near full load on a design day; however, the evaluation observed significantly more motors with manual controls than expected, with the motors operating below full-load input kW. Since the TRM predicts near-zero summer kW reductions, this results in very high realization ratios. It is recommended the PA's examine the TRM summer On-Peak kW reduction values for accuracy.

Recommendation 9: It is not recommended that the realization rates for demand savings from this study are applied to the TRM due to the poor precisions. However, we think that the observations noted above, plus the results of the aforementioned NEEP study, can be used together to improve upon the savings estimates in the TRM.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

Savings Impact: While the overall realization ratio is close to 100%, there is a significant variation at the motor level, and many motors are either close to 0% or much higher than 100%. Overall, the onsite savings were lower than the tracking estimates with a realization rate of 94%.

Formulas Used in Impact Analysis: A custom 8,760 hour spreadsheet model was used for each motor metered. Savings were typically developed using time-of-use trends, while very few were developed using outdoor air temperature trends depending on the operation of the motor and VSD.

Application of Results: Retrospectively

How the Study Came to the Recommended Conclusions: This study attempted to obtain pre and post installation metering on retrofit VSD installations. The recommended sample size of 44 drives was not achieved due to several issues involved in trying to obtain pre installation metering. The final sample size was 26 drives. Evaluators conducted pre and post metering on each of the 26 drives using true power meters. Savings were developed by comparing the metered pre installation energy use and the metered post installation energy use, and annualized in an 8,760 hour spreadsheet model.

A copy of the complete study can be found in Appendix C, Study 13

14. Impact Evaluation of 2010 Prescriptive Lighting Installations

Type of Study: Impact Evaluation
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 6/21/2013

Evaluation Objective and High Level Findings: This document summarizes the work performed by DNV KEMA between 2011 and 2013 to quantify the actual energy and demand savings of 56 prescriptive lighting projects installed through the Massachusetts Energy Efficiency Program Administrator's (PAs) C&I New Construction & Major Renovation and C&I Large Retrofit programs in 2010. Note that this document presents the final results following 12 months of metering for the four prescriptive lighting categories of interest, systems, controls, Advanced Lighting Design and refrigerated LED case lighting.

The final study results, produced following 12 months of monitoring, will be used to determine the final realization rates for prescriptive lighting energy efficiency projects installed in the C&I New Construction & Major Renovation and C&I Large Retrofit programs in 2012. This report presents realization rates for gross energy savings and savings factors at the statewide level using 12 months of metered data collected from each site. These savings factors should be applied to future Technical Reference Manual (TRM) updates. Key findings include the following:

- Lighting systems energy kWh realization rate including HVAC interactive effects was 112.3% with a relative precision of +/-7.9% at the 90% confidence interval.

- Lighting controls energy kWh realization rate including HVAC interactive effects was 72.0% with a relative precision of +/-23.2% at the 90% confidence interval.

- Advanced Lighting Design energy kWh realization rate including HVAC interactive effects was 124.6% with a relative precision of +/-7.6% at the 90% confidence interval.

- Refrigerated LED case lighting systems energy kWh realization rate including HVAC interactive effects was 94.3% with a relative precision of +/-6.3% at the 90% confidence interval.

- A comparison of 3-month metering interim results vs. 12-month metering results showed that energy savings were generally over-estimated in the 3-month analysis. The comparison analysis also found that the most representative 3-month metering period occurred between September and November.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Electric)

- C&I Large Retrofit (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

General Lighting:

Recommendation 1: For future lighting impact evaluations, three month data collection should be sufficient to estimate annual energy savings. It is recommended that the PAs consider monitoring for a minimum of three months. Also consider including a winter or summer month in that period if possible.

Lighting Systems:

Recommendation 2: It is recommended that the lighting systems component of the TRM be updated to reflect these new results.

Recommendation 3: It is recommended that the PAs continue to use site specific data when estimating lighting hours of use.

Lighting Controls:

Recommendation 4: Depending on the outcome of the current lighting controls market study, a pre/post metering lighting controls study may be needed in the future.

Recommendation 5: To help implementation and TA vendors and produce more reliable estimates of hours reduced, it is recommended that the PAs consider requiring pre-installation metering to establish an estimate of baseline hours.

Recommendation 6: Until a new pre/post lighting controls impact evaluation is done, it is recommended that the lighting controls component of the TRM be updated to reflect these new results.

Advanced Lighting Design:

Recommendation 7: It is recommended that for all Advanced Lighting Design projects, the PAs try to collect the final lighting as-built, which would be used to adjust the proposed connected kW savings.

Recommendation 8: It is recommended that the PAs and EEAC consider updating the TRM using these realization rates and savings factors.

Refrigerated LED Case Lighting:

Recommendation 9: This report recommends that the TRM be updated to utilize a refrigeration system efficiency of 1.9 kW/Ton. This value is based on a larger proportion of lower temperature freezer cases than cooler cases found in these applications.

Recommendation 10: It is recommended that in all future freezer/cooler case LED lighting applications, lighting controls be considered.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

Savings Impact: Results from this study will be applied to the gross energy and demand savings to produce net energy and demand savings adjusted for actual conditions found in the field such as technology, documentation, quantity, operation, interactive HVAC effects and coincidence with system the peak.

Formulas Used in Impact Analysis:

Summer Coincidence Factor = Summer Coincidence * Summer kW HVAC Interactive Effect Factor

Gross Adjusted Summer kW = Gross kW * Connected kW Realization Rate * Summer Coincidence Factor

Winter Coincidence Factor = Winter Coincidence * Winter kW HVAC Interactive Effect Factor

Gross Adjusted Winter kW = Gross kW * Connected kW Realization Rate * Winter Coincidence Factor

kWh Realization Rate = Connected kWh Realization Rate * Hours-of-Use Realization Rate * kWh HVAC Interactive Effect Factor

Gross Adjusted kWh = Gross kWh * kWh Realization Rate

Application of Results: Retrospectively

How the Study Came to the Recommended Conclusions: Data collection included 12 months of metering using mostly time-of-use lighting loggers. The sample was designed to achieve 90/10% precision for energy savings for each measure. The sample sizes were 34 lighting systems, 26 lighting controls, 10 advanced lighting design and 10 refrigerated LED lighting sites.

A copy of the complete study can be found in Appendix C, Study 14.

15. Impact Evaluation of 2011 Custom Refrigeration, Motor and Other Installations

Type of Study: Impact Evaluation
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 6/18/2013

Evaluation Objective and High Level Findings: This document summarizes the work performed by DNV KEMA, DMI and SBW Consulting during 2012 and 2013 to quantify the actual energy and demand savings due to the installation of 48 custom refrigeration, motor and other (RMO) measures installed through the Massachusetts Energy Efficiency Program Administrator's (PAs) Commercial & Industrial (C&I) New Construction & Major Renovation and C&I Large Retrofit programs in 2011.

The objective of this impact evaluation is to provide verification or re-estimation of electric energy and demand savings estimates for 48 custom RMO projects installed in 2011 through site-specific inspection, monitoring, and analysis. The results of this study will be used to determine the final realization rates to be applied to custom RMO energy efficiency measures installed in the C&I New Construction & Major Renovation and C&I Large Retrofit programs in 2012. This evaluation report presents realization rates for gross energy savings for all PAs. It also provides realization rates for on-peak summer and winter demand savings for all PAs except for Western Massachusetts Electric (WMECo). For WMECo, realization rates for summer and winter seasonal peak savings are provided. For National Grid, realization rates for percent on-peak energy savings are also provided. Realization rates for each of these parameters are also provided at the statewide level.

Key findings include the following:

Custom Refrigeration:

Statewide energy kWh realization rate of 110.5% with a relative precision of +/-12.2% at 90% confidence.

National Grid energy kWh realization rate of 118.8% with a relative precision of +/-17.7% at 90% confidence.

NSTAR energy kWh realization rate of 112.7% with a relative precision of +/-5.7% at 90% confidence.

Cape Light Compact energy kWh realization rate of 75.0% with a relative precision of +/-73.2% at 90% confidence.

WMECo energy kWh realization rate of 65.8% with a relative precision of +/-18.3% at 90% confidence.

Custom Motor:

Statewide energy kWh realization rate of 91.4% with a relative precision of +/-3.7% at 90% confidence.

National Grid energy kWh realization rate of 88.5% with a relative precision of +/-4.8% at 90% confidence.

NSTAR energy kWh realization rate of 134.2% with a relative precision of +/-0.0% at 90% confidence.

WMECo energy kWh realization rate of 77.7% with a relative precision of +/-0.0% at 90% confidence.

Custom Other:

Statewide energy kWh realization rate of 61.4% with a relative precision of +/-1.9% at 90% confidence.

National Grid energy kWh realization rate of 31.0% with a relative precision of +/-4.3% at 90% confidence.

WMECo energy kWh realization rate of 270.7% with a relative precision of +/-0.0% at 90% confidence.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Electric)
- C&I Large Retrofit (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Statewide:

Recommendation 1: Make sure customers and TA vendors understand they need to be prepared to provide assistance if their project is selected for evaluation.

Recommendation 2: Ensure sufficient time is allowed for logging data for projects with seasonal variability.

Recommendation 3: All PAs should require more complete pre-retrofit or baseline documentation.

Recommendation 4: PAs should work together to require consistent methodologies and documentation for similar projects across different PAs.

Recommendation 5: Consider specifying documentation requirements for compressed air leak repairs.

Recommendation 6: Consider more of a whole system approach for grouping measures for evaluation.

Recommendation 7: Require TA vendors to provide metering for retrofit projects.

Recommendation 8: Consider specifying TA verification of savings via commissioning, and in some cases, pre/post metering for specific measures.

Cape Light Compact:

Recommendation 9: Perform closer review of large savings measures.

Recommendation 10: Include interactive refrigeration savings.

National Grid:

Recommendation 11: Require adequate savings documentation.

Recommendation 12: Verify proposed load assumptions as part of the final inspection of new construction projects.

Recommendation 13: Verify proposed item count assumptions as part of the final inspection.

Recommendation 14: Verify plant operating hours using whole building interval data.

Recommendation 15: Ensure consistent use of data throughout the calculations.

NSTAR:

Recommendation 16: Provide sufficient documentation for understanding the determination of measure savings.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

Savings Impact: Custom refrigeration savings were generally greater than tracking assumptions with a statewide realization rate of 110.5%. Custom motor savings were somewhat lower than

tracking estimates with a statewide realization rate of 91.4%. Custom other had a low realization rate of 61.4% due to some underperforming sampled sites.

Formulas Used in Impact Analysis: Evaluated savings were developed using custom analysis methods which were similar to the methods to develop tracking estimates.

Application of Results: Retrospectively

How the Study Came to the Recommended Conclusions: Data collection included true power metering, amperage metering and time-of-use metering. In some cases, the evaluation relied on existing customer metering when necessary. The sample was designed to achieve 90/20% precision for energy savings for each measure and each PA. The sample sizes were 28 refrigeration sites, 13 motor sites, and 7 other sites.

A copy of the complete study can be found in Appendix C, Study 15.

16. Process Evaluation of the 2012 Bright Opportunities Program

Type of Study: Process Evaluation
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 6/14/2013

Evaluation Objective and High Level Findings: The evaluation objectives included:

- Determining whether this program, which is brand-new, is appropriately designed;
- Determining whether the program is being delivered in an efficient/effective manner;
- Providing estimates of net-to-gross ratios for the program net of free-ridership; and
- Providing preliminary estimates of participant spillover for the program.

The high level findings included:

- The preponderance of the evidence indicates that the Bright Opportunities Program is a well-designed and well-run program. This evidence includes:
    - Generally high program satisfaction levels from end users and participating trade allies;
    - Lack of barriers to program participation (beyond unawareness of the program);
    - Generally high program net-to-gross ratios; and
    - Lack of significant complaints from program implementers.

- The recommended net-to-gross ratios for the lighting products discounted by the program were 82 percent for LED bulbs and 74 percent for linear fluorescent lamps. The evaluation calculated the participant spillover to be not statistically different from zero.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Electric)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Recommendation 1: Do more marketing of the program, especially to end users.

Recommendation 2: Encourage participating trade allies to do more to educate their customers about the source and size of the buydown discounts.

Recommendation 3: Do more consumer education about the use of LED bulbs with dimmer switches.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

Savings Impact: The recommended net-to-gross ratios for the lighting products discounted by the program were 82 percent for LED bulbs and 74 percent for linear fluorescent lamps. The evaluation calculated the participant spillover to be not statistically different from zero.

Formulas Used in Impact Analysis:

Net Summer kW Savings = Gross Adjusted Summer kW * Net-to-Gross ratio

Net Winter kW Savings = Gross Adjusted Winter kW * Net-to-Gross ratio

Net kWh Savings = Gross Adjusted kWh * Net-to-Gross ratio

Application of Results: Retroactively

How the Study Came to the Recommended Conclusions: Data collection activities included:

- Conducting interviews with staff from the program and from Ecova, the main implementation contractor;
- Completing telephone surveys with 200 program participants; and
- Conducting in-depth interviews with 25 participating lighting distributors, 8 nonparticipating lighting distributors, and 25 participating lighting contractors.

A copy of the complete study can be found in Appendix C, Study 16.

17. C&I Customer Profile Project

Type of Study: Market Characterization
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 6/20/2013

Evaluation Objective and High Level Findings: The primary goals of the C&I Customer Profile project were to:

- Characterize the Massachusetts energy efficiency market by analyzing recent customer usage and program participation data.
- Collect comprehensive billing and tracking data for all C&I customers to develop a single database to provide a consistent source of program tracking and billing data to support ongoing evaluation efforts.
- Estimate the extent to which customers of various sizes and types participated in energy efficiency programs during 2011.
- Document the processes used to consolidate and normalize PA data, and recommend enhancements to tracking systems to improve accuracy of results in future studies.

Highlights of the results of the analyses of participation by sector include:

- Custom vs. Prescriptive: The vast majority of savings in 2011 came from custom projects (64% of electric and 81% of gas). This would support a continuation of impact evaluation work of customer projects to ensure that methods used to calculate savings are effective.
- End Uses: On the electric side, the end use categories with the highest 2011 savings were lighting, combined heat and power (CHP) and heating, ventilation and air-conditioning (HVAC). While impact evaluations are underway for lighting and CHP, it has been several years since the last HVAC study. For gas projects, most 2011 savings came from HVAC.
- Business Type: The reliability of the estimated participation and savings rates by business type is limited by the fact that only 59% of billing accounts could be assigned to a business type. However, it appears that while only 1.8% of electric accounts classified as healthcare participated, their average savings was 23%. Similarly for gas, of the 3% of accounts classified as healthcare and education, the average savings was high. This may indicate the potential for significantly more savings in these sectors.
- Account Size: Participation rates increase as account size increases for both gas and electric, reflecting the individualized attention paid to these entities by PA account managers. However, the average savings percent is highest for small gas and electric accounts.

- Same PAs: The participation rate for gas customers with the same electric PA is 2.6%, which is higher than the 1.6% participation rate for those with different electric PAs. This may be an indication of the challenges faced in coordinating marketing efforts between PAs.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Electric & Gas)
- C&I Large Retrofit (Electric & Gas)
- C&I Small Retrofit (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: The following recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Recommendation 1: Standardization of tracking database information about end uses and building types would increase the accuracy of any information derived from the records received.

Recommendation 2: In order to evaluate overall customer participation, it is necessary to build the capability to link accounts across fuels.

Recommendation 3: Leverage the baseline information collected here for other market characterization projects and efforts to estimate savings opportunities in each sector.

Recommendation 4: Incorporate checks to ensure that account numbers entered into tracking systems are accurate, and correspond to those in billing systems.

Recommendation 5: If there is a need for more reliable information by business type, explore services and software to use names and addresses to lookup business type rather than relying on PA designations.

Recommendation 6: Build on this one year snapshot with additional data going forward to accumulate program participation history.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

Savings Impact: Not applicable. This is a market characterization study.

Formulas Used in Impact Analysis: Not applicable. This is a market characterization study.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: The project involved the collection, organization and analysis of 2011 energy efficiency project tracking data and billed energy usage for all Massachusetts Commercial and Industrial (C&I) gas and electric customers. The statewide database developed from this project has already provided information upon which other C&I impact and process evaluation work has been based. Once the data were collected and consolidated, it was analyzed to produce summaries that characterize the current energy efficiency market in Massachusetts.

A copy of the complete study can be found in Appendix C, Study 17.

18. Mid-Sized Customer Needs Assessment - Interim Results

Type of Study: Market Characterization
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 6/28/2013

Evaluation Objective and High Level Findings: This study provides results to date for the Massachusetts Mid-Sized Customer Needs Assessment for 2011 C&I customers. The study aims to investigate the extent to which current program offerings effectively serve the needs of mid-sized customers. In addition, if it is found that mid-sized customers or pockets of customers are underserved, the study will explore whether variations to existing program offerings or additional programs would be needed to optimally serve these customers. DNV KEMA completed research activities that addressed the following three objectives:

- Determine how Massachusetts PAs currently address mid-sized customers;
- Identify and describe the population of mid-sized customers across PAs (on-going);
- Estimate program participation rates for the largest, smallest, and mid-sized customers.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Electric & Gas)
- C&I Large Retrofit (Electric & Gas)
- C&I Small Retrofit (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: The following preliminary recommendations were made by the evaluators conducting this study. The initial response from the Program Administrator to these recommendations is summarized below.

Recommendation 1: *Improve processes for linking multiple accounts to customers* – The PA's ability to accurately and consistently classify customers depends upon their ability to track multiple account customers within and across PAs. The PAs employ a range of tools to help them link customers; however, these tools did not provide sufficient support to enable

the research team to link account representatives to the accounts they manage by account number. Moreover, we found large discrepancies between the segments that the PAs felt they were managing and those we were able to match with account representatives.

Recommendation 2: *Standardize classification and marketing approaches to multi-account customers* – The research found that multiple account customers were treated differently across PAs, and also within a PA, across customers. The lack of standardized approaches for treating multiple account customers limits our ability to isolate segments of customers based on size and complicates the PA's ability to effectively market to those customers.

Recommendation 3: *Link electric and gas customers* – Because much of the identification and marketing to Direct Install customers is handled through the electric PAs, the gas-only PAs lose some autonomy regarding how their customers are marketed. Consequently, some large gas customers are not identified until after they receive Direct Install prescriptive solutions from installation contractors. Improved coordination of tracking systems across PAs would reduce the risk of this occurring. DNV KEMA found that the PA's ability to link accounts across firms is constrained by legal privacy issues that must be addressed before this will be possible.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: All recommendations are being considered for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

This memorandum provides preliminary results of this mid-sized customer needs assessment. The findings were limited to those relating to the in-depth interviews with PA staff and implementation contractors, and limited analysis of the C&I Customer Profile Project database. Continued research efforts include a detailed data mining exercise to investigate the relationship between in-depth interview responses and the customer billing and program tracking records as well as implementation of a survey of participants and non-participants to test various hypotheses developed based on the PA interviews and data analysis conducted to date. Results of these analyses will be reported in the final report which is expected to be completed in the second half of 2013.

Savings Impact: Not applicable. This is a market characterization study.

Formulas Used in Impact Analysis: Not applicable. This is a market characterization study.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: Interviews with each PA and 5 implementation contractors provided a set of criteria used to segment customers by size. In addition to reviewing the interview findings, DNV KEMA used the available customer billing and tracking data to examine differences in participation rates across the three size groups.

A copy of the complete study can be found in Appendix C, Study 18.

19. Impact Evaluation of 2011 Prescriptive Gas Measures

This study applies to gas energy efficiency programs only and is, therefore, not included in the Electric PAs' Energy Efficiency Annual Reports

20. Standard Boiler Research Plan and Interview Results Memo

This study applies to gas energy efficiency programs only and is, therefore, not included in the Electric PAs' Energy Efficiency Annual Reports

21. Impact Evaluation of 2011 Custom Gas Installations

This study applies to gas energy efficiency programs only and is, therefore, not included in the Electric PAs' Energy Efficiency Annual Reports

F. Special & Cross Sector Studies

22. Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report

Type of Study: Impact and Process Evaluation
Evaluation Conducted by: Opinion Dynamics with Navigant Consulting and Evergreen Economics
Date Evaluation Completed: 6/20/2013

Evaluation Objective and High Level Findings: This report includes impact findings of behavior/feedback programs and pilots administered by National Grid, NSTAR, Western Massachusetts Electric Company (WMECo) and Cape Light Compact (CLC) during the 2012 program year. It also includes process findings for CLC's Smart Home Energy Monitoring Pilot (SHEMP) from 2009 - 2012.

The evaluation includes the following findings:

- The 2012 impacts for the National Grid and NSTAR behavior/feedback programs range from 41 kWh to 258 kWh per household for the electric cohorts and from 0.28 MMBtus to 1.90 MMBtus for the gas cohorts.

- OPower electric programs have demonstrated an average adjusted net savings gain of 27% from program year (PY) 1 to PY2, and 16% from PY2 to PY3. Gas programs have demonstrated an average adjusted net savings gain of 20% from PY1 to PY2, and 23% from PY2 to PY3.

- Since 2009, the National Grid and NSTAR behavior/feedback programs using OPower have channeled 24,122 additional participants into other residential programs and resulted in a savings of 5,298 MWh and 28,581 MMBtus. The additional savings are a result of the OPower program driving increased participation in other residential programs.

- For National Grid and NSTAR behavior/feedback programs, the report provided savings estimate ratios to adjust implementer estimate of savings based on comparison of treatment and control group usage for each month of participation. The savings estimates range between 90% - 111%.

- The WMECo program achieved a total overall savings of 2,263 MWh in 2012 attributable to "passive" participants that receive energy saving reports (mailers), and "activated" participants that interact with an online web platform.

- The WMECo program has had a substantial positive impact on participation in other energy efficiency programs. For instance, online activation of the web portal has increased participation in the Mass Save program by 431 customers in 2012.

- CLC's SHEMP Pilot using the Tendril in-home displays had significant savings differences between the older Legacy cohort and the more recent Energize cohort. Legacy customers' savings range from 7.8%-8.8% average savings per household. Comparatively, Energize savings estimates are significantly lower, ranging from 1.49%-1.99% average savings per household.

- CLC's SHEMP Pilot had differences between Legacy and Energize cohorts' cross-program participation levels. Legacy customers demonstrated a sharp increase in cross-program participation during the Legacy participation period. Energize customers' monthly cross-program participation dropped during the treatment period.

Programs to which the Results of the Study Apply:

- Behavior/Feedback (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: There were no recommendations as part of this report.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: Not applicable

Savings Impact: For the National Grid and NSTAR behavior/feedback programs, the net savings increase or decrease slightly compared to the 2012 TRM for various cohorts. Please see Table 2 on page 10 in the report for additional information.

Similarly for WMECo, net savings increase or decrease compared to planned values, with passive participants exhibiting increased savings while activated participants exhibiting decreased savings. Please see Table 14 in the report for additional information

CLC's SHEMP pilot results do not impact savings.

Formulas Used in Impact Analysis:

Impact analysis for Behavior/Feedback programs using OPower HER, and for passive participants in the WMECo program:

$$ADC_{it} = \alpha_i + \beta_1 Post_t + \beta_2 Treatment_i \cdot Post_t + \varepsilon_{it} \qquad \text{(Equation 1)}$$

where:
ADC_{it} = Average daily consumption (kWh) for household i at time t
α_i = Household-specific intercept
β_1 = Coefficient for the change in consumption between pre- and post-periods
β_2 = Coefficient for the change in consumption for the treatment group in the post-period compared to the pre-period, and to the comparison group. This is the basis for the net savings estimate.

Please refer to section 3.1.2 of the report for additional information.

Developing Savings Estimate Ratio for Behavior/Feedback programs using OPower HER:

$$\textbf{Savings Estimate Ratio}_{u,f} = \frac{(Estimated\ Modeled\ Savings) = \sum_{i=0}^{3} n * kWh\ Savings_{u,c,i,f}}{(OPOWER\ Reported\ Savings) = \sum_{i=0}^{3} n * kWh\ Savings_{u,c,i,f}}$$

(Equation 3)

where:
n is the average number of participants in a given cohort
u is a given utility
c is a given cohort
i is a given time period
f is a given fuel type

Please refer to section 3.1.2 of the report for additional information.

Impact Analysis for WMECo's Activated Participants:

The matching method was employed to calculate savings for WMECo's activated participants. The matching method follows the approach summarized in Imbens and Woorldige (2009) and applied in Abadie and Imbens (2011). In this model, the effect of the activation in month *t* is the difference between the energy use of participant *k* and its estimated counterfactual (baseline) consumption.

Impact Analysis for CLC's SHEMP Pilot -- Model 1:

$$kWh_{kt} = \alpha_{0t} + \alpha_1 Treatment_{kt} + \alpha_2 PREkWh_{kt} + \sum_{j=1}^{J} \beta^j EE_{kt}^j + \varepsilon_{kt}$$

where:

kWh_{kt} is the average daily electricity use by household k during month t;

all Greek characters denote coefficients to be estimated, and in particular α_{0t} is a monthly fixed effect.

$Treatment_{kt}$ is an indicator variable taking a value of 1 if customer k is a SHEMP participant, and 0 otherwise;

$PREkWh_{kt}$ is the average daily electricity use by household k during the most recent month before household k enrolled in SHEMP that is also the same calendar month as month t. For instance, if household k enrolled in August 2011, the value of $PREkWh_{kt}$ for June 2012 is June 2011.

EE_{kt}^{j} is an indicator variable for energy efficiency program j, taking a value of 1if customer k is in the program in period t and 0 otherwise. In the analysis we consider four EE programs (that is, J=4), denoted by the following variables in regression results reported in Appendix C (of the Evaluation Report):
LISF= Low Income Single Family program;
MFR= Multi-Family Retrofit program;
RHE= Residential Home Energy program;
RP= Residential Products program.

ε_{kt} is the error term

In this model α_1 indicates average daily savings generated by the program for participants over the course of the initiative.

Please refer to section 3.3.4 of the report for additional information.

Impact Analysis for CLC's SHEMP Pilot -- Model 2:

$$Savings_{kt} = kWh_{kt} - \widehat{kWh}_{kt}^{C}$$

$$\widehat{kWh}_{kt}^{C} = kWh_{kt}^{M} + \hat{\beta}\left(\mathbf{X}_{kt} - \mathbf{X}_{kt}^{M}\right)$$

where**:**

kWh_{kt} = the average daily electricity use by household *k* during month t;

$\widehat{kWh}_{kt}^{C}$ = the estimated counterfactual energy use by household *k* during month *t*;

kWh_{kt}^{M} = the energy use by household *k*'s match during month *t*;

$\mathbf{X}_{kt}$ = the values for household *k* in month *t* of the independent variables **X** affecting energy use;

$\mathbf{X}_{kt}^{M}$ = the values of **X** in month *t* for household *k's* match.

$\hat{\beta}$ = the factors used to adjust household *k*'s energy use to reflect differences between household *k* and its match in the value of **X.**

Please refer to section 3.3.4 of the report for additional information.

Application of Results:

- The National Grid and NSTAR Behavior/Feedback results will be applied in the 2012 Annual Report.
- The National Grid and NSTAR Behavior/Feedback savings estimate ratio will be applied in 2013 and going forward.
- The WMECo Behavior/Feedback results will be applied in the 2012 Annual Report.
- CLC SHEMP is a pilot program that will not directly affect savings for any program during this annual report year.

How the Study Came to the Conclusions: For the National Grid and NSTAR Behavior/Feedback programs and WMECo passive participants, the evaluation developed its savings estimate based on a billing analysis of the entire program population and its randomly assigned control groups using a linear fixed effects regression. A channeling analysis was then performed to determine what portion of HER savings, as measured through the billing analysis, were captured in other programs. For more information, please see section 3.1 of the study.

For the WMECo Western Mass Saves (WMS) activated participants, the matching method was employed to calculate savings. More details can be found in Section 3.2.2 of the study.

For CLC's SHEMP pilot process evaluation, the evaluation findings are based on a literature review, survey research from pre and post treatments surveys and an additional survey to a comparison group. For CLC's impact analysis, the evaluation uses a billing analysis of the opt-in treatment group to a matched comparison group. For more information, please see section 3.3 of the study.

A copy of the complete study can be found in Appendix C, Study 22.

23. 2012 Massachusetts Statewide Marketing Campaign Evaluation Report

Type of Study: Market Assessment
Evaluation Conducted by: Opinion Dynamics Corporation
Date Evaluation Completed: 1/11/2013

Evaluation Objective and High Level Findings: This report presents results from the post 2012 statewide umbrella marketing survey effort conducted by Opinion Dynamics. The primary goal of this research is to enable the PAs to track changes in Mass Save awareness over time as well as to measure the effectiveness of the campaign. As such, this report presents the results from residential and C&I quantitative surveys conducted immediately following the 2012 campaign, which ran from April 2 to August 19, 2012. A comparison of results from the pre- and post-campaign surveys indicates that there have been some changes in Mass Save awareness or familiarity as a result of 2012 campaign activities. However, there are differing results within the residential and commercial populations.

Overall, the team found divergent results within the residential and C&I populations, with C&I customers showing greater changes in awareness and other metrics over time. For example, there has been a significant increase in Mass Save awareness among C&I customers compared to awareness prior to the 2012 campaign launch. The August 2012 survey shows that awareness among C&I customers has risen from 33% pre-campaign to 40% post-campaign. However, awareness of and familiarity with Mass Save has not changed significantly among residential PA customers since the pre-campaign survey. In addition, there has been little change in residential familiarity compared to the 2010 baseline study conducted by the campaign implementer.

Programs to which the Results of the Study Apply:

- Residential New Construction and Major Renovation (Electric & Gas)
- Residential Cooling and Heating Equipment (Electric & Gas)
- Residential Multi-Family Retrofit (Electric & Gas)
- Residential Mass Save (Home Energy Services) (Electric & Gas)
- Residential ENERGY STAR® Lighting (Electric)
- Residential ENERGY STAR® Appliances (Electric)
- C&I New Construction and Major Renovation (Electric & Gas)
- C&I Large Retrofit (Electric & Gas)
- C&I Small Retrofit (Electric & Gas)
- Behavior/Feedback Program (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: There were no recommendations from this report as it was designed to track changes in awareness from the campaign and to measure the campaigns effectiveness.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: Not applicable.

Savings Impact: No savings impact.

Formulas Used in Impact Analysis: Not applicable.

Application of Results: Prospectively.

How the Study Came to the Recommended Conclusions: A telephone survey was conducted with a random sample of 402 residential customers between August 20 and September 9, 2012, immediately following the conclusion of the 2012 marketing campaign. The sample of customers was based on files that the PAs provided to the evaluators, which merged PA Customer Information System (CIS) data with program tracking databases to develop a master file of all PA residential customers. The evaluators used the merged customer database to create a sample frame containing all unique residential accounts with valid contact information. From this frame, a random sample was created and survey quotas set for each PA combination, in

proportion to their representation in the overall population to ensure that the sample was representative of the overall customer base.

Weights were developed and applied to the residential telephone survey data to match the composition of customers within the Massachusetts population based on home ownership.

The evaluators also conducted a telephone survey among PA business customers to assess changes in awareness, familiarity, and associations with Mass Save. The team surveyed a simple random sample of 295 C&I customers in August and September 2012. The fielding of the survey was timed to take place immediately following the 2012 marketing campaign. The team based the sample of C&I customers on customer files provided by the PAs. Given the lack of readily available population-level data on Massachusetts businesses, the evaluators conducted an unweighted analysis of the commercial survey data.

A copy of the complete study can be found in Appendix C, Study 23.

24. 2013 Massachusetts Statewide Marketing Campaign Pre-Campaign Results

Type of Study: Market Assessment
Evaluation Conducted by: Opinion Dynamics Corporation
Date Evaluation Completed: 6/5/2013

Evaluation Objective and High Level Findings: This report presents results from the pre-2013 statewide umbrella marketing survey effort conducted by Opinion Dynamics. The goal of the research is to document current levels of awareness of Mass Save against which to measure changes over time.

The pre-campaign survey indicates that unaided awareness of Mass Save among residential customers remains moderate (36%) and has not changed since the post 2012 campaign survey. Further, consistent with prior surveys, the percentage of residential customers who consider themselves somewhat or very familiar with Mass Save, remains relatively low (19%). Just under half of residential (46%) customers aware of Mass Save identify utilities or energy efficiency service providers as sponsors.

Among C&I customers, unaided awareness of Mass Save is moderate with 47% reporting that they have seen or heard the term before. This represents an increase since the last statewide marketing survey when awareness was 40%. Additionally, just over half of commercial customers (55%) aware of Mass Save identify utilities or energy efficiency service providers as sponsors.

Programs to which the Results of the Study Apply:

- Residential New Construction and Major Renovation (Electric & Gas)
- Residential Cooling and Heating Equipment (Electric & Gas)

- Residential Multi-Family Retrofit (Electric & Gas)
- Residential Mass Save (Home Energy Services) (Electric & Gas)
- Residential ENERGY STAR® Lighting (Electric)
- Residential ENERGY STAR® Appliances (Electric)
- C&I New Construction and Major Renovation (Electric & Gas)
- C&I Large Retrofit (Electric & Gas)
- C&I Small Retrofit (Electric & Gas)
- Behavior/Feedback Program (Electric & Gas)

Evaluation Recommendations and Program Administrator Response: There were no recommendations from this report as it was designed to establish baseline campaign awareness.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: Not applicable.

Savings Impact: No savings impact.

Formulas Used in Impact Analysis: Not applicable.

Application of Results: Prospectively

How the Study Came to the Recommended Conclusions: Evaluators conducted a telephone survey with a random sample of 504 residential PA customers. The team drew the sample from multiple data files provided by the PAs. The team integrated customer data to create a sample frame containing all unique residential accounts with valid contact information. From this frame, the team drew a random sample and set survey quotas for each PA combination in proportion to their representation in the overall population to ensure that the sample was representative of the overall customer base.

Similar to the 2012 surveys, the team developed and applied weights to the residential telephone survey data to match the composition of customers within the Massachusetts population based on homeownership.

The team also surveyed a random sample of 456 PA C&I customers in March of 2013. The team drew the sample of C&I customers from customer data provided by the PAs.

Given the lack of readily available population-level data on Massachusetts businesses, the evaluators did not weight the results of the commercial survey. However, the team also considered whether weighting the survey results to those from the first survey with this group was necessary. The team determined that it was appropriate to leave the data unweighted due to the fact that the team spoke with similar firms across each of the survey waves, and the fact that

there is no consistent or significant relationship between any of the firmographics and Mass Save awareness across the waves.

A copy of the complete study can be found in Appendix C, Study 24.

25. Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure

Type of Study: Impact Evaluation
Evaluation Conducted by: NMR Group
Date Evaluation Completed: July 15, 2013

Evaluation Objective and High Level Findings: Non-Energy Impacts (NEIs) associated with heating, cooling, and water heating equipment may differ according to whether the program-sponsored equipment is an early replacement measure, a measure that is replacing failed equipment, or equipment that was scheduled to be replaced.

This memorandum provides adjusted deemed NEI values that address the differences in NEIs for residential heating, cooling, and water heating equipment that is early replacement compared to replace on failure. These deemed NEIs update the NEIs provided in the residential NEI report submitted to the PAs on August 15, 2011[11].

Programs to which the Results of the Study Apply:

- Residential Cooling & Heating Equipment (Electric)
- Residential Heating and Water Heating (Gas)

Evaluation Recommendations and Program Administrator Response: The study did not offer any recommendations.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: The study did not offer any recommendations.

Savings Impact:

[11] NMR Group, Inc. (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts. (http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2011/2011%20Residential%20Studies/Mass%20Crosscutting%20NEIs%20Final%20Report%20081511.pdf)

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Percent ROF	Overall NEI Value ($/Year)
Cooling System	Central Air Conditioner/ Heat Pump	Noise Reduction	Annual	$2.83	67%	$1.90	35.4%	$2.50
		Home Durability	Annual	$1.54	33%	$0.51		$1.17
		Property Value Increase	One Time	$62.65	50%	$31.33		$51.56
Heating and Cooling System	Ductless Mini-Split	Noise Reduction	Annual	$1.42	67%	$0.95	1.3%	$1.41
		Home Durability	Annual	$1.98	33%	$0.65		$1.96
		Property Value Increase	One Time	$80.69	50%	$40.35		$80.19
Heating System	Boilers between 90 and 96% AFUE	Home Durability	Annual	$17.42	33%	$5.75	86.5%	$7.33
		Property Value Increase	One Time	$678.52	50%	$339.26		$385.23
	Boilers greater than or equal to 96% AFUE	Home Durability	Annual	$17.42	33%	$5.75	86.8%	$7.30
		Property Value Increase	One Time	$678.52	50%	$339.26		$384.21
	Furnaces greater than or equal to 95% AFUE	Home Durability	Annual	$17.42	33%	$5.75	88.4%	$7.10
		Property Value Increase	One Time	$678.52	50%	$339.26		$378.61
Heating and Hot Water System	Integrated Boiler / Water Heater	Home Durability	Annual	$0.72	33%	$0.24	67.9%	$0.39
		Property Value	One Time	$29.17	50%	$14.59		$19.27

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Percent ROF	Overall NEI Value ($/Year)
		Increase						
Hot Water System	Storage Water Heater	Home Durability	Annual	$2.13	33%	$0.70	58.4%	$1.30
		Property Value Increase	One Time	$82.56	50%	$41.28		$58.47
	Tankless Water Heater	Home Durability	Annual	$2.13	33%	$0.70	63.4%	$1.23
		Property Value Increase	One Time	$82.56	50%	$41.28		$56.39

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Final Adjust-ment	Adjusted NEI Value ($/Year)
Cooling System	Central Air Conditioner / Heat Pump	Thermal Comfort	Annual	$3.92	100%	$3.92	÷ 2	$1.96
		Health Benefits		$0.13		$0.13		$0.07
Heating and Cooling System	Ductless Mini-Split	Thermal Comfort	Annual	$5.05	100%	$5.05	÷ 2	$2.53
		Health Benefits		$0.16		$0.16		$0.08
Heating System	Boilers between 90 and 96% AFUE	Thermal Comfort	Annual	$48.63	100%	$48.63	÷ 2	$24.32
		Health Benefits		$1.56		$1.56		$0.78
	Boilers greater than or equal to	Thermal Comfort	Annual	$48.63	100%	$48.63	÷ 2	$24.32

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Final Adjust-ment	Adjusted NEI Value ($/Year)
	96% AFUE	Health Benefits		$1.56		$1.56		$0.78
	Furnaces greater than or equal to 95% AFUE	Thermal Comfort	Annual	$48.63	100%	$48.63	÷ 2	$24.32
		Health Benefits		$1.56		$1.56		$0.78
Heating and Hot Water System	Integrated Boiler / Water Heater	Thermal Comfort	Annual	$1.83	100%	$1.83	÷ 2	$0.92
		Health Benefits		$0.06		$0.06		$0.03

Formulas Used in Impact Analysis:

$$Overall\ NEI\ Value = [(EE\ Portion\ of\ NEI \times Full\ NEI\ Value) \times ROF\%] + [Full\ NEI\ Value \times (1 - ROF\%)]$$

Application of Results: Retroactively

How the Study Came to the Recommended Conclusions: First, NMR developed a method based on industry knowledge and published literature in order to attribute a portion of the NEIs associated with heating, cooling, and water heating systems to the measure's "newness" and a portion to the measure for being energy efficient.

Second, using the attribution factors, NMR estimated the value of the portion of NEIs for heating, cooling, and water heating measures associated with the energy efficiency of the measure for systems that are replaced on failure. Then, using data from the current HEHE and Cool Smart evaluation,[12] the percentage of program participants that replaced failed systems was determined and the adjusted NEI values was attributed to these participants.

A copy of the complete study can be found in Appendix C, Study 25.

12 Cadmus. 2013. 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing (Draft Final Report). June 2013. Prepared for The Electric and Gas Program Administrators of Massachusetts.

G. Future Studies

Table III.B summarizes the studies expected to be included in next year's Annual Report. There are a number of other studies which have been identified and are in the process of being scoped, however it is not known at this time whether they will be completed in time for the next Annual Report.

Table III.B: Evaluation Studies in Next Annual Report		
Studies	Docket & Exhibit Approving Planned Evaluation Studies	Expected to be Implemented as Approved? (yes/no)
Residential Studies		
Residential New Construction Net Savings	Study was approved in January 2013 with the 2013-2015 Three Year Plan. D.P.U. 12-100 through D.P.U. 12-111	Yes
Multifamily Process Evaluation	Study is planned but not yet submitted for approval.	
Home Energy Services Home Performance Contractor and Lead Vendor Analysis		
Regional Hours of Use Lighting Logger Study	Study was approved in January 2013 with the 2013-2015 Three Year Plan. D.P.U. 12-100 through D.P.U. 12-111	
LED Market Effects Baseline Study (Residential and C&I)	Study is planned but not yet submitted for approval.	
Understand Current Stagnation of Lighting Saturation		
Lighting Market Assessment		
Incremental Cost Assessment for Lighting and Products		
Top 10 Products Impact Assessment		
Low-Income Studies		
Low Income Hours of Use	Study was approved in January 2013 with the 2013-2015 Three Year Plan. D.P.U. 12-100 through D.P.U. 12-111	Yes
Low Income Multi-family Impact Scoping Study	Study is planned but not yet submitted for approval.	

Table III.B (continued)

Commercial & Industrial Studies		
Mid-Sized Customer Needs Assessment - Final Report	Study was approved in January 2013 with the 2013-2015 Three Year Plan. D.P.U. 12-100 through D.P.U. 12-111	Yes
CHP Impact Evaluation		
Existing Buildings Market Characterization		
Whole System Approach Study		
Codes & Standards Research using Existing New Construction Data		
Lighting Controls Scoping Study		
LED Market Effects Baseline Study (Residential and C&I)	Study is planned but not yet submitted for approval.	
Market Assessment of Roof Top Units		
Learning from Successful Projects		
Documentation of Program Administrator Differences		
C&I Customer Profile - 2012 Data		
Characterization of Supply Side Population		
Commercial Real Estate Market Characterization		
Process Evaluation of Direct Install Delivery Method		
Impact Evaluation of Custom HVAC Installations		
Impact Evaluation of Prescriptive Non-Lighting Installations		
Special & Cross-Cutting Studies		
2013 Massachusetts Statewide Marketing Campaign Post-Campaign Results	Study was approved in January 2013 with the 2013-2015 Three Year Plan. D.P.U. 12-100 through D.P.U. 12-111	Yes
Efficient Neighborhoods Plus	Study is planned but not yet submitted for approval.	
Serrafix CMI (Northampton/Pittsfield)	Study was approved in January 2013 with the 2013-2015 Three Year Plan. D.P.U. 12-100 through D.P.U. 12-111	
Brand Assessment Analysis of Gas Networks and CoolSmart	Study is planned but not yet submitted for approval.	
New Construction Non Energy Impact Study		
Analysis of Non Energy Impacts for C&I Marketing		
Top Down Net to Gross Scoping Study		
Codes and Standards Scoping Study		

IV. STATUTORY BUDGET REQUIREMENTS

A. Introduction

The Green Communities Act requires that energy efficiency programs minimize administrative costs, utilize competitive procurement processes, and spend a certain amount on low-income programs. G.L. c. 25 §§ 19(a) - (c).

For each sector, Tables IV.A through IV.C summarize and compare planned and actual program planning and administration ("PP&A") costs, outsourced activities, and budget allocation, respectively.

B. Minimization of Administrative Costs

General Laws c. 25, § 19(a) requires the Department, when authorizing energy efficiency programs, to ensure that such programs minimize administrative costs to the fullest extent practicable. Administrative costs, also commonly referred to as Program Planning & Administration ("PP&A") costs, have traditionally been defined as all in-house and outsourced costs associated with planning activities and program administration. These include costs associated with developing program plans, and day-to-day program administration, including labor, overhead costs, and any regulatory costs associated with energy efficiency activities.

The most significant factor in the PA approach to minimizing administrative costs is the statewide collaborative process, which is used by the Program Administrators to coordinate planning, the adoption of consistent programs and processes, program design, EM&V studies, statewide marketing, regulatory proceedings, and the development and sharing of all best practices. Sharing of these costs, which would otherwise be borne by each Program Administrator individually, results in economies of scale that reduce the cost for each Program Administrator. For example, joint releases of Requests for Proposals ("RFPs") lead to minimization of administrative costs in that the cost for preparation and release of the RFP are shared by the PAs. The Program Administrators also minimize administrative costs by coordinating energy efficiency program delivery, where appropriate, with other customer service activities such as customer acquisition, key account management and trade ally relationships.

Notwithstanding any appropriate coordination with other customer service departments, it is necessary and appropriate for all Program Administrators to maintain a skilled and dedicated administrative staff in order to ensure successful delivery of programs, compliance with the Green Communities Act, timely responses to the directives of the Council, Department, and DOER; and documentation and achievement of substantial savings. The Program Administrators seek to balance the need to minimize administrative costs to the extent prudent with the need to maximize program quality and oversight. Councilors have emphasized the need to devote sufficient administrative resources to successfully implement the aggressive programs called for in the three-year plans.

While the economies of scale and other steps taken by the PAs to minimize costs are effective, and administrative costs incurred by the PAs are transparent and are presented in each Program Administrator's narrative and supporting tables, exact quantification of the minimization of administrative costs is not possible in a meaningful way. This is because the continuous scaling

up and evolution of the plans make it impossible to establish a solid baseline for a comparison. When the variables are constantly (and necessarily) shifting, there is no opportunity to make a meaningful quantitative comparison or to estimate a counterfactual. Further, a direct quantitative comparison would not be useful because it would only provide a comparison of two points in time; the mandate of the Green Communities Act, however, is to seek administrative efficiencies, which is a continuous process that evolves along with energy efficiency planning and programming, whereas costs and administrative efficiency opportunities are always changing. The Program Administrators seek to minimize costs at all available opportunities, and not just from one point in time to another.

Please refer to Table IV.A

Table IV.A: Program Planning and Administration Costs						
Customer Sector / Program	**Planned**		**Actual**		**Change from Planned to Actual**	
	Value ($)	% of Total Program Costs	Value ($)	% of Total Program Costs	Value ($)	% of Total Program Costs
Residential						
Residential New Construction & Major Renovation	105,040	17%	68,602	9%	-36,438	-9%
Residential Cooling & Heating Equipment	58,080	16%	61,885	7%	3,805	-9%
Multi-Family Retrofit	56,960	12%	47,178	8%	-9,782	-4%
MassSAVE	319,772	7%	260,824	6%	-58,948	-1%
Behavior/Feedback Program	31,080	12%	27,041	15%	-4,039	3%
ENERGY STAR Lighting	125,663	6%	155,240	6%	29,577	0%
ENERGY STAR Appliances	58,480	19%	56,203	11%	-2,277	-8%
Residential Education Program	0	0%	0	0%	0	0%
Workforce Development	16,160	34%	0	0%	-16,160	-34%
Heat Loan Program	20,000	3%	24,173	3%	4,173	0%
R&D and Demonstration	0	0%	0	0%	0	0%
Deep Energy Retrofit	10,160	9%	1,516	3%	-8,644	-5%
Behavior/Feedback Pilot	0	0%	0	0%	0	0%
RNC - Major Renovation statewide pilot	0	0%	0	0%	0	0%
RNC Multi Family (4-8 story) statewide pilot	0	0%	0	0%	0	0%
RNC Lighting Design statewide pilot	0	0%	0	0%	0	0%
RNC V3 Energy Star Homes statewide pilot	0	0%	0	0%	0	0%
Heat Pump Water Heater Pilot	0	0%	0	0%	0	0%
Residential Technical Development	0	0%	0	0%	0	0%
Hot Roofs	0	0%	0	0%	0	0%
Home Automation	0	0%	0	0%	0	0%
Community Based Pilot	0	0%	0	0%	0	0%
Statewide Marketing & Education	0	0%	0	0%	0	0%
EEAC Consultants	0	0%	0	0%	0	0%
DOER Assessment	49,450	100%	63,497	100%	14,047	0%
Sponsorships & Subscriptions	0	0%	0	0%	0	0%
Residential Total	**850,845**	**9%**	**766,158**	**7%**	**-84,687**	**-2%**
Low-Income						
Low-Income Residential New Construction	13,374	9%	14,101	34%	727	25%
Low-Income 1 to 4 Family Retrofit	385,722	9%	469,695	11%	83,973	1%
Statewide Marketing & Education	0	0%	0	0%	0	0%
Low-Income Energy Affordability Network Funding	40,284	100%	24,863	100%	-15,421	0%
DOER Assessment	26,627	100%	34,191	100%	7,564	0%
Low-Income Total	**466,007**	**11%**	**542,849**	**12%**	**76,842**	**1%**
Commercial & Industrial						
C&I New Construction and Major Renovation	590,509	12%	364,572	9%	-225,938	-3%
C&I Large Retrofit	642,827	8%	644,496	11%	1,669	3%
C&I Small Retrofit	405,406	7%	458,798	7%	53,392	0%
Community Based Pilot	0	0%	0	0%	0	0%
Statewide Marketing & Education	0	0%	0	0%	0	0%
EEAC Consultants	0	0%	0	0%	0	0%
DOER Assessment	114,115	100%	146,531	100%	32,416	0%
Sponsorships & Subscriptions	0	0%	0	0%	0	0%
C&I Total	**1,752,857**	**9%**	**1,614,397**	**10%**	**-138,461**	**0%**
GRAND TOTAL	**3,069,710**	**9%**	**2,923,403**	**9%**	**-146,306**	**0%**

The Company did not experience any variances greater than ten percent between planned and actual PP&A spending at the sector level.

C. Competitive Procurement

Table IV.B: Outsourced & Competitively Procured Services									
Customer Sector	In-House Activities		Outsourced Activities						TOTAL Activities
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities		
	$	% of Total Activities	$	% of Total Outsourced	$	% of Total Outsourced	$	% of Total Activities	$
Residential									
Planned	$2,464,421	15%	$13,470,370	95%	$782,877	5%	$14,253,247	85%	$16,717,668
Actual	$1,734,831	12%	$11,893,446	94%	$794,604	6%	$12,688,050	88%	$14,422,881
% Difference from Planned to Actual		-3%		-1%		1%		3%	
Low-Income									
Planned	$855,265	19%	$1,661,095	47%	$1,880,751	53%	$3,541,846	81%	$4,397,111
Actual	$575,601	15%	$1,269,649	39%	$1,951,823	61%	$3,221,472	85%	$3,797,073
% Difference from Planned to Actual		-4%		-7%		7%		4%	
Commercial & Industrial									
Planned	$15,842,391	43%	$18,644,676	89%	$2,349,588	11%	$20,994,264	57%	$36,836,655
Actual	$11,577,683	54%	$8,496,604	85%	$1,548,458	15%	$10,045,062	46%	$21,622,745
% Difference from Planned to Actual		11%		-4%		4%		-11%	
TOTAL									
Planned	$19,162,077	33%	$33,776,141	87%	$5,013,216	13%	$38,789,357	67%	$57,951,434
Actual	$13,888,115	35%	$21,659,698	83%	$4,294,886	17%	$25,954,584	65%	$39,842,699
% Difference from Planned to Actual		2%		-4%		4%		-2%	

The Company did not experience any significant variances between planned and reported outsourced activities and competitively procured activities.

D. Low-Income Spending

Table IV.C: Customer Sector Budget Allocation						
Customer Sector	Planned		Actual		Change from Planned to Actual	
	Total Program Costs	% of Total Program Costs	Total Program Costs	% of Total Program Costs	Value	% of Total Program Costs
Residential	$9,760,079	30%	$10,619,614	34%	$859,535	4%
Low-Income	$4,355,186	13%	$4,519,790	14%	$164,603	1%
Commercial & Industrial	$18,499,010	57%	$16,501,597	52%	-$1,997,413	-5%
TOTAL	$32,614,276	100%	$31,641,002	100%	-$973,274	0%

As shown in Table IV.C, the Company met the minimum statutory requirement by spending 14% percent of energy efficiency funds in the low-income customer sector.

V. PERFORMANCE INCENTIVES

The performance incentive mechanism includes three components: the Savings Mechanism, the Value Mechanism, and other Performance Metrics. The Savings Mechanism provides an incentive for achieving dollar benefits from energy efficiency program efforts at or above threshold levels. The Value Mechanism provides an incentive for achieving net benefits equal to or in excess of the threshold level of performance. Performance metrics establish a focus on specified program outcomes or plan development, with each metric stating the specific requirements for reaching each level of the metric. Table V summarizes the performance incentives earned by the Company by component for its successful delivery of energy efficiency programs in 2012.

Table V: Performance Incentives Summary

Incentive Components	Threshold	Design	Exemplary	Actual Incentive
Savings Mechanism	$ 901,970	$ 1,202,626	$ 1,503,283	$ 957,561
Value Mechanism	$ 663,452	$ 884,602	$ 1,105,753	$ 684,924
Performance Metrics	$ 246,425	$ 328,566	$ 410,708	$ 299,817
Total Incentive (before-tax)	$ 1,811,846	$ 2,415,794	$ 3,019,743	$ 1,942,303
Total Incentive (after-tax)	$ 693,997	$ 925,329	$ 1,156,661	$ 1,180,435

The planned values referenced in the Performance Incentives Summary Table above were originally filed in the performance incentives model set forth at Exhibit D, Attachment 2 to the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 and revised by the Company on February 15, 2013 in Western Massachusetts Electric Company, D.P.U. 11-112 ("2012 MTM"). The Company earned $1,942,303 in actual before-tax incentives, which is 80 percent of design level. The tax rate used to calculate the after-tax total incentive is 0.39225.

All supporting documentation for each performance incentive component, including detailed information on the Company's clear and distinct role in achieving the performance metrics, can be found in Appendix D. The Company applied the 25 percent EM&V impact bandwidth to the savings mechanism, as shown on Attachment D-1.

For the Savings and Value components of the performance incentive, the Company calculated its earned performance incentive in accordance with the incentive mechanism included in the 2012 MTM, using the post-evaluation benefits and taking into account the 25 percent EM&V impact bandwidth. The Company achieved 80 percent of its planned benefits and 77 percent of its planned net benefits at the portfolio level, surpassing the 75 percent threshold required in order to earn both the savings and value mechanisms of the performance incentive. Using evaluated results (subject to the +/- 25 percent impact bandwidth), the Company calculated the lifetime benefits and net benefits that each program achieved. The benefits were multiplied by the savings payout rate of $0.0066 and the net benefits were multiplied by the value payout rate of $0.0064 per the 2012 MTM. Although performance under both the Savings and Value Mechanisms is assessed at the portfolio level, this calculation was done at the sector level, as shown in Appendix D, to facilitate the allocation of earned performance incentives in the cost-effectiveness calculations. The incentive dollars earned from performance metrics were

allocated to sectors consistent with the allocation presented in the 2012 MTM. A model illustrating the calculation of the performance incentives in accordance with this methodology is included in Appendix D, Section 1.

A summary of the Company's performance for each Performance Metric is set forth below. Achievement of performance metrics relate to the metrics filed in Exhibit D, Attachment 1 to the 2012 MTM. Additional supporting documentation related to performance metrics is included at Appendix D, Section 2.

WESTERN MASSACHUSETTS ELECTRIC COMPANY

2012 SUMMARY OF PERFORMANCE METRIC ACHIEVEMENT

Residential Metric Number And Name	Achievement Level	Notes
1. Mass Save/Weatherization: Deeper Savings {Electric & Gas} – Statewide	Exemplary (125% of design)	2011 Baseline Conversion Rate = 17% 2012 Conversion Rate = 51%
2. Mass Save/Weatherization: Lost Opportunity/ Market Opportunity {Electric & Gas} – Statewide	Exemplary (125% of design)	See Supporting Documentation
Low-Income Metric Number And Name	**Achievement Level**	**Notes**
1. Best Practices Program Strategies Research & Technical Review of Potential New Measures {Electric & Gas} – Statewide	Exemplary (125% of design)	See Supporting Documentation
2. Multi-Family Building Inventory Electric & Gas} – Statewide	Exemplary (125% of design)	See Supporting Documentation
Commercial & Industrial Metric Number And Name	**Achievement Level**	**Notes**
C&I #1 Retrofit -- Depth of savings	Design (100%)	X=2, Y=115% (at Design) X*Y=3 Achieved 3
C&I #2 New Construction -- Comprehensiveness and depth of savings	Below Threshold (0%)	X=36%, Y=110% (at Threshold) X*Y=40% Achieved 14%
C&I #3 Direct Install Electric and Gas Integration	Below Threshold (0%)	X=16%, Z=110% (at Threshold) X*Z=118% Achieved 15%
C&I #4 Combined Heat & Power	Below Threshold (0%)	X=2, Y=110% (at Threshold) X*Y=2 Achieved 1
Other Funding Metric Number And Name	**Achievement Level**	**Notes**
1. Other Financing Capital	Exemplary (2012 loans issued = $7,633,113.20)	Exemplary = 2011 achievement plus 40% or $7,043,517.42
2. Cost Efficiency of Program Expenditures	Threshold (80% of design)	4.67

VI. AUDITS

An audit of WMECo's energy efficiency programs was conducted by Northeast Utilities' Internal Audit Department in 2009 and filed with the Company's 2010 Energy Efficiency Annual in Western Massachusetts Electric Company, D.P.U. 11-69.

VII. APPENDICES

A. Glossary of Defined Terms – includes Types of Costs in each Budget Category and a Glossary of Terms and Abbreviations.

B. Cost-Effectiveness Supporting Tables and Documentation – includes the D.P.U. 08-50 Tables, the Screening Tool, and Technical Reference Manual.

C. Program and Pilot Program EM&V Studies – includes evaluation studies for the residential, low-income, and C&I sector programs and pilot programs.

D. Performance Incentives Supporting Documentation – includes documentation that supports the Company's determination of actual performance incentives earned though the performance metrics.

E. Other Supporting Documentation – includes additional supporting documentation with regard to competitive procurement activities in 2012.

F. Lost Base Revenue Information – includes a reference to the information on savings on which LBR is based.

APPENDIX A

GLOSSARY OF DEFINED TERMS

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Glossary of Defined Terms

Types of Costs in each Budget Category

Please see the following descriptions of budget cost categories. The categories described below were generally consistent among all Program Administrators in 2012, with the exception of the categorization of employee salaries and related expenses. This difference is due to different historical practices and differing staff sizes and staff assignments, as well as internal tracking mechanisms. The Company has accounted for employee labor and related expenses in Program Planning and Administration ("PPA"), Marketing and Advertising, Sales, Technical Assistance & Training, and Evaluation & Market Research categories, depending on the employee's responsibility. Going forward, pursuant to the Order approving each Program Administrator's 2013-2015 Three-Year Plan in D.P.U. 12-100 through D.P.U. 12-111 ("2013-2015 Plan"), the Department has directed all PAs to report all non-administrative employee costs in the cost category that applies to the employee's job description. Program Administrators that do not report in this manner will be making adjustments in order to comply with this directive.

The Company and the other electric and gas Program Administrators have worked together to develop consistent cost categories to the extent that they are efficient and appropriate for each Program Administrator, and the Program Administrators will continue to strive for consistency in this area. In particular, with respect to vendor costs, in the 2013-2015 Plan Order, the Department has directed the PAs to develop uniform practices to the extent possible (noting tracking system differences), and, where limitations exist, to adopt reasonable alternative allocation methods based on cost-causation principles (actual factors underlying the incurrence of costs). The Program Administrators will report on their progress towards meeting the requirements related to cost-categorization set forth in the 2013-2015 Plan Order by July 31, 2014.

Costs that cannot be assigned directly to a program are allocated among relevant programs on an appropriate basis and tracked accordingly.

Program Planning and Administration are costs associated with developing program plans, including market transformation plans, research and development ("R&D") (excluding R&D assigned to Evaluation and Market Research), and day-to-day program administration, including labor, benefits, expenses, materials, supplies, and overhead costs, and any regulatory costs associated with energy efficiency activities. Also, PPA includes costs for energy efficiency services contracted to non-affiliated companies such as outside consultants used to prepare plans, screen programs, improve databases, and perform legal services.

Marketing and Advertising are costs to advertise, through television, radio, billboards, brochures, telemarketing, web-sites, and mailings, the existence and availability of energy efficiency programs or technologies, and to induce customers or trade allies to participate in energy efficiency programs.

Participant Incentives are funds paid by the reporting Program Administrator to customers or trade allies, often in the form of rebates, for installation of energy efficiency measures and/or products.

Sales, Technical Assistance & Training are those costs to motivate and/or train (1) customers to install energy efficiency products and services, (2) retailers to stock energy efficiency products, (3) trade professionals to offer energy efficiency services, (4) manufacturers to make energy efficiency products; and (5) vendor services and supplies that demonstrate benefits of energy efficiency.

Evaluation and Market Research are costs associated with evaluation activities, including costs related to cost-effectiveness evaluation, market research (e.g., baseline studies, market assessments, and surveys), impact and process evaluation reports, tracking and reporting program inputs and outputs, funding studies, and other costs associated with evaluating the program.

GLOSSARY OF DEFINED TERMS & ACRONYMS

Act	An Act Relative to Green Communities, Chapter 169 of the Acts of 2008. Signed into law on July 2, 2008.
AESC	Avoided Energy Supply Component
ARRA	American Recovery and Reinvestment Act
BCR	Benefit/Cost Ratio
BPWG	Best Practices Working Group
C&I	Commercial and Industrial
C&IMC	Commercial and Industrial Management Committee
CAP	Community Action Program
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CMI	Community Mobilization Initiative
Consultants	Consultants employed by the Energy Efficiency Advisory Council
COOL Smart	The Residential Cooling and Heating Equipment program is commonly known as the COOL Smart program.
Council	Energy Efficiency Advisory Council
Department	Massachusetts Department of Public Utilities
DER	Deep Energy Retrofit
DOE	Department of Energy
DOER	Massachusetts Department of Energy Resources
DPU	Massachusetts Department of Public Utilities
ECM	Electronically Commutated Motor
EEAC	Energy Efficiency Advisory Council

EMC	Evaluation Management Committee
EM&V	Evaluation, Monitoring, and Verification
ENERGY STAR®	Brand name for the voluntary energy efficiency labeling initiative sponsored by the U.S. Environmental Protection Agency and Department of Energy.
EPA	U.S. Environmental Protection Agency
FR	Free Rider or Free-ridership
Free Riders	Customers who participate in an energy efficiency program but would have installed the same measure(s) on their own if the program had not been available.
Free-Ridership Rate	The percent of savings attributable to Free Riders.
Gas and Electric Orders	Orders of the Department dated January 28, 2010 in D.P.U. 09-116 through 09-127 approving the Program Administrators' Three-Year Plans
GHGs	Greenhouse Gas Emissions
Green Communities Act	An Act Relative to Green Communities, Chapter 169 of the Acts of 2008. Signed into law on July 2, 2008.
HEA	Home Energy Assessment
HEHE	High Efficiency Heating and Water Heating
HERS	Home Energy Rating System
HES	Home Energy Services, also known as Mass Save or Residential Conservation Services
HPCs	Home Performance Contractors
HPWH	Heat Pump Water Heater
HVAC	Heating, Ventilation, and Air Conditioning
IIC	Independent Installation Contractor

Impact Factor	Generic term for persistence, realization rates, in-service rates, non-coincident connected demand factors, etc., developed during the evaluation of energy efficiency programs and used to calculate net savings.
JMC	Joint Management Committee of PAs that manage the Residential New Construction program.
LEAN	The Low-Income Energy Affordability Network
LED	Light Emitting Diode
LBR	Lost Base Revenue (For companies not operating under decoupled rate structure, these costs account for revenues not collected by the Company's distribution business as a result of the energy efficiency undertaken during the program year)
LCIEC	Large Commercial & Industrial Evaluation Contractor
Lifetime	The expected length of time, in years, that an installed measure will be in service and producing savings.
Measure	Specific technology or practice that produces energy and/or demand savings for which the PA provides financial incentives.
MMI	Multi-Family Market Integrator
MTAC	Massachusetts Technical Assessment Committee
MTM	Mid-Term Modification
NCP	Negotiated Cooperative Promotions
NEI	Non-Energy Impact
Net to Gross Ratio ("NTGR")	A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts.
Network	Low-Income Weatherization and Fuel Assistance Program Network
NPS	Non Participant Spillover
NTG	Net-to-Gross

PAs or Program Administrators	Utilities and municipal aggregators that offer energy efficiency programs.
Participant Cost	The total or incremental cost of a project or measure less the customer incentive.
Performance Incentive ("PI")	Compensation for the Company's successful execution of the energy efficiency programs during the program year as determined by Massachusetts Department of Public Utilities.
Plan	Three-Year Energy Efficiency Plan approved by the Department by its Orders, dated January 28, 2010, in dockets D.P.U. 09-121 to D.P.U. 09-128 and D.P.U. 09-116 to D.P.U. 09-120.
PP&A	Program Planning and Administration
QC	Quality Control
QIV	Quality Installation Verification
RCS	Residential Conservation Services, also known as Home Energy Services and Residential Mass Save
RFP	Request For Proposal
RGGI	Regional Greenhouse Gas Initiative
RMC	Residential Management Committee
SO	Participant Spillover
Spillover	Additional energy efficient equipment installed by customers that was influenced by the Company's sponsored program, but without direct financial or technical assistance from the program. Spillover is separated into Participant and Non- participant factors. Non-participating customers may be influenced by product availability, publicity, education and other factors that are affected by the program.
Spillover Rate	Estimate of energy savings attributable to spillover effects expressed as a percent of savings installed by participants through an energy efficiency program.
T&D	Transmission and Distribution
Term	Three-year term of the energy efficiency plan

Three-Year Plans	Three-Year Energy Efficiency Plans approved by the Department by its Orders, dated January 28, 2010, in dockets D.P.U. 09-121 to D.P.U. 09-128 and D.P.U. 09-116 to D.P.U. 09-120.
TRC	Total Resource Cost
TRM	Technical Reference Manual
WAP	Weatherization Assistance Program

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APPENDIX B
COST-EFFECTIVENESS SUPPORTING TABLES AND DOCUMENTATION

SECTION 1
D.P.U. 08-50-C SUPPORTING TABLES

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IV.C. WMECo PA Budgets

1. Summary Table

Program Administrator Budget, Planned (1)								
Customer Sector / Program	Program Costs						Performance Incentive (2)	TOTAL PA Budget (3)
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs		
Residential (total)	**$850,845**	**$362,529**	**$6,328,844**	**$1,830,070**	**$387,791**	**$9,760,079**	**$1,085,533**	**$10,845,612**
Residential New Construction & M	105,040	19,630	250,284	172,530	53,635	601,119	28,020	629,139
Residential Cooling & Heating Equ	58,080	14,722	217,850	58,604	19,957	369,213	18,274	387,487
Multi-Family Retrofit	56,960	19,630	291,345	83,651	24,947	476,533	38,038	514,571
MassSAVE	319,772	19,630	3,157,714	1,142,152	146,623	4,785,891	847,161	5,633,052
Behavior/Feedback Program	31,080	124,125	100,000	-	12,473	267,678	5,599	273,277
ENERGY STAR Lighting	125,663	136,329	1,500,500	209,128	103,214	2,074,834	141,750	2,216,584
ENERGY STAR Appliances	58,480	19,630	147,935	63,784	14,469	304,298	6,691	310,989
Residential Education Program	-	-	-	-	-	-	-	-
Workforce Development	16,160	-	-	31,369	-	47,529	-	47,529
Heat Loan Program	20,000	-	613,216	31,369	-	664,585	-	664,585
R&D and Demonstration	-	-	-	-	-	-	-	-
Deep Energy Retrofit	10,160	8,833	50,000	37,483	12,473	118,949	-	118,949
Behavior/Feedback Pilot	-	-	-	-	-	-	-	-
Residential New Construction & M	-	-	-	-	-	-	-	-
Residential New Construction Mul	-	-	-	-	-	-	-	-
Residential New Construction Ligh	-	-	-	-	-	-	-	-
Residential New Construction V3 I	-	-	-	-	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-	-	-	-	-
Residential Technical Developmer	-	-	-	-	-	-	-	-
Hot Roofs	-	-	-	-	-	-	-	-
Home Automation	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	-	-	-	-	-	-
DOER Assessment	49,450	-	-	-	-	49,450	-	49,450
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
Low Income (total)	**$466,007**	**$51,304**	**$2,644,370**	**$1,000,124**	**$193,381**	**$4,355,186**	**$236,549**	**$4,591,735**
Low-Income Residential New Con	13,374	10,261	83,346	25,394	11,885	144,260	8,137	152,397
Low-Income 1 to 4 Family Retrofit	385,722	41,043	2,561,024	974,730	181,496	4,144,015	228,412	4,372,427
Statewide Marketing & Education	-	-	-	-	-	-	-	-
Low-Income Energy Affordability M	40,284	-	-	-	-	40,284	-	40,284
DOER Assessment	26,627	-	-	-	-	26,627	-	26,627
Commercial & Industrial (total)	**$1,752,857**	**$220,774**	**$13,777,652**	**$1,859,813**	**$887,913**	**$18,499,010**	**$1,093,712**	**$19,592,722**
C&I New Construction and Major R	590,509	77,635	3,209,228	782,756	358,658	5,018,787	364,861	5,383,648
C&I New Construction and Major R	-	-	-	-	-	-	-	-
C&I Large Retrofit	642,827	82,487	6,010,777	778,299	259,673	7,774,063	533,868	8,307,931
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-
C&I Small Retrofit	405,406	60,652	4,557,646	213,681	269,582	5,506,967	194,983	5,701,950
C&I Small Retrofit - Government	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	-	-	-	-	-	-
DOER Assessment	114,115	-	-	-	-	114,115	-	114,115
Sponsorships & Subscriptions	-	-	-	85,077	-	85,077	-	85,077
GRAND TOTAL	**$3,069,710**	**$634,607**	**$22,750,866**	**$4,690,008**	**$1,469,085**	**$32,614,276**	**$2,415,794**	**$35,030,070**

Program Administrator Budget, Actual (1)								
Customer Sector / Program	Program Costs						Performance Incentive (2)	TOTAL PA Budget (3)
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs		
Residential (total)	**$766,158**	**$304,365**	**$7,099,814**	**$2,328,780**	**$120,497**	**$10,619,614**	**$776,900**	**$11,396,514**
Residential New Construction & M	68,602	4,876	449,914	238,782	17,484	779,658	26,808	806,466
Residential Cooling & Heating Equ	61,885	12,853	703,177	98,048	3,931	879,894	11,049	890,943
Multi-Family Retrofit	47,178	2,350	364,923	156,541	2,563	573,555	6,040	579,595
MassSAVE	260,824	77,595	2,681,265	1,294,116	19,435	4,333,236	479,585	4,812,821
Behavior/Feedback Program	27,041	36,993	-	120,000	825	184,859	1,524	186,383
ENERGY STAR Lighting	155,240	111,901	1,971,673	240,405	42,500	2,521,719	240,966	2,762,685
ENERGY STAR Appliances	56,203	57,614	237,422	135,661	33,559	520,460	10,928	531,388
Residential Education Program	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	12,024	-	12,024	-	12,024
Heat Loan Program	24,173	-	673,298	8,584	-	706,055	-	706,055
R&D and Demonstration	-	-	-	-	-	-	-	-
Deep Energy Retrofit	1,516	183	18,141	24,618	200	44,657	-	44,657
Behavior/Feedback Pilot	-	-	-	-	-	-	-	-
Residential New Construction & M	-	-	-	-	-	-	-	-
Residential New Construction Mul	-	-	-	-	-	-	-	-
Residential New Construction Ligh	-	-	-	-	-	-	-	-
Residential New Construction V3 I	-	-	-	-	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-	-	-	-	-
Residential Technical Developmer	-	-	-	-	-	-	-	-
Hot Roofs	-	-	-	-	-	-	-	-
Home Automation	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	-	-	-	-	-	-
DOER Assessment	63,497	-	-	-	-	63,497	-	63,497
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
Low Income (total)	**$542,849**	**$52,564**	**$3,182,357**	**$609,822**	**$132,199**	**$4,519,790**	**$274,468**	**$4,794,258**
Low-Income Residential New Con	14,101	174	3,342	23,662	190	41,468	1,266	42,734
Low-Income 1 to 4 Family Retrofit	469,695	52,390	3,179,015	586,160	132,009	4,419,268	273,202	4,692,470
Statewide Marketing & Education	-	-	-	-	-	-	-	-
Low-Income Energy Affordability M	24,863	-	-	-	-	24,863	-	24,863
DOER Assessment	34,191	-	-	-	-	34,191	-	34,191
Commercial & Industrial (total)	**$1,614,397**	**$83,477**	**$13,923,698**	**$654,269**	**$225,757**	**$16,501,597**	**$890,935**	**$17,392,532**
C&I New Construction and Major F	364,572	24,608	3,520,772	136,647	86,854	4,133,453	298,656	4,432,109
C&I New Construction and Major F	-	-	-	-	-	-	-	-
C&I Large Retrofit	644,496	31,330	4,730,711	171,259	93,802	5,671,598	338,237	6,009,835
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-
C&I Small Retrofit	458,798	27,540	5,672,214	341,363	45,100	6,545,015	254,042	6,799,057
C&I Small Retrofit - Government	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	-	-	-	-	-	-
DOER Assessment	146,531	-	-	-	-	146,531	-	146,531
Sponsorships & Subscriptions	-	-	-	5,000	-	5,000	-	5,000
GRAND TOTAL	**$2,923,403**	**$440,406**	**$24,205,868**	**$3,592,871**	**$478,453**	**$31,641,002**	**$1,942,303**	**$33,583,305**

Program Administrator Budget, Percent Variance (1)

Customer Sector / Program	Program Costs						Performance Incentive (2)	TOTAL PA Budget (3)
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs		
Residential (total)	**-10%**	**-16%**	**12%**	**27%**	**-69%**	**9%**	**-28%**	**5%**
Residential New Construction & M	-35%	-75%	80%	38%	-67%	30%	-4%	28%
Residential Cooling & Heating Equ	7%	-13%	223%	67%	-80%	138%	-40%	130%
Multi-Family Retrofit	-17%	-88%	25%	87%	-90%	20%	-84%	13%
MassSAVE	-18%	295%	-15%	13%	-87%	-9%	-43%	-15%
Behavior/Feedback Program	-13%	-70%	-100%	-	-93%	-31%	-73%	-32%
ENERGY STAR Lighting	24%	-18%	31%	15%	-59%	22%	70%	25%
ENERGY STAR Appliances	-4%	194%	60%	113%	132%	71%	63%	71%
Residential Education Program	-	-	-	-	-	-	-	-
Workforce Development	-100%	-	-	-62%	-	-75%	-	-75%
Heat Loan Program	21%	-	10%	-73%	-	6%	-	6%
R&D and Demonstration	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-85%	-98%	-64%	-34%	-98%	-62%	-	-62%
Behavior/Feedback Pilot	-	-	-	-	-	-	-	-
Residential New Construction & M	-	-	-	-	-	-	-	-
Residential New Construction Mul	-	-	-	-	-	-	-	-
Residential New Construction Ligh	-	-	-	-	-	-	-	-
Residential New Construction V3 I	-	-	-	-	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-	-	-	-	-
Residential Technical Developmer	-	-	-	-	-	-	-	-
Hot Roofs	-	-	-	-	-	-	-	-
Home Automation	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	-	-	-	-	-	-
DOER Assessment	28%	-	-	-	-	28%	-	28%
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
Low Income (total)	**16%**	**2%**	**20%**	**-39%**	**-32%**	**4%**	**16%**	**4%**
Low-Income Residential New Con	5%	-98%	-96%	-7%	-98%	-71%	-84%	-72%
Low-Income 1 to 4 Family Retrofit	22%	28%	24%	-40%	-27%	7%	20%	7%
Statewide Marketing & Education	-	-	-	-	-	-	-	-
Low-Income Energy Affordability N	-38%	-	-	-	-	-38%	-	-38%
DOER Assessment	28%	-	-	-	-	28%	-	28%
Commercial & Industrial (total)	**-8%**	**-62%**	**1%**	**-65%**	**-75%**	**-11%**	**-19%**	**-11%**
C&I New Construction and Major I	-38%	-68%	10%	-83%	-76%	-18%	-18%	-18%
C&I New Construction and Major I	-	-	-	-	-	-	-	-
C&I Large Retrofit	0%	-62%	-21%	-78%	-64%	-27%	-37%	-28%
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-
C&I Small Retrofit	13%	-55%	24%	60%	-83%	19%	30%	19%
C&I Small Retrofit - Government	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	-	-	-	-	-	-
DOER Assessment	28%	-	-	-	-	28%	-	28%
Sponsorships & Subscriptions	-	-	-	-94%	-	-94%	-	-94%
GRAND TOTAL	**-5%**	**-31%**	**6%**	**-23%**	**-67%**	**-3%**	**-20%**	**-4%**

Notes:

(1) Refer to common definitions in Appendix A for allocation of costs.

(2) Values listed in this table represent pre-tax performance incentive amounts. See Appendix D, Section 1 for supporting calculations.

(3) The Total PA Budget is the sum of Total Program Costs and Performance Incentives.

(4)The Planned Values in this table and all subsequent tables that contain Planned Values in this Annual Report (except as otherwise noted) were originally submitted to the Department on October 28, 2011 and revised on February 15, 2013 in Western Massachusetts Electric Company , D.P.U. 11-112.

IV.D. WMECo Cost Effectiveness
1. Summary Table

Total Resource Cost Test, Planned				
Customer Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs (1)**
Residential	**6.18**	**$66,919,399**	**$79,839,934**	**$12,920,535**
Residential New Construction & Major Renovation	2.94	1,678,777	$2,543,842	$865,065
Residential Cooling & Heating Equipment	1.31	125,197	$531,336	$406,140
Multi-Family Retrofit	5.51	2,581,744	$3,154,404	$572,660
MassSAVE	8.45	53,319,688	$60,480,194	$7,160,507
Behavior/Feedback Program	2.04	284,900	558,177	$273,277
ENERGY STAR Lighting	4.91	9,475,230	$11,898,874	$2,423,644
ENERGY STAR Appliances	1.99	334,376	$673,106	$338,730
Residential Education Program	-	-	-	-
Workforce Development	-	-	-	$47,529
Heat Loan Program	-	-	-	$664,585
R&D and Demonstration	-	-	-	-
Deep Energy Retrofit	-	-	-	$118,949
Behavior/Feedback Pilot	-	-	-	-
Residential New Construction & Major Renovation - Major Renovation statewide pilot	-	-	-	-
Residential New Construction Multi Family (4-8 story) statewide pilot	-	-	-	-
Residential New Construction Lighting Design statewide pilot	-	-	-	-
Residential New Construction V3 Energy Star Homes statewide pilot	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-
Residential Technical Development	-	-	-	-
Hot Roofs	-	-	-	-
Home Automation	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	-	-	-	$49,450
Sponsorships & Subscriptions	-	-	-	-
Low Income	**2.89**	**$8,633,553**	**$13,204,268**	**$4,570,715**
Low-Income Residential New Construction	3.40	364,994	$517,391	$152,397
Low-Income Retrofit	2.92	8,335,470	$12,686,877	$4,351,407
Statewide Marketing & Education	-	-	-	-
Low-Income Energy Affordability Network Funding	-	-	-	$40,284
DOER Assessment	-	-	-	$26,627
Commercial & Industrial	**3.09**	**$59,636,946**	**$88,117,250**	**$28,480,304**
C&I New Construction and Major Renovation	5.04	22,482,464	$28,050,504	$5,568,040
C&I New Construction and Major Renovation - Government	-	-	-	-
C&I Large Retrofit	2.92	28,898,866	$43,943,369	$15,044,503
Large C&I Retrofit - Government	-	-	-	-
C&I Small Retrofit	2.10	8,454,807	$16,123,376	$7,668,569
C&I Small Retrofit - Government	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	-	-	-	$114,115
Sponsorships & Subscriptions	-	-	-	$85,077
GRAND TOTAL	**3.94**	**$135,189,898**	**$181,161,453**	**$45,971,555**

Total Resource Cost Test, Evaluated				
Customer Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs (1)**
Residential	**3.69**	**$40,045,444**	**$54,954,121**	**$14,908,676**
Residential New Construction & Major Renovation	1.67	1,004,598	2,499,949	1,495,352
Residential Cooling & Heating Equipment	1.14	169,134	1,394,710	1,225,575
Multi-Family Retrofit	1.11	77,796	788,414	710,618
MassSAVE	5.77	26,491,822	32,040,924	5,549,102
Behavior/Feedback Program	1.09	16,358	202,741	186,383
ENERGY STAR Lighting	3.89	12,671,207	17,054,703	4,383,496
ENERGY STAR Appliances	1.83	440,762	972,679	531,917
Residential Education Program	-	-	-	-
Workforce Development	-	-	-	12,024
Heat Loan Program	-	-	-	706,055
R&D and Demonstration	-	-	-	-
Deep Energy Retrofit	-	-	-	44,657
Behavior/Feedback Pilot	-	-	-	-
Residential New Construction & Major Renovation - Major Renovation statewide pilot	-	-	-	-
Residential New Construction Multi Family (4-8 story) statewide pilot	-	-	-	-
Residential New Construction Lighting Design statewide pilot	-	-	-	-
Residential New Construction V3 Energy Star Homes statewide pilot	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-
Residential Technical Development	-	-	-	-
Hot Roofs	-	-	-	-
Home Automation	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	-	-	-	63,497
Sponsorships & Subscriptions	-	-	-	-
Low Income	**3.24**	**$10,829,741**	**$15,670,157**	**$4,840,416**
Low-Income Residential New Construction	1.35	31,296	120,189	88,893
Low-Income 1 to 4 Family Retrofit	3.31	10,857,498	15,549,968	4,692,470
Statewide Marketing & Education	-	-	-	-
Low-Income Energy Affordability Network Funding	-	-	-	24,863
DOER Assessment	-	-	-	34,191
Commercial & Industrial	**3.62**	**$53,368,806**	**$73,750,319**	**$20,381,513**
C&I New Construction and Major Renovation	4.41	18,569,007	24,014,032	5,445,024
C&I New Construction and Major Renovation - Government	-	-	-	-
C&I Large Retrofit	3.77	20,453,494	27,846,831	7,393,337
Large C&I Retrofit - Government	-	-	-	-
C&I Small Retrofit	2.96	14,497,836	21,889,456	7,391,620
C&I Small Retrofit - Government	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	-	-	-	146,531
Sponsorships & Subscriptions	-	-	-	5,000
GRAND TOTAL	**3.60**	**$104,243,990**	**$144,374,596**	**$40,130,606**

Total Resource Cost Test, Percent Variance				
Customer Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs (1)**
Residential	**-40%**	**-40%**	**-31%**	**15%**
Residential New Construction & Major Renovation	-43%	-40%	-2%	73%
Residential Cooling & Heating Equipment	-13%	35%	162%	202%
Multi-Family Retrofit	-80%	-97%	-75%	24%
MassSAVE	-32%	-50%	-47%	-23%
Behavior/Feedback Program	-	-	-	-32%
ENERGY STAR Lighting	-21%	34%	43%	81%
ENERGY STAR Appliances	-8%	32%	45%	57%
Residential Education Program	-	-	-	-
Workforce Development	-	-	-	-75%
Heat Loan Program	-	-	-	6%
R&D and Demonstration	-	-	-	-
Deep Energy Retrofit	-	-	-	-62%
Behavior/Feedback Pilot	-	-	-	-
Residential New Construction & Major Renovation - Major Renovation statewide pilot	-	-	-	-
Residential New Construction Multi Family (4-8 story) statewide pilot	-	-	-	-
Residential New Construction Lighting Design statewide pilot	-	-	-	-
Residential New Construction V3 Energy Star Homes statewide pilot	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-
Residential Technical Development	-	-	-	-
Hot Roofs	-	-	-	-
Home Automation	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	-	-	-	28%
Sponsorships & Subscriptions	-	-	-	-
Low Income	**12%**	**25%**	**19%**	**6%**
Low-Income Residential New Construction	-60%	-91%	-77%	-42%
Low-Income 1 to 4 Family Retrofit	14%	30%	23%	8%
Statewide Marketing & Education	-	-	-	-
Low-Income Energy Affordability Network Funding	-	-	-	-38%
DOER Assessment	-	-	-	28%
Commercial & Industrial	**17%**	**-11%**	**-16%**	**-28%**
C&I New Construction and Major Renovation	-12%	-17%	-14%	-2%
C&I New Construction and Major Renovation - Government	-	-	-	-
C&I Large Retrofit	29%	-29%	-37%	-51%
Large C&I Retrofit - Government	-	-	-	-
C&I Small Retrofit	41%	71%	36%	-4%
C&I Small Retrofit - Government	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	-	-	-	28%
Sponsorships & Subscriptions	-	-	-	-94%
GRAND TOTAL	**-9%**	**-23%**	**-20%**	**-13%**

Notes:
(1) See Table IV.D.2.1 Total Resource Costs Summary for more information regarding TRC Test Costs.

(2) For purpose of determining cost-effectiveness, the benefits and costs of "hard to measure programs" are taken into account at the customer sector level.See DPU 08-50-A at 30-31.

(3) For the purpose of determining cost-effectiveness, General Support costs are taken into account at the customer sector level.

IV.D. WMECo Cost Effectiveness

2.1. Cost Summary Table

TRC Costs Summary, Planned				
Programs	PA Costs		Participant Costs	Total TRC Test Costs
	Program Costs (1)	Performance Incentive (2)		
Residential (total)	**$9,760,079**	**$1,085,533**	**$2,074,923**	**$12,920,535**
Residential New Construction & Major Renovation	601,119	28,020	235,926	865,065
Residential Cooling & Heating Equipment	369,213	18,274	18,653	406,140
Multi-Family Retrofit	476,533	38,038	58,089	572,660
MassSAVE	4,785,891	847,161	1,527,455	7,160,507
Behavior/Feedback Program	267,678	5,599	-	273,277
ENERGY STAR Lighting	2,074,834	141,750	207,060	2,423,644
ENERGY STAR Appliances	304,298	6,691	27,741	338,730
Residential Education Program	-	-	-	-
Workforce Development	47,529	-	-	47,529
Heat Loan Program	664,585	-	-	664,585
R&D and Demonstration	-	-	-	-
Deep Energy Retrofit	118,949	-	-	118,949
Behavior/Feedback Pilot	-	-	-	-
Residential New Construction & Major Renovation - Major Renovation statewide	-	-	-	-
Residential New Construction Multi Family (4-8 story) statewide pilot	-	-	-	-
Residential New Construction Lighting Design statewide pilot	-	-	-	-
Residential New Construction V3 Energy Star Homes statewide pilot	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-
Residential Technical Development	-	-	-	-
Hot Roofs	-	-	-	-
Home Automation	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	49,450	-	-	49,450
Sponsorships & Subscriptions	-	-	-	-
Low Income (total)	**$4,355,186**	**$236,549**	**-$21,020**	**$4,570,715**
Low-Income Residential New Construction	144,260	8,137	-	152,397
Low-Income 1 to 4 Family Retrofit	4,144,015	228,412	-21,020	4,351,407
Statewide Marketing & Education	-	-	-	-
Low-Income Energy Affordability Network Funding	40,284	-	-	40,284
DOER Assessment	26,627	-	-	26,627
Commercial & Industrial (total)	**$18,499,010**	**$1,093,712**	**$8,887,582**	**$28,480,304**
C&I New Construction and Major Renovation	5,018,787	364,861	184,391	5,568,040
C&I New Construction and Major Renovation - Government	-	-	-	-
C&I Large Retrofit	7,774,063	533,868	6,736,572	15,044,503
Large C&I Retrofit - Government	-	-	-	-
C&I Small Retrofit	5,506,967	194,983	1,966,619	7,668,569
C&I Small Retrofit - Government	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	114,115	-	-	114,115
Sponsorships & Subscriptions	85,077	-	-	85,077
GRAND TOTAL	**$32,614,276**	**$2,415,794**	**$10,941,485**	**$45,971,555**

TRC Costs Summary, Actual				
Programs	PA Costs		Participant Costs	Total TRC Test Costs
	Program Costs (1)	Performance Incentive (2)		
Residential (total)	**$10,619,614**	**$776,900**	**$3,512,162**	**$14,908,676**
Residential New Construction & Major Renovation	779,658	26,808	688,886	1,495,352
Residential Cooling & Heating Equipment	879,894	11,049	334,632	1,225,575
Multi-Family Retrofit	573,555	6,040	131,023	710,618
MassSAVE	4,333,236	479,585	736,281	5,549,102
Behavior/Feedback Program	184,859	1,524	-	186,383
ENERGY STAR Lighting	2,521,719	240,966	1,620,811	4,383,496
ENERGY STAR Appliances	520,460	10,928	528	531,917
Residential Education Program	-	-	-	-
Workforce Development	12,024	-	-	12,024
Heat Loan Program	706,055	-	-	706,055
R&D and Demonstration	-	-	-	-
Deep Energy Retrofit	44,657	-	-	44,657
Behavior/Feedback Pilot	-	-	-	-
Residential New Construction & Major Renovation - Major Renovation statewide	-	-	-	-
Residential New Construction Multi Family (4-8 story) statewide pilot	-	-	-	-
Residential New Construction Lighting Design statewide pilot	-	-	-	-
Residential New Construction V3 Energy Star Homes statewide pilot	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-
Residential Technical Development	-	-	-	-
Hot Roofs	-	-	-	-
Home Automation	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	63,497	-	-	63,497
Sponsorships & Subscriptions	-	-	-	-
Low Income (total)	**$4,519,790**	**$274,468**	**$46,159**	**$4,840,416**
Low-Income Residential New Construction	41,468	1,266	46,159	88,893
Low-Income 1 to 4 Family Retrofit	4,419,268	273,202	-	4,692,470
Statewide Marketing & Education	-	-	-	-
Low-Income Energy Affordability Network Funding	24,863	-	-	24,863
DOER Assessment	34,191	-	-	34,191
Commercial & Industrial (total)	**$16,501,597**	**$890,935**	**$2,988,981**	**$20,381,513**
C&I New Construction and Major Renovation	4,133,453	298,656	1,012,916	5,445,024
C&I New Construction and Major Renovation - Government	-	-	-	-
C&I Large Retrofit	5,671,598	338,237	1,383,502	7,393,337
Large C&I Retrofit - Government	-	-	-	-
C&I Small Retrofit	6,545,015	254,042	592,563	7,391,620
C&I Small Retrofit - Government	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	146,531	-	-	146,531
Sponsorships & Subscriptions	5,000	-	-	5,000
GRAND TOTAL	**$31,641,002**	**$1,942,303**	**$6,547,301**	**$40,130,606**

TRC Costs Summary, Percent Variance				
Programs	**PA Costs**		**Participant Costs**	**Total TRC Test Costs**
	Program Costs (1)	**Performance Incentive (2)**		
Residential (total)	**9%**	**-28%**	**69%**	**15%**
Residential New Construction & Major Renovation	30%	-4%	192%	73%
Residential Cooling & Heating Equipment	138%	-40%	1694%	202%
Multi-Family Retrofit	20%	-84%	126%	24%
MassSAVE	-9%	-43%	-52%	-23%
Behavior/Feedback Program	-31%	-73%	-	-32%
ENERGY STAR Lighting	22%	70%	683%	81%
ENERGY STAR Appliances	71%	63%	-98%	57%
Residential Education Program	-	-	-	-
Workforce Development	-75%	-	-	-75%
Heat Loan Program	6%	-	-	6%
R&D and Demonstration	-	-	-	-
Deep Energy Retrofit	-62%	-	-	-62%
Behavior/Feedback Pilot	-	-	-	-
Residential New Construction & Major Renovation - Major Renovation statewide	-	-	-	-
Residential New Construction Multi Family (4-8 story) statewide pilot	-	-	-	-
Residential New Construction Lighting Design statewide pilot	-	-	-	-
Residential New Construction V3 Energy Star Homes statewide pilot	-	-	-	-
Heat Pump Water Heater Pilot	-	-	-	-
Residential Technical Development	-	-	-	-
Hot Roofs	-	-	-	-
Home Automation	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	28%	-	-	28%
Sponsorships & Subscriptions	-	-	-	-
Low Income (total)	**4%**	**16%**	**-320%**	**6%**
Low-Income Residential New Construction	-71%	-84%	-	-42%
Low-Income 1 to 4 Family Retrofit	7%	20%	-100%	8%
Statewide Marketing & Education	-	-	-	-
Low-Income Energy Affordability Network Funding	-38%	-	-	-38%
DOER Assessment	28%	-	-	28%
Commercial & Industrial (total)	**-11%**	**-19%**	**-66%**	**-28%**
C&I New Construction and Major Renovation	-18%	-18%	449%	-2%
C&I New Construction and Major Renovation - Government	-	-	-	-
C&I Large Retrofit	-27%	-37%	-79%	-51%
Large C&I Retrofit - Government	-	-	-	-
C&I Small Retrofit	19%	30%	-70%	-4%
C&I Small Retrofit - Government	-	-	-	-
Community Based Pilot	-	-	-	-
Statewide Marketing & Education	-	-	-	-
EEAC Consultants	-	-	-	-
DOER Assessment	28%	-	-	28%
Sponsorships & Subscriptions	-94%	-	-	-94%
GRAND TOTAL	**-3%**	**-20%**	**-40%**	**-13%**

Notes:

(1) Program Costs include Program Planning and Administration, Marketing and Advertising, Program Incentive, Sales, Technical Assistance & Training, Evaluation and Market Research (See Table IV.C.1, Budget Summary)

(2) Values listed in this table represent pre-tax performance incentive amounts. See Appendix D, Section 1 for supporting calculations.

IV.D WMECo Cost Effectiveness

3.1.i. Benefits Summary Table

Electric Benefits, Planned ($)

Program	Capacity						Energy						Non-Electric Benefits, Planned ($)									TOTAL BENEFITS
	Generation		Trans.	Distrib.	DRIPE	TOTAL	Winter		Summer		DRIPE	TOTAL	Resource Benefits							Non- Resource Benefits (1)	TOTAL	
	Summer	Winter					Peak	Off Peak	Peak	Off Peak			Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Water	Kerosene			
Residential (total)	$2,118,331	$0	$871,087	$2,578,296	$1,510,984	$7,078,697	$3,184,512	$3,994,496	$2,613,497	$2,207,227	$4,130,328	$16,130,061	-$33,217	$20,621,105	$0	$5,989,320	$0	$193,254	$0	$29,860,715	$56,631,176	$79,839,934
Residential New Construction & Major Renovation	27,135	-	10,484	31,031	17,170	85,820	51,360	66,427	35,477	34,601	54,193	242,058	-	-	-	1,624,085	-	-	-	591,880	2,215,964	2,543,842
Residential Cooling & Heating Equipment	25,802	-	10,808	31,990	22,736	91,336	136,046	40,925	41,973	13,778	48,971	281,693	(33,217)	31,747	-	84,915	-	-	-	74,863	159,308	531,336
Multi-Family Retrofit	5,701	-	3,445	10,197	6,134	25,478	277,230	357,187	155,390	176,480	187,433	1,153,721	-	-	-	-	-	-	-	1,975,205	1,975,205	3,154,404
MassSAVE	1,754,012	-	592,146	1,752,670	1,069,754	5,168,582	581,294	753,849	1,133,113	623,795	876,036	3,968,087	-	20,589,357	-	4,280,320	-	193,254	-	26,280,594	51,343,525	60,480,194
Behavior/Feedback Program	10,018	-	8,748	25,892	-	44,658	103,421	131,004	58,807	65,129	155,158	513,519	-	-	-	-	-	-	-	-	-	558,177
ENERGY STAR Lighting	276,629	-	231,676	685,730	366,294	1,560,329	1,931,691	2,510,134	1,127,384	1,227,180	2,671,526	9,467,915	-	-	-	-	-	-	-	870,631	870,631	11,898,874
ENERGY STAR Appliances	19,034	-	13,780	40,786	28,895	102,495	103,470	134,970	61,354	66,264	137,011	503,068	-	-	-	-	-	-	-	67,543	67,543	673,106
Low Income (total)	$178,927	$0	$84,062	$248,812	$156,022	$667,823	$769,729	$998,152	$439,244	$489,998	$759,482	$3,456,605	$106,210	$2,889,766	$0	$5,758	$0	$27,648	$0	$6,050,459	$9,079,841	$13,204,268
Low-Income Residential New Construction	4,683	-	2,248	6,655	3,620	17,206	11,236	14,588	6,542	7,138	15,076	54,580	106,210	-	-	5,758	-	2,513	-	331,125	445,606	517,391
Low-Income 1 to 4 Family Retrof	174,244	-	81,814	242,157	152,402	650,617	758,493	983,564	432,702	482,860	744,406	3,402,025	-	2,889,766	-	-	-	25,135	-	5,719,334	8,634,235	12,686,877
Commercial & Industrial (total)	$4,838,960	$0	$2,328,283	$6,891,395	$6,376,319	$20,434,957	$22,908,793	$4,902,917	$23,526,199	$5,239,255	$17,362,599	$73,939,764	-$2,179,953	-$4,900,876	$0	$0	$0	$0	$0	$823,357	-$6,257,471	$88,117,250
C&I New Construction and Major Renovation	1,588,215	-	724,374	2,144,047	1,928,265	6,384,901	5,564,432	1,472,647	8,073,930	1,757,230	5,265,155	22,133,393	(95,191)	(467,382)	-	-	-	-	-	94,783	-467,790	28,050,504
C&I New Construction and Major Renovation - Gov	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C&I Large Retrofit	2,354,008	-	1,126,473	3,334,204	3,102,155	9,916,841	12,604,055	2,512,406	11,741,220	2,578,054	8,744,989	38,180,724	(1,722,160)	(2,644,582)	-	-	-	-	-	212,545	-4,154,196	43,943,369
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C&I Small Retrofit	896,737	-	477,436	1,413,143	1,345,899	4,133,215	4,740,306	917,865	3,711,049	903,971	3,352,455	13,625,646	(362,602)	(1,788,912)	-	-	-	-	-	516,029	-1,635,485	16,123,376
C&I Small Retrofit - Governmen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	$7,136,218	$0	$3,283,432	$9,718,502	$8,043,325	$28,181,478	$26,863,034	$9,895,565	$26,578,941	$7,936,481	$22,252,409	$93,526,430	-$2,106,960	$18,609,995	$0	$5,995,077	$0	$220,901	$0	$36,734,532	$59,453,545	$181,161,453

Electric Benefits, Evaluated ($)

Program	Capacity						Energy						Non-Electric Benefits, Evaluated ($)									TOTAL BENEFITS
	Generation		Trans.	Distrib.	DRIPE	TOTAL	Winter		Summer		DRIPE	TOTAL	Resource Benefits							Non- Resource Benefits (1)	TOTAL	
	Summer	Winter					Peak	Off Peak	Peak	Off Peak			Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Water	Kerosene			
Residential (total)	$859,397	$0	$495,876	$1,467,724	$820,439	$3,643,436	$5,336,783	$4,752,183	$2,313,964	$1,844,998	$4,886,314	$19,134,243	-$4,946	$10,694,982	$0	$3,546,113	$0	$485,412	$0	$17,454,881	$32,176,441	$54,954,121
Residential New Construction & Major Renovation	43,094	-	17,128	50,696	28,169	139,087	129,298	143,430	56,186	40,479	94,000	463,392	46,707	127,764	-	1,065,927	-	371	-	656,702	1,897,471	$2,499,949
Residential Cooling & Heating Equipment	75,231	-	35,374	104,702	74,116	289,423	334,414	319,679	140,900	53,285	243,318	1,091,596	-56,256	-	-	-	-	-	-	69,946	13,690	$1,394,710
Multi-Family Retrofit	27,206	-	13,370	39,573	29,530	109,680	173,562	150,673	35,794	28,096	104,981	493,106	-	-	-	-	-	90,039	-	95,590	185,628	$788,414
MassSAVE	294,273	-	103,543	306,472	171,106	875,394	590,319	591,704	290,253	216,707	550,417	2,239,400	4,603	10,567,218	-	2,480,186	-	395,003	-	15,479,121	28,926,131	$32,040,924
Behavior/Feedback Program	3,551	-	3,101	9,179	-	15,831	37,643	47,683	21,404	23,705	56,474	186,910	-	-	-	-	-	-	-	-	-	$202,741
ENERGY STAR Lighting	382,115	-	296,075	876,342	475,837	2,030,371	3,885,441	3,333,750	1,661,149	1,398,431	3,629,496	13,908,267	-	-	-	-	-	-	-	1,116,066	1,116,066	$17,054,703
ENERGY STAR Appliances	33,926	-	27,285	80,761	41,680	183,651	186,106	165,266	108,278	84,294	207,627	751,571	-	-	-	-	-	-	-	37,456	37,456	$972,679
Low Income (total)	$209,048	$0	$83,194	$246,244	$163,693	$702,179	$967,745	$967,569	$346,001	$295,201	$677,966	$3,254,483	$4,701	$5,109,105	$0	$0	$0	$210,359	$0	$6,389,329	$11,713,495	$15,670,157
Low-Income Residential New Construction	1,749	-	737	2,181	1,198	5,865	3,938	3,322	1,787	1,436	3,770	14,253	-	-	-	-	-	-	-	100,071	100,071	$120,189
Low-Income 1 to 4 Family Retrof	207,299	-	82,458	244,063	162,495	696,314	963,808	964,247	344,215	293,765	674,196	3,240,230	4,701	5,109,105	-	-	-	210,359	-	6,289,258	11,613,424	$15,549,968
Commercial & Industrial (total)	$2,955,127	$0	$1,553,131	$4,597,052	$3,866,577	$12,971,887	$16,520,676	$3,936,965	$16,465,691	$3,914,954	$12,542,461	$53,380,748	-$1,821,077	$0	$0	$0	$0	$0	$0	$9,218,760	$7,397,684	$73,750,319
C&I New Construction and Major Renovation	1,262,078	-	659,939	1,953,327	1,406,357	5,281,702	5,522,112	1,066,531	6,632,633	1,349,847	4,356,306	18,927,429	-195,099	-	-	-	-	-	-	-	-195,099	$24,014,032
C&I New Construction and Major Renovation - Gov	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
C&I Large Retrofit	740,642	-	389,733	1,153,556	1,031,933	3,315,865	5,637,482	1,767,978	5,994,482	1,551,830	4,538,593	19,490,365	-308,246	-	-	-	-	-	-	5,348,847	5,040,601	$27,846,831
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
C&I Small Retrofit	952,407	-	503,459	1,490,168	1,428,287	4,374,321	5,361,082	1,102,457	3,838,576	1,013,277	3,647,561	14,962,953	-1,317,731	-	-	-	-	-	-	3,869,913	2,552,182	$21,889,456
C&I Small Retrofit - Governmen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAND TOTAL	$4,023,573	$0	$2,132,201	$6,311,020	$4,850,709	$17,317,502	$22,825,204	$9,656,718	$19,125,656	$6,055,153	$18,106,742	$75,769,474	-$1,821,321	$15,804,087	$0	$3,546,113	$0	$695,771	$0	$33,062,970	$51,287,620	$144,374,596

Electric Benefits, Percent Variance ($)

Program	Capacity						Energy						Non-Electric Benefits, Percent Variance ($)									TOTAL BENEFITS
	Generation		Trans.	Distrib.	DRIPE	TOTAL	Winter		Summer		DRIPE	TOTAL	Resource Benefits							Non- Resource Benefits (1)	TOTAL	
	Summer	Winter					Peak	Off Peak	Peak	Off Peak			Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Water	Kerosene			
Residential (total)	-59%	0%	-43%	-43%	-46%	-49%	68%	19%	-11%	-16%	18%	19%	-85%	-48%	0%	-41%	0%	151%	0%	-42%	-43%	-31%
Residential New Construction & Major Renovation	59%	-	63%	63%	64%	62%	152%	116%	58%	17%	73%	91%	-	-	-	-34%	-	-	-	11%	-14%	-2%
Residential Cooling & Heating Equipment	192%	-	227%	227%	226%	217%	146%	681%	236%	287%	397%	288%	69%	-100%	-	-100%	-	-	-	-7%	-91%	162%
Multi-Family Retrofit	377%	-	288%	288%	381%	330%	-37%	-58%	-77%	-84%	-44%	-57%	-	-	-	-	-	-	-	-95%	-91%	-75%
MassSAVE	-83%	-	-83%	-83%	-84%	-83%	2%	-22%	-74%	-65%	-37%	-44%	-	-49%	-	-42%	-	104%	-	-41%	-44%	-47%
Behavior/Feedback Program	-65%	-	-65%	-65%	-	-65%	-64%	-64%	-64%	-64%	-64%	-64%	-	-	-	-	-	-	-	-	-	-64%
ENERGY STAR Lighting	38%	-	28%	28%	30%	30%	101%	33%	47%	14%	36%	47%	-	-	-	-	-	-	-	28%	28%	43%
ENERGY STAR Appliances	78%	-	98%	98%	44%	79%	80%	22%	76%	27%	52%	49%	-	-	-	-	-	-	-	-45%	-45%	45%
Low Income (total)	17%	0%	-1%	-1%	5%	5%	26%	-3%	-21%	-40%	-11%	-6%	-96%	77%	0%	-100%	0%	661%	0%	6%	29%	19%
Low-Income Residential New Construction	-63%	-	-67%	-67%	-67%	-66%	-65%	-77%	-73%	-80%	-75%	-74%	-100%	-	-	-100%	-	-100%	-	-70%	-78%	-77%
Low-Income 1 to 4 Family Retrof	19%	-	1%	1%	7%	7%	27%	-2%	-20%	-39%	-9%	-5%	-	77%	-	-	-	737%	-	10%	35%	23%
Commercial & Industrial (total)	-39%	0%	-33%	-33%	-39%	-37%	-28%	-20%	-30%	-25%	-28%	-28%	16%	-100%	0%	0%	0%	0%	0%	1020%	-218%	-16%
C&I New Construction and Major Renovation	-21%	-	-9%	-9%	-27%	-17%	-1%	-28%	-18%	-23%	-17%	-14%	105%	-100%	-	-	-	-	-	-100%	-58%	-14%
C&I New Construction and Major Renovation - Gov	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C&I Large Retrofit	-69%	-	-65%	-65%	-67%	-67%	-55%	-30%	-49%	-40%	-48%	-49%	82%	-100%	-	-	-	-	-	2417%	-221%	-37%
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C&I Small Retrofit	6%	-	5%	5%	6%	6%	13%	20%	3%	12%	9%	10%	263%	-100%	-	-	-	-	-	650%	-256%	36%
C&I Small Retrofit - Governmen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	-44%	0%	-35%	-35%	-40%	-39%	-15%	-2%	-28%	-24%	-19%	-19%	-14%	-15%	0%	-41%	0%	215%	0%	-10%	-14%	-20%

Notes:

(1) See Appendix B, Section 2 (Screening Tool) and Appendix B, Section 3 (Technical Reference Manual) for detailed categories of non-resource benefits and all supporting documentation

(2) There were no hard to measure programs with quantifiable benefits.

See Section IV.D.3.2. Saving Summary for information on the savings used to determine the benefits in these tables.

See Section IV.D.3.3. for the Avoided Cost Factors used to determine the benefits in these tables

IV.D. WMECo Cost Effectiveness
3.2.i. Savings Summary Table

Program	# of Participants	Electric Savings, Planned										Non Electric Resources, Planned						
		Capacity (kW)			Energy (MWh)							MMBTU						Gallons
		Annual		Lifetime	Summer (Annual)		Winter (Annual)		Annual MWh	Lifetime		Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Kerosene	Water
		Summer	Winter		Peak	Off Peak	Peak	Off Peak										
Residential (total)	**143,997**	**3,409**	**5,246**	**41,200**	**3,537**	**5,007**	**6,627**	**9,709**	**24,880**	**167,743**		**-218**	**37,987**	**0**	**8,284**	**0**	**0**	**2,601,422**
Residential New Construction & Major Renovation	141	35	48	500	34	50	66	98	249	2,556		-	-	-	2,018	-	-	-
Residential Cooling & Heating Equipment	711	34	59	506	26	12	97	34	169	2,948		-218	132	-	246	-	-	-
Multi-Family Retrofit	530	20	34	157	102	157	212	314	784	12,553		-	-	-	-	-	-	-
MassSAVE	5,597	1,450	616	28,688	777	793	861	1,276	3,707	40,279		-	37,855	-	6,021	-	-	2,601,422
Behavior/Feedback Program	25,000	376	1,500	376	760	1,169	1,578	2,338	5,844	5,844		-	-	-	-	-	-	-
ENERGY STAR Lighting	108,375	1,422	2,897	10,351	1,757	2,703	3,649	5,406	13,514	98,343		-	-	-	-	-	-	-
ENERGY STAR Appliances	3,643	72	92	621	81	123	165	244	612	5,221		-	-	-	-	-	-	-
Low Income (total)	**2,996**	**350**	**763**	**3,896**	**456**	**702**	**946**	**1,402**	**3,507**	**37,088**		**538**	**6,357**	**0**	**13**	**0**	**0**	**362,432**
Low-Income Residential New Construction	26	10	16	105	10	15	20	30	76	568		538	-	-	13	-	-	24,080
Low-Income 1 to 4 Family Retrofi	2,970	340	747	3,791	446	687	926	1,372	3,431	36,520		-	6,357	-	-	-	-	338,352
Commercial & Industrial (total)	**898**	**7,887**	**4,745**	**107,605**	**18,729**	**5,803**	**21,969**	**5,373**	**51,875**	**706,386**		**-19,288**	**-18,258**	**0**	**0**	**0**	**0**	**0**
C&I New Construction and Major Renovation	138	2,351	1,615	33,607	6,393	1,947	5,338	1,637	15,315	208,871		-815	-1,597	-	-	-	-	-
C&I New Construction and Major Renovation - Gove	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
C&I Large Retrofit	248	3,796	2,286	52,085	9,077	2,749	11,729	2,631	26,186	367,097		-15,020	-9,900	-	-	-	-	-
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
C&I Small Retrofit	512	1,740	844	21,913	3,260	1,107	4,902	1,105	10,373	130,418		-3,452	-	-	-	-	-	-
C&I Small Retrofit - Government	-	-	-	-	-	-	-	-	-	-		-	(6,760.88)	-	-	-	-	-
GRAND TOTAL	**147,891**	**11,646**	**10,754**	**152,701**	**22,722**	**11,511**	**29,543**	**16,485**	**80,261**	**911,217**		**-18,968**	**26,086**	**0**	**8,297**	**0**	**0**	**2,963,854**

Program	# of Participants	Electric Savings, Evaluated										Non Electric Resources, Evaluated						
		Capacity (kW)			Energy (MWh)							MMBTU						Gallons
		Annual		Lifetime	Summer (Annual)		Winter (Annual)		Total Annual MWh	Lifetime		Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Kerosene	Water
		Summer	Winter		Peak	Off Peak	Peak	Off Peak										
Residential (total)	**220,038**	**2,644**	**6,012**	**22,701**	**3,320**	**3,898**	**9,077**	**9,330**	**25,625**	**199,282**		**-28**	**22,976**	**0**	**5,956**	**0**	**0**	**6,532,779**
Residential New Construction & Major Renovation	156	59	100	815	54	59	149	164	425	4,933		251	223	-	1,344	-	-	3,552
Residential Cooling & Heating Equipment	1,323	123	235	1,641	116	62	335	411	924	11,462		-369	-	-	-	-	-	-
Multi-Family Retrofit	1,135	99	229	614	55	59	242	242	599	5,295		-	-	-	-	-	-	1,212,025
MassSAVE	4,095	292	818	4,998	354	402	953	983	2,692	23,333		91	22,753	-	4,612	-	-	5,317,202
Behavior/Feedback Program	71,031	133	532	133	277	425	574	851	2,127	2,127		-	-	-	-	-	-	-
ENERGY STAR Lighting	135,204	1,754	3,869	13,282	2,297	2,712	6,467	6,331	17,806	144,400		-	-	-	-	-	-	-
ENERGY STAR Appliances	7,095	184	229	1,217	168	179	357	349	1,052	7,731		-	-	-	-	-	-	-
Low Income (total)	**2,625**	**313**	**928**	**3,917**	**408**	**504**	**1,155**	**1,311**	**3,378**	**34,982**		**97**	**11,183**	**0**	**0**	**0**	**0**	**2,831,684**
Low-Income Residential New Construction	15	3	5	35	2	3	7	7	19	147		-	-	-	-	-	-	-
Low-Income 1 to 4 Family Retrofi	2,610	311	923	3,882	406	501	1,148	1,304	3,359	34,834		97	11,183	-	-	-	-	2,831,684
Commercial & Industrial (total)	**883**	**5,719**	**4,616**	**71,432**	**13,155**	**4,511**	**16,758**	**4,544**	**38,969**	**511,880**		**-17,158**	**0**	**0**	**0**	**0**	**0**	**0**
C&I New Construction and Major Renovation	98	2,465	2,064	30,388	4,984	1,463	5,727	1,231	13,405	180,192		-1,605	-	-	-	-	-	-
C&I New Construction and Major Renovation - Gove	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
C&I Large Retrofit	146	1,423	1,375	17,915	4,831	1,821	5,494	2,001	14,146	187,394		-3,014	-	-	-	-	-	-
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
C&I Small Retrofit	639	1,830	1,177	23,129	3,339	1,227	5,537	1,313	11,417	144,294		-12,540	-	-	-	-	-	-
C&I Small Retrofit - Government	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
GRAND TOTAL	**223,546**	**8,676**	**11,556**	**98,050**	**16,883**	**8,913**	**26,990**	**15,184**	**67,971**	**746,144**		**-17,089**	**34,159**	**0**	**5,956**	**0**	**0**	**9,364,463**

Program	# of Participants	Electric Savings, Percent Variance										Non Electric Resources, Percent Variance						
		Capacity (kW)			Energy (MWh)							MMBTU						Gallons
		Annual		Lifetime	Summer (Annual)		Winter (Annual)		Total Annual MWh	Lifetime		Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Kerosene	Water
		Summer	Winter		Peak	Off Peak	Peak	Off Peak										
Residential (total)	**53%**	**-22%**	**15%**	**-45%**	**-6%**	**-22%**	**37%**	**-4%**	**3%**	**19%**		**-87%**	**-40%**	**0%**	**-28%**	**0%**	**0%**	**151%**
Residential New Construction & Major Renovation	11%	70%	110%	63%	56%	18%	124%	66%	71%	93%		-	-	-	-33%	-	-	-
Residential Cooling & Heating Equipment	86%	266%	297%	224%	343%	416%	246%	1104%	446%	289%		69%	-100%	-	-100%	-	-	-
Multi-Family Retrofit	114%	389%	570%	291%	-46%	-63%	14%	-23%	-24%	-58%		-	-	-	-	-	-	-
MassSAVE	-27%	-80%	33%	-83%	-54%	-49%	11%	-23%	-27%	-42%		-	-40%	-	-23%	-	-	104%
Behavior/Feedback Program	184%	-65%	-65%	-65%	-64%	-64%	-64%	-64%	-64%	-64%		-	0%	-	0%	-	-	0%
ENERGY STAR Lighting	25%	23%	34%	28%	31%	0%	77%	17%	32%	47%		-	-	-	-	-	-	-
ENERGY STAR Appliances	95%	154%	149%	96%	108%	46%	117%	43%	72%	48%		-	-	-	-	-	-	-
Low Income (total)	**-12%**	**-10%**	**22%**	**1%**	**-10%**	**-28%**	**22%**	**-7%**	**-4%**	**-6%**		**-82%**	**76%**	**0%**	**-100%**	**0%**	**0%**	**681%**
Low-Income Residential New Construction	-42%	-72%	-70%	-67%	-75%	-81%	-67%	-78%	-75%	-74%		-100%	-	-	-100%	-	-	-100%
Low-Income 1 to 4 Family Retrofi	-12%	-9%	24%	2%	-9%	-27%	24%	-5%	-2%	-5%		-	76%	-	-	-	-	737%
Commercial & Industrial (total)	**-2%**	**-27%**	**-3%**	**-34%**	**-30%**	**-22%**	**-24%**	**-15%**	**-25%**	**-28%**		**-11%**	**-100%**	**0%**	**0%**	**0%**	**0%**	**0%**
C&I New Construction and Major Renovation	-29%	5%	28%	-10%	-22%	-25%	7%	-25%	-12%	-14%		97%	-100%	-	-	-	-	-
C&I New Construction and Major Renovation - Gove	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
C&I Large Retrofit	-41%	-63%	-40%	-66%	-47%	-34%	-53%	-24%	-46%	-49%		-80%	-100%	-	-	-	-	-
Large C&I Retrofit - Government	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
C&I Small Retrofit	25%	5%	40%	6%	2%	11%	13%	19%	10%	11%		263%	-	-	-	-	-	-
C&I Small Retrofit - Government	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
GRAND TOTAL	**51%**	**-25%**	**7%**	**-36%**	**-26%**	**-23%**	**-9%**	**-8%**	**-15%**	**-18%**		**-10%**	**31%**	**0%**	**-28%**	**0%**	**0%**	**216%**

IV.D. WMECo Cost Effectiveness

3.3.i. Avoided Cost Factors Summary Table

Avoided Cost Factors

Year	Capacity ($/kW-yr) (1)		Energy ($/kWh) (1)				Non-Electric (1)							Distribution ($/kW) (2)	Transmission ($/kW) (2)
			Winter		Summer		$/MMBTU						$/Gallons		
	Summer	Winter	Peak	Off Peak	Peak	Off Peak	Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Kerosene	Water		
2012	26.25	0.0	0.061	0.052	0.072	0.052	7.96	22.75	21.51	40.16	5.63	10.08	0.01	59.76	19.93
2013	25.73	0.0	0.063	0.055	0.075	0.055	8.18	22.27	21.25	38.54	5.88	9.78	0.01	59.76	19.93
2014	25.73	0.0	0.066	0.058	0.078	0.056	8.57	21.73	20.86	37.30	6.46	9.49	0.01	59.76	19.93
2015	25.73	0.0	0.072	0.063	0.084	0.062	9.04	21.38	20.57	36.33	6.96	9.21	0.01	59.76	19.93
2016	15.97	0.0	0.073	0.064	0.092	0.063	9.06	21.39	20.56	35.45	7.53	9.02	0.01	59.76	19.93
2017	23.51	0.0	0.075	0.066	0.092	0.063	9.05	21.23	20.43	34.76	8.15	9.01	0.01	59.76	19.93
2018	32.84	0.0	0.080	0.072	0.102	0.070	9.07	21.88	21.08	35.39	8.77	8.93	0.01	59.76	19.93
2019	36.85	0.0	0.079	0.072	0.099	0.069	9.13	22.36	21.60	35.66	9.35	9.19	0.01	59.76	19.93
2020	51.59	0.0	0.081	0.071	0.094	0.070	9.23	22.69	21.93	35.91	9.37	9.36	0.01	59.76	19.93
2021	52.58	0.0	0.083	0.073	0.095	0.071	9.33	22.86	22.13	36.16	9.42	9.50	0.01	59.76	19.93
2022	78.95	0.0	0.085	0.076	0.097	0.074	9.51	23.14	22.41	36.38	9.45	9.56	0.01	59.76	19.93
2023	95.17	0.0	0.090	0.079	0.102	0.078	9.79	23.39	22.65	36.68	9.48	9.64	0.01	59.76	19.93
2024	104.15	0.0	0.093	0.081	0.104	0.080	9.96	23.55	22.81	36.97	9.55	9.76	0.01	59.76	19.93
2025	108.12	0.0	0.094	0.082	0.105	0.082	10.05	23.83	23.10	37.25	9.51	9.84	0.01	59.76	19.93
2026	110.52	0.0	0.094	0.082	0.108	0.081	10.18	24.04	23.30	37.41	9.63	9.95	0.01	59.76	19.93
2027	111.51	0.0	0.097	0.084	0.110	0.083	10.32	24.38	23.64	37.71	9.81	10.06	0.01	59.76	19.93
2028	112.10	0.0	0.100	0.086	0.113	0.086	10.45	24.72	23.99	38.02	9.99	10.19	0.01	59.76	19.93
2029	112.28	0.0	0.103	0.088	0.116	0.088	10.59	25.06	24.34	38.33	10.18	10.33	0.01	59.76	19.93
2030	112.46	0.0	0.106	0.090	0.120	0.091	10.73	25.41	24.70	38.65	10.36	10.46	0.01	59.76	19.93
2031	112.64	0.0	0.109	0.093	0.123	0.093	10.88	25.77	25.06	38.96	10.56	10.60	0.01	59.76	19.93
2032	112.68	0.0	0.113	0.095	0.126	0.096	11.02	26.13	25.43	39.28	10.75	10.74	0.01	59.76	19.93

Notes:

(1) For all factors: Please refer to WMECo Appendix B, Section 2 - Screening Model

V.D. WMECo Outsourced/Competitive Procured Services
1. Summary Table

Program	Program Planning and Administration																													
	Planned									Actual										Percent Variance										
	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL		
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities			
	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	
Residential (total)	**$ 2,133,462**	**76%**	**$ 167,359**	**25%**	**$ 496,338**	**75%**	**$ 663,697**	**24%**	**$ 2,797,159**	**$ 1,577,032**	**69%**	**$ 161,682**	**23%**	**$ 533,011**	**77%**	**$ 694,693**	**31%**	**$ 2,271,725**	**-26%**	**-9%**	**-3%**	**-8%**	**7%**	**3%**	**5%**	**29%**	**-19%**
Residential New Construction & Maj Reno	$ 79,265	88%	$ 6,220	57%	$ 4,636	43%	$ 10,856	12%	$ 90,121	$ 58,501	88%	$ 6,009	76%	$ 1,907	24%	$ 7,916	12%	$ 66,417	-26%	0%	-3%	32%	-59%	-44%	-27%	-1%	-26%
Residential Cooling & Heating Equipment	$ 128,792	88%	$ 10,108	57%	$ 7,534	43%	$ 17,642	12%	$ 146,434	$ 95,193	88%	$ 9,765	76%	$ 3,098	24%	$ 12,863	12%	$ 108,056	-26%	0%	-3%	32%	-59%	-44%	-27%	-1%	-26%
Multi-Family Retrofit	$ 249,147	88%	$ 19,632	57%	$ 14,633	43%	$ 34,265	12%	$ 283,412	$ 184,542	88%	$ 18,966	76%	$ 6,018	24%	$ 24,984	12%	$ 209,526	-26%	0%	-3%	32%	-59%	-44%	-27%	-1%	-26%
MassSAVE	$ 1,009,040	85%	$ 79,112	45%	$ 95,965	55%	$ 175,077	15%	$ 1,184,117	$ 745,573	82%	$ 76,428	48%	$ 82,547	52%	$ 158,975	18%	$ 904,548	-26%	-3%	-3%	6%	-14%	-5%	-9%	19%	-24%
Behavior/Feedback Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
ENERGY STAR Lighting	$ 435,905	88%	$ 34,210	57%	$ 25,499	43%	$ 59,709	12%	$ 495,614	$ 322,269	88%	$ 33,050	73%	$ 12,418	27%	$ 45,468	12%	$ 367,737	-26%	0%	-3%	27%	-51%	-36%	-24%	3%	-26%
ENERGY STAR Appliances	$ 128,792	88%	$ 10,108	57%	$ 7,534	43%	$ 17,642	12%	$ 146,434	$ 95,193	88%	$ 9,765	75%	$ 3,247	25%	$ 13,012	12%	$ 108,205	-26%	0%	-3%	31%	-57%	-42%	-26%	0%	-26%
Residential Education Program	$ 54,502	88%	$ 4,276	57%	$ 3,187	43%	$ 7,463	12%	$ 61,965	$ 40,156	88%	$ 4,131	76%	$ 1,311	24%	$ 5,442	12%	$ 45,598	-26%	0%	-3%	32%	-59%	-44%	-27%	-1%	-26%
Workforce Development	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Heat Loan Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
R&D and Demonstration	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	$ 28,228	88%	$ 2,138	57%	$ 1,594	43%	$ 3,732	12%	$ 31,960	$ 20,724	88%	$ 2,066	76%	$ 655	24%	$ 2,721	12%	$ 23,445	-27%	0%	-3%	33%	-59%	-44%	-27%	-1%	-27%
Behavior/Feedback Pilot	$ -		$ -		$ -		$ -			$ -	-	$ -	-	$ -	-	$ -	-	$ -									
Residential New Construction & Major Renovation -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Residential New Construction Multi Family (4-8 story	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Residential New Construction Lighting Design statev	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Residential New Construction V3 Energy Star Home	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Heat Pump Water Heater Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Community Based Pilot	$ 19,791	88%	$ 1,555	57%	$ 1,159	43%	$ 2,714	12%	$ 22,505	$ 14,881	88%	$ 1,502	76%	$ 477	24%	$ 1,979	12%	$ 16,860	-25%	0%	-3%	32%	-59%	-44%	-27%	-3%	-25%
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment	$ -	-	$ -	-	$ 261,942	100%	$ 261,942	100%	$ 261,942	$ -	-	$ -	-	$ 351,379	100%	$ 351,379	100%	$ 351,379	-	-	-	-	34%	-	34%	-	34%
Sponsorships & Subscriptions	$ -	-	$ -	-	$ 72,655	100%	$ 72,655	100%	$ 72,655	$ -	-	$ -	-	$ 69,954	100%	$ 69,954	100%	$ 69,954	-	-	-	-	-4%	-	-4%	-	-4%
Low Income (total)	**$ 718,972**	**57%**	**$ 58,040**	**11%**	**$ 480,574**	**89%**	**$ 538,614**	**43%**	**$ 1,257,586**	**$ 510,574**	**64%**	**$ 56,072**	**19%**	**$ 236,054**	**81%**	**$ 292,126**	**36%**	**$ 802,700**	**-29%**	**11%**	**-3%**	**78%**	**-51%**	**-9%**	**-46%**	**-15%**	**-36%**
Low-Income Residential New Construction	$ 59,578	88%	$ 4,803	57%	$ 3,580	43%	$ 8,383	12%	$ 67,961	$ 42,358	87%	$ 4,640	76%	$ 1,472	24%	$ 6,112	13%	$ 48,470	-29%	0%	-3%	33%	-59%	-44%	-27%	2%	-29%
Low-Income Retrofit	$ 659,394	88%	$ 53,237	57%	$ 39,680	43%	$ 92,917	12%	$ 752,311	$ 468,216	87%	$ 51,432	76%	$ 16,320	24%	$ 67,752	13%	$ 535,968	-29%	0%	-3%	32%	-59%	-44%	-27%	2%	-29%
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Low-Income Energy Affordability Network Funding	$ -	-	$ -	-	$ 350,000	100%	$ 350,000	100%	$ 350,000	$ -	-	$ -	-	$ 101,136	100%	$ 101,136	100%	$ 101,136	-	-	-	-	-71%	-	-71%	-	-71%
DOER Assessment	$ -	-	$ -	-	$ 87,314	100%	$ 87,314	100%	$ 87,314	$ -	-	$ -	-	$ 117,126	100%	$ 117,126	100%	$ 117,126	-	-	-	-	34%	-	34%	-	34%
Commercial & Industrial (total)	**$ 8,283,873**	**80%**	**$ 603,834**	**30%**	**$ 1,438,988**	**70%**	**$ 2,042,822**	**20%**	**$ 10,326,695**	**$ 5,992,241**	**75%**	**$ 652,029**	**35%**	**$ 1,310,926**	**70%**	**$ 1,877,477**	**24%**	**$ 7,955,196**	**-28%**	**-6%**	**8%**	**17%**	**-9%**	**-1%**	**-8%**	**19%**	**-23%**
C&I New Construction and Maj Reno	$ 1,927,342	87%	$ 201,278	71%	$ 80,925	29%	$ 282,203	13%	$ 2,209,545	$ 1,364,841	87%	$ 172,948	83%	$ 35,124	17%	$ 208,072	13%	$ 1,572,913	-29%	-1%	-14%	17%	-57%	-41%	-26%	4%	-29%
C&I New Construction and Maj Reno - Gvmt	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
C&I Large Retrofit	$ 5,735,955	93%	$ 201,278	46%	$ 240,895	54%	$ 442,173	7%	$ 6,178,128	$ 4,196,977	91%	$ 335,872	76%	$ 104,181	24%	$ 440,053	9%	$ 4,637,030	-27%	-3%	67%	68%	-57%	-57%	0%	33%	-25%
Large C&I Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
C&I Small Retrofit	$ 493,205	61%	$ 201,278	65%	$ 108,705	35%	$ 309,983	39%	$ 803,188	$ 342,618	64%	$ 141,290	75%	$ 47,611	25%	$ 188,901	36%	$ 531,519	-31%	5%	-30%	15%	-56%	-28%	-39%	-8%	-34%
C&I Small Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Community based Pilot	$ 127,371	99%	$ -	-	$ 1,476	-	$ 1,476	1%	$ 128,847	$ 87,805	97%	$ 1,919	75%	$ 641	25%	$ 2,560	3%	$ 90,365	-31%	-2%	-	-	-57%	-	73%	147%	-30%
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment	$ -	-	$ -	-	$ 523,884	-	$ 523,884	100%	$ 523,884	$ -	-	$ -	-	$ 702,757	100%	$ 702,757	100%	$ 702,757	-	-	-	-	34%	-	34%	-	34%
Sponsorships & Subscriptions	$ -	-	$ -	-	$ 483,103	-	$ 483,103	100%	$ 483,103	$ -	-	$ -	-	$ 420,612	126%	$ 335,134	80%	$ 420,612	-	-	-	-	-13%	-	-31%	-20%	-13%
TOTAL	**$ 11,136,307**	**77%**	**$ 829,233**	**26%**	**$ 2,415,900**	**74%**	**$ 3,245,133**	**23%**	**$ 14,381,440**	**$ 8,079,847**	**73%**	**$ 869,783**	**30%**	**$ 2,079,991**	**73%**	**$ 2,864,296**	**26%**	**$ 11,029,621**	**-27%**	**-5%**	**5%**	**19%**	**-14%**	**-2%**	**-12%**	**15%**	**-23%**

Marketing and Advertising																														
	Planned									Actual									Percent Variance											
Program	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL		
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities			
	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	
Residential (total)	**$ 55,580**	**2%**	**$ 3,343,851**	**92%**	**$ 286,539**	**8%**	**$ 3,630,390**	**98%**	**$ 3,685,970**	**$ 26,501**	**1%**	**$ 3,000,991**	**92%**	**$ 261,593**	**8%**	**$ 3,262,584**	**99%**	**$ 3,289,085**	**-52%**	**-47%**	**-10%**	**0%**	**-9%**	**2%**	**-10%**	**1%**	**-11%**	
Residential New Construction & Maj Reno	$ 2,526	2%	$ 146,264	90%	$ 16,252	10%	$ 162,515	98%	$ 165,041	$ 1,205	1%	$ 108,940	90%	$ 12,104	10%	$ 121,044	99%	$ 122,249	-52%	-36%	-26%	-	-26%	-	-26%	1%	-26%	
Residential Cooling & Heating Equipment	$ 2,526	2%	$ 135,000	90%	$ 15,000	10%	$ 150,000	98%	$ 152,526	$ 1,204	2%	$ 57,634	90%	$ 6,404	10%	$ 64,038	98%	$ 65,242	-52%	11%	-57%	0%	-57%	0%	-57%	0%	-57%	
Multi-Family Retrofit	$ 7,579	7%	$ 91,249	90%	$ 10,139	10%	$ 101,388	93%	$ 108,967	$ 3,614	71%	$ 1,355	90%	$ 151	10%	$ 1,506	29%	$ 5,120	-52%	915%	-99%	-	-99%	0%	-99%	-68%	-95%	
MassSAVE	$ 25,264	2%	$ 945,000	90%	$ 105,000	10%	$ 1,050,000	98%	$ 1,075,264	$ 12,046	1%	$ 915,086	90%	$ 101,676	10%	$ 1,016,762	99%	$ 1,028,808	-52%	-50%	-3%	-	-3%	-	-3%	1%	-4%	
Behavior/Feedback Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
ENERGY STAR Lighting	$ 10,106	1%	$ 762,434	90%	$ 84,715	10%	$ 847,149	99%	$ 857,255	$ 4,818	1%	$ 830,019	90%	$ 92,224	10%	$ 922,243	99%	$ 927,061	-52%	-56%	9%	0%	9%	0%	9%	1%	8%	
ENERGY STAR Appliances	$ 5,053	4%	$ 110,931	90%	$ 12,326	10%	$ 123,257	96%	$ 128,310	$ 2,409	2%	$ 118,418	90%	$ 13,158	10%	$ 131,575	98%	$ 133,984	-52%	-54%	7%	-	7%	-	7%	2%	4%	
Residential Education Program	$ 2,526	1%	$ 182,250	90%	$ 20,250	10%	$ 202,500	99%	$ 205,026	$ 1,205	1%	$ 171,788	90%	$ 19,088	10%	$ 190,875	99%	$ 192,080	-52%	-49%	-6%	-	-6%	-	-6%	1%	-6%	
Workforce Development	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Heat Loan Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
R&D and Demonstration	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Deep Energy Retrofit	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Behavior/Feedback Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Residential New Construction & Major Renovation -	$ -	-	$ 46,063	90%	$ 5,118	10%	$ 51,181	100%	$ 51,181	$ -	-	$ 13,959	90%	$ 1,551	10%	$ 15,510	1.00	$ 15,510	-	-	-70%	-	-70%	-	-70%	-	-70%	
Residential New Construction Multi Family (4-8 story	$ -	-	$ 64,260	90%	$ 7,140	10%	$ 71,400	100%	$ 71,400	$ -	-	$ 54,085	90%	$ 6,009	10%	$ 60,094	100%	$ 60,094	-	-	-16%	-	-16%	-	-16%	-	-16%	
Residential New Construction Lighting Design statew	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Residential New Construction V3 Energy Star Home	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Heat Pump Water Heater Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Community Based Pilot	$ -	-	$ 95,400	90%	$ 10,600	10%	$ 106,000	100%	$ 106,000	$ -	-	$ 83,058	90%	$ 9,229	10%	$ 92,287	100%	$ 92,287	-	-	-13%	-	-13%	-	-13%	-	-13%	
Statewide Marketing & Education	$ -	-	$ 765,000	100%	$ -	-	$ 765,000	100%	$ 765,000	$ -	-	$ 646,650	100%	$ -	-	$ 646,650	100%	$ 646,650	-	-	-15%	-	-	-	-15%	-	-15%	
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Sponsorships & Subscriptions	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Low Income (total)	**$ 20,192**	**5%**	**$ 372,500**	**92%**	**$ 32,500**	**8%**	**$ 405,000**	**95%**	**$ 425,192**	**$ 9,634**	**12%**	**$ 70,760**	**99%**	**$ 449**	**1%**	**$ 71,209**	**88%**	**$ 80,843**	**-52%**	**151%**	**-81%**	**8%**	**-99%**	**-92%**	**-82%**	**-8%**	**-81%**	
Low-Income Residential New Construction	$ 2,524	100%	$ -	-	$ -	-	$ -	-	$ 2,524	$ 1,204	100%	$ -	-	$ -	-	$ -	-	$ 1,204	-52%	-	-	-	-	-	-	-	-52%	
Low-Income Retrofit	$ 17,668	5%	$ 292,500	90%	$ 32,500	10%	$ 325,000	95%	$ 342,668	$ 8,430	65%	$ 4,044	90%	$ 449	10%	$ 4,493	35%	$ 12,923	-52%	1165%	-99%	0%	-99%	0%	-99%	-63%	-96%	
Statewide Marketing & Education	$ -	-	$ 80,000	100%	$ -	-	$ 80,000	100%	$ 80,000	$ -	-	$ 66,716	100%	$ -	-	$ 66,716	100%	$ 66,716	-	-	-17%	-	-	-	-17%	-	-17%	
Low-Income Energy Affordability Network Funding	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Commercial & Industrial (total)	**$ 967,876**	**25%**	**$ 2,914,922**	**100%**	**$ 10,600**	**0%**	**$ 2,925,522**	**75%**	**$ 3,893,398**	**$ 303,442**	**21%**	**$ 1,135,036**	**144%**	**$ 26,106**	**3%**	**$ 786,872**	**54%**	**$ 1,464,584**	**-69%**	**-17%**	**-61%**	**45%**	**146%**	**816%**	**-73%**	**-28%**	**-62%**	
C&I New Construction and Maj Reno	$ 227,764	22%	$ 800,000	100%	$ -	-	$ 800,000	78%	$ 1,027,764	$ 71,849	45%	$ 85,828	96%	$ 3,576	4%	$ 89,404	55%	$ 161,253	-68%	101%	-89%	-4%	-	-	-89%	-29%	-84%	
C&I New Construction and Maj Reno - Gvmt	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
C&I Large Retrofit	$ 677,573	36%	$ 1,200,000	100%	$ -	-	$ 1,200,000	64%	$ 1,877,573	$ 213,368	51%	$ 199,141	96%	$ 8,298	4%	$ 207,439	49%	$ 420,807	-69%	41%	-83%	-4%	-	-	-83%	-23%	-78%	
Large C&I Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
C&I Small Retrofit	$ 62,539	16%	$ 319,522	100%	$ -	-	$ 319,522	84%	$ 382,061	$ 18,225	5%	$ 336,773	96%	$ 14,032	4%	$ 350,805	95%	$ 369,030	-71%	-70%	5%	-4%	-	-	10%	14%	-3%	
C&I Small Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Community based Pilot	$ -	-	$ 95,400	90%	$ 10,600	10%	$ 106,000	100%	$ 106,000	$ -	-	$ 1,799	90%	$ 200	10%	$ 1,999	100%	$ 1,999	-	-	-98%	0%	-98%	0%	-98%	-	-98%	
Statewide Marketing & Education	$ -	-	$ 500,000	100%	$ -	-	$ 500,000	100%	$ 500,000	$ -	-	$ 511,495	373%	$ -	-	$ 137,225	27%	$ 511,495	-	-	2%	273%	-	-	-73%	-73%	2%	
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
Sponsorships & Subscriptions	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-	
TOTAL	**$ 1,043,648**	**13%**	**$ 6,631,273**	**95%**	**$ 329,639**	**5%**	**$ 6,960,912**	**87%**	**$ 8,004,560**	**$ 339,577**	**7%**	**$ 4,206,786**	**102%**	**$ 288,149**	**7%**	**$ 4,120,665**	**85%**	**$ 4,834,512**	**-67%**	**-46%**	**-37%**	**7%**	**-13%**	**48%**	**-41%**	**-2%**	**-40%**	

Sales, Technical Assistance & Training

Program	Planned									Actual									Percent Variance							
	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities					
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities		TOTAL
	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$
Residential (total)	$ -	0%	$ 8,347,130	100%	$ -	0%	$ 8,347,130	100%	$ 8,347,130	$ -	0%	$ 7,806,918	100%	$ -	0%	$ 7,806,918	100%	$ 7,806,918	0%	0%	-6%	0%	0%	0%	-6%	0%	-6%
Residential New Construction & Maj Reno	-	-	$ 148,362	100%	$ -	-	$ 148,362	100%	$ 148,362	$ -	-	$ 204,605	100%	$ -	-	$ 204,605	100%	$ 204,605	-	-	38%	-	-	-	38%	-	38%
Residential Cooling & Heating Equipment	-	-	$ 325,190	100%	$ -	-	$ 325,190	100%	$ 325,190	$ -	-	$ 267,866	100%	$ -	-	$ 267,866	100%	$ 267,866	-	-	-18%	-	-	-	-18%	-	-18%
Multi-Family Retrofit	-	-	$ 509,500	100%	$ -	-	$ 509,500	100%	$ 509,500	$ -	-	$ 489,498	100%	$ -	-	$ 489,498	100%	$ 489,498	-	-	-4%	-	-	-	-4%	-	-4%
MassSAVE	-	-	$ 3,931,260	100%	$ -	-	$ 3,931,260	100%	$ 3,931,260	$ -	-	$ 4,257,761	100%	$ -	-	$ 4,257,761	100%	$ 4,257,761	-	-	8%	-	-	-	8%	-	8%
Behavior/Feedback Program	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
ENERGY STAR Lighting	-	-	$ 945,091	100%	$ -	-	$ 945,091	100%	$ 945,091	$ -	-	$ 756,210	100%	$ -	-	$ 756,210	100%	$ 756,210	-	-	-20%	-	-	-	-20%	-	-20%
ENERGY STAR Appliances	-	-	$ 997,722	100%	$ -	-	$ 997,722	100%	$ 997,722	$ -	-	$ 718,264	100%	$ -	-	$ 718,264	100%	$ 718,264	-	-	-28%	-	-	-	-28%	-	-28%
Residential Education Program	-	-	$ 663,000	100%	$ -	-	$ 663,000	100%	$ 663,000	$ -	-	$ 642,203	100%	$ -	-	$ 642,203	100%	$ 642,203	-	-	-3%	-	-	-	-3%	-	-3%
Workforce Development	-	-	$ 150,000	100%	$ -	-	$ 150,000	100%	$ 150,000	$ -	-	$ 35,779	100%	$ -	-	$ 35,779	100%	$ 35,779	-	-	-76%	-	-	-	-76%	-	-76%
Heat Loan Program	-	-	$ 281,600	100%	$ -	-	$ 281,600	100%	$ 281,600	$ -	-	$ 279,344	100%	$ -	-	$ 279,344	100%	$ 279,344	-	-	-1%	-	-	-	-1%	-	-1%
R&D and Demonstration	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	$ 75,000	100%	$ -	-	$ 75,000	100%	$ 75,000	$ -	-	$ 1,723	100%	$ -	-	$ 1,723	100%	$ 1,723	-	-	-98%	-	-	-	-98%	-	-98%
Behavior/Feedback Pilot	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Residential New Construction & Major Renovation -	-	-	$ 2,635	100%	$ -	-	$ 2,635	100%	$ 2,635	$ -	-	$ 15,751	100%	$ -	-	$ 15,751	100%	$ 15,751	-	-	498%	-	-	-	498%	-	498%
Residential New Construction Multi Family (4-8 story	-	-	$ 64,770	100%	$ -	-	$ 64,770	100%	$ 64,770	$ -	-	$ 26,015	100%	$ -	-	$ 26,015	100%	$ 26,015	-	-	-60%	-	-	-	-60%	-	-60%
Residential New Construction Lighting Design statew	-	-	$ 3,000	100%	$ -	-	$ 3,000	100%	$ 3,000	$ -	-	$ 5,312	100%	$ -	-	$ 5,312	100%	$ 5,312	-	-	77%	-	-	-	77%	-	77%
Residential New Construction V3 Energy Star Home	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Heat Pump Water Heater Pilot	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Community Based Pilot	-	-	$ 250,000	100%	$ -	-	$ 250,000	100%	$ 250,000	$ -	-	$ 106,587	100%	$ -	-	$ 106,587	100%	$ 106,587	-	-	-57%	-	-	-	-57%	-	-57%
Statewide Marketing & Education	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
EEAC Consultants	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Sponsorships & Subscriptions	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Low Income (total)	$ -	0%	$ 570,227	29%	$ 1,367,677	71%	$ 1,937,904	100%	$ 1,937,904	$ -	0%	$ 836,965	33%	$ 1,715,320	67%	$ 2,552,285	100%	$ 2,552,285	0%	0%	47%	11%	25%	-5%	32%	0%	32%
Low-Income Residential New Construction	-	-	$ 24,000	100%	$ -	-	$ 24,000	100%	$ 24,000	$ -	-	$ 24,000	100%	$ -	-	$ 24,000	100%	$ 24,000	-	-	-	-	-	-	-	-	-
Low-Income Retrofit	-	-	$ 546,227	29%	$ 1,367,677	71%	$ 1,913,904	100%	$ 1,913,904	$ -	-	$ 812,965	32%	$ 1,715,320	68%	$ 2,528,285	100%	$ 2,528,285	-	-	49%	13%	25%	-5%	32%	-	32%
Statewide Marketing & Education	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Low-Income Energy Affordability Network Funding	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment			$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Commercial & Industrial (total)	$ 5,725,639	34%	$ 10,194,402	92%	$ 900,000	8%	$ 11,094,402	66%	$ 16,820,041	$ 4,860,748	48%	$ 5,107,927	96%	$ 211,427	4%	$ 5,319,354	52%	$ 10,180,102	-15%	40%	-50%	5%	-77%	-51%	-52%	-21%	-39%
C&I New Construction and Maj Reno	$ 1,371,072	41%	$ 1,700,000	85%	$ 300,000	15%	$ 2,000,000	59%	$ 3,371,072	$ 1,163,964	61%	$ 630,918	85%	$ 111,339	15%	$ 742,257	39%	$ 1,906,221	-15%	50%	-63%	-	-63%	-	-63%	-34%	-43%
C&I New Construction and Maj Reno - Gvmt	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
C&I Large Retrofit	$ 4,074,704	50%	$ 3,400,000	85%	$ 600,000	15%	$ 4,000,000	50%	$ 8,074,704	$ 3,459,196	84%	$ 567,166	85%	$ 100,088	15%	$ 667,254	16%	$ 4,126,450	-15%	66%	-83%	0%	-83%	-	-83%	-67%	-49%
Large C&I Retrofit - Government	-	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
C&I Small Retrofit	$ 259,323	5%	$ 4,900,402	100%	$ -	-	$ 4,900,402	95%	$ 5,159,725	$ 220,150	5%	$ 3,884,843	100%	$ -	-	$ 3,884,843	95%	$ 4,104,993	-15%	7%	-21%	-	-	-	-21%	0%	-20%
C&I Small Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Community based Pilot	$ 20,540	10%	$ 194,000	100%	$ -	-	$ 194,000	90%	$ 214,540	$ 17,438	41%	$ 25,000	100%	$ -	-	$ 25,000	59%	$ 42,438	-15%	329%	-87%	-	-	-	-87%	-35%	-80%
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Sponsorships & Subscriptions	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
TOTAL	**$ 5,725,639**	**21%**	**$ 19,111,759**	**89%**	**$ 2,267,677**	**11%**	**$ 21,379,436**	**79%**	**$ 27,105,075**	**$ 4,860,748**	**24%**	**$ 13,751,811**	**88%**	**$ 1,926,746**	**12%**	**$ 15,678,557**	**76%**	**$ 20,539,305**	**-15%**	**12%**	**-28%**	**-2%**	**-15%**	**16%**	**-27%**	**-3%**	**-24%**

Evaluation and Market Research																																
Program	Planned									Actual										Percent Variance												
	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL					
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					
	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$					
Residential (total)	**$ 275,379**	**15%**	**$ 1,612,030**	**100%**	**$ -**	**0%**	**$ 1,612,030**	**85%**	**$ 1,887,409**	**$ 131,298**	**12%**	**$ 923,855**	**100%**	**$ -**	**0%**	**$ 923,855**	**88%**	**$ 1,055,153**	**-52%**	**-15%**	**-43%**	**0%**	**0%**	**0%**	**-43%**	**3%**	**-44%**					
Residential New Construction & Maj Reno	$ 12,631	14%	$ 78,054	100%	$ -	-	$ 78,054	86%	$ 90,685	$ 6,023	4%	$ 138,318	100%	$ -	-	$ 138,318	96%	$ 144,341	-52%	-70%	77%	-	-	-	77%	11%	59%					
Residential Cooling & Heating Equipment	$ 5,053	18%	$ 23,565	100%	$ -	-	$ 23,565	82%	$ 28,618	$ 2,409	2%	$ 122,301	100%	$ -	-	$ 122,301	98%	$ 124,710	-52%	-89%	419%	-	-	-	419%	19%	336%					
Multi-Family Retrofit	$ 32,843	15%	$ 181,578	100%	$ -	-	$ 181,578	85%	$ 214,421	$ 15,659	15%	$ 91,861	100%	$ -	-	$ 91,861	85%	$ 107,520	-52%	-5%	-49%	-	-	-	-49%	1%	-50%					
MassSAVE	$ 149,059	15%	$ 870,218	100%	$ -	-	$ 870,218	85%	$ 1,019,277	$ 71,070	21%	$ 272,431	100%	$ -	-	$ 272,431	79%	$ 343,501	-52%	41%	-69%	-	-	-	-69%	-7%	-66%					
Behavior/Feedback Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
ENERGY STAR Lighting	$ 53,055	15%	$ 297,642	100%	$ -	-	$ 297,642	85%	$ 350,697	$ 25,296	13%	$ 167,883	100%	$ -	-	$ 167,883	87%	$ 193,179	-52%	-13%	-44%	-	-	-	-44%	2%	-45%					
ENERGY STAR Appliances	$ 15,159	14%	$ 89,436	100%	$ -	-	$ 89,436	86%	$ 104,595	$ 7,227	12%	$ 54,077	100%	$ -	-	$ 54,077	88%	$ 61,304	-52%	-19%	-40%	-	-	-	-40%	3%	-41%					
Residential Education Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Workforce Development	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Heat Loan Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
R&D and Demonstration	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Deep Energy Retrofit	$ -	-	$ 25,000	100%	$ -	-	$ 25,000	100%	$ 25,000	$ -	-	$ 22,840	100%	$ -	-	$ 22,840	100%	$ 22,840	-	-	-9%	-	-	-	-9%	-	-9%					
Behavior/Feedback Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Residential New Construction & Major Renovation -	$ -	-	$ 10,000	100%	$ -	-	$ 10,000	100%	$ 10,000	$ -	-	$ 7,112	100%	$ -	-	$ 7,112	100%	$ 7,112	-	-	-29%	-	-	-	-29%	-	-29%					
Residential New Construction Multi Family (4-8 story	$ -	-	$ 20,000	100%	$ -	-	$ 20,000	100%	$ 20,000	$ -	-	$ 33,029	100%	$ -	-	$ 33,029	100%	$ 33,029	-	-	65%	-	-	-	65%	-	65%					
Residential New Construction Lighting Design statew	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Residential New Construction V3 Energy Star Home	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Heat Pump Water Heater Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Community Based Pilot	$ 7,579	31%	$ 16,537	100%	$ -	-	$ 16,537	69%	$ 24,116	$ 3,614	21%	$ 14,003	100%	$ -	-	$ 14,003	79%	$ 17,617	-52%	-35%	-15%	-	-	-	-15%	16%	-27%					
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Sponsorships & Subscriptions	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Low Income (total)	**$ 116,101**	**15%**	**$ 660,328**	**100%**	**$ -**	**0%**	**$ 660,328**	**85%**	**$ 776,429**	**$ 55,393**	**15%**	**$ 305,852**	**100%**	**$ -**	**0%**	**$ 305,852**	**85%**	**$ 361,245**	**-52%**	**3%**	**-54%**	**0%**	**0%**	**0%**	**-54%**	**0%**	**-53%**					
Low-Income Residential New Construction	$ 10,096	42%	$ 13,716	100%	$ -	-	$ 13,716	58%	$ 23,812	$ 4,817	29%	$ 11,557	100%	$ -	-	$ 11,557	71%	$ 16,374	-52%	-31%	-16%	-	-	-	-16%	23%	-31%					
Low-Income Retrofit	$ 106,005	14%	$ 646,612	100%	$ -	-	$ 646,612	86%	$ 752,617	$ 50,576	15%	$ 294,295	100%	$ -	-	$ 294,295	85%	$ 344,871	-52%	4%	-54%	-	-	-	-54%	-1%	-54%					
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Low-Income Energy Affordability Network Funding	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Commercial & Industrial (total)	**$ 865,003**	**15%**	**$ 4,931,518**	**100%**	**$ -**	**0%**	**$ 4,931,518**	**85%**	**$ 5,796,521**	**$ 421,252**	**21%**	**$ 1,601,611**	**100%**	**$ -**	**0%**	**$ 1,601,611**	**79%**	**$ 2,022,863**	**-51%**	**40%**	**-68%**	**0%**	**0%**	**0%**	**-68%**	**-7%**	**-65%**					
C&I New Construction and Maj Reno	$ 225,653	15%	$ 1,319,439	100%	$ -	-	$ 1,319,439	85%	$ 1,545,092	$ 109,892	19%	$ 455,748	100%	$ -	-	$ 455,748	81%	$ 565,640	-51%	33%	-65%	-	-	-	-65%	-6%	-63%					
C&I New Construction and Maj Reno - Gvmt	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
C&I Large Retrofit	$ 501,451	15%	$ 2,845,671	100%	$ -	-	$ 2,845,671	85%	$ 3,347,122	$ 244,204	22%	$ 871,863	100%	$ -	-	$ 871,863	78%	$ 1,116,067	-51%	46%	-69%	-	-	-	-69%	-8%	-67%					
Large C&I Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
C&I Small Retrofit	$ 130,377	15%	$ 741,408	100%	$ -	-	$ 741,408	85%	$ 871,785	$ 63,493	20%	$ 261,203	100%	$ -	-	$ 261,203	80%	$ 324,696	-51%	31%	-65%	-	-	-	-65%	-5%	-63%					
C&I Small Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Community based Pilot	$ 7,522	23%	$ 25,000	100%	$ -	-	$ 25,000	77%	$ 32,522	$ 3,663	22%	$ 12,797	100%	$ -	-	$ 12,797	78%	$ 16,460	-51%	-4%	-49%	-	-	-	-49%	1%	-49%					
Statewide Marketing & Education	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
DOER Assessment	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
Sponsorships & Subscriptions	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-					
TOTAL	**$ 1,256,483**	**15%**	**$ 7,203,876**	**100%**	**$ -**	**0%**	**$ 7,203,876**	**85%**	**$ 8,460,359**	**$ 607,943**	**18%**	**$ 2,831,318**	**100%**	**$ -**	**0%**	**$ 2,831,318**	**82%**	**$ 3,439,261**	**-52%**	**19%**	**-61%**	**0%**	**0%**	**0%**	**-61%**	**-3%**	**-59%**					

Program	Total																											
	Planned									Actual									Percent Variance									
	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL	In-House Activities		Outsourced Activities						TOTAL
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities					Competitively Procured		Non-Competitively Procured		Total Outsourced Activities		
	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$	$	% of Total	$	% of Outsource	$	% of Outsource	$	% of Total	$
Residential (total)	**$ 2,464,421**	**15%**	**$ 13,470,370**	**95%**	**$ 782,877**	**5%**	**$ 14,253,247**	**85%**	**$ 16,717,668**	**$ 1,734,831**	**12%**	**$ 11,893,446**	**94%**	**$ 794,604**	**6%**	**$ 12,688,050**	**88%**	**$ 14,422,881**	**-30%**	**-18%**	**-12%**	**-1%**	**1%**	**14%**	**-11%**	**3%**	**-14%**
Residential New Construction & Maj Reno	$ 94,422	19%	$ 378,900	95%	$ 20,888	5%	$ 399,787	81%	$ 494,209	$ 65,729	12%	$ 457,872	97%	$ 14,011	3%	$ 471,883	88%	$ 537,612	-30%	-36%	21%	2%	-33%	-43%	18%	9%	9%
Residential Cooling & Heating Equipment	$ 136,371	21%	$ 493,863	96%	$ 22,534	4%	$ 516,397	79%	$ 652,768	$ 98,806	17%	$ 457,566	98%	$ 9,502	2%	$ 467,068	83%	$ 565,874	-28%	-16%	-7%	2%	-58%	-53%	-10%	4%	-13%
Multi-Family Retrofit	$ 289,569	26%	$ 801,959	97%	$ 24,772	3%	$ 826,731	74%	$ 1,116,300	$ 203,815	25%	$ 601,680	99%	$ 6,169	1%	$ 607,849	75%	$ 811,664	-30%	-3%	-25%	2%	-75%	-66%	-26%	1%	-27%
MassSAVE	$ 1,183,363	16%	$ 5,825,590	97%	$ 200,965	3%	$ 6,026,555	84%	$ 7,209,918	$ 828,689	13%	$ 5,521,706	97%	$ 184,223	3%	$ 5,705,929	87%	$ 6,534,618	-30%	-23%	-5%	0%	-8%	-3%	-5%	4%	-9%
Behavior/Feedback Program	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
ENERGY STAR Lighting	$ 499,066	19%	$ 2,039,377	95%	$ 110,214	5%	$ 2,149,591	81%	$ 2,648,657	$ 352,383	16%	$ 1,787,162	94%	$ 104,642	6%	$ 1,891,804	84%	$ 2,244,187	-29%	-17%	-12%	0%	-5%	8%	-12%	4%	-15%
ENERGY STAR Appliances	$ 149,004	11%	$ 1,208,197	98%	$ 19,860	2%	$ 1,228,057	89%	$ 1,377,061	$ 104,829	10%	$ 900,524	98%	$ 16,405	2%	$ 916,928	90%	$ 1,021,757	-30%	-5%	-25%	0%	-17%	11%	-25%	1%	-26%
Residential Education Program	$ 57,028	6%	$ 849,526	97%	$ 23,437	3%	$ 872,963	94%	$ 929,991	$ 41,361	5%	$ 818,122	98%	$ 20,399	2%	$ 838,520	95%	$ 879,881	-27%	-23%	-4%	0%	-13%	-9%	-4%	2%	-5%
Workforce Development	$ -	-	$ 150,000	100%	$ -	-	$ 150,000	100%	$ 150,000	$ -	-	$ 35,779	100%	$ -	-	$ 35,779	100%	$ 35,779	-	-	-76%	-	-	-	-76%	-	-76%
Heat Loan Program	$ -	-	$ 281,600	100%	$ -	-	$ 281,600	100%	$ 281,600	$ -	-	$ 279,344	100%	$ -	-	$ 279,344	100%	$ 279,344	-	-	-1%	-	-	-	-1%	-	-1%
R&D and Demonstration																												
Deep Energy Retrofit	$ 28,228	21%	$ 102,138	98%	$ 1,594	2%	$ 103,732	79%	$ 131,960	$ 20,724	43%	$ 26,629	98%	$ 655	2%	$ 27,284	57%	$ 48,008	-27%	102%	-74%	-1%	-59%	56%	-74%	-28%	-64%
Behavior/Feedback Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Residential New Construction & Major Renovation -	$ -	-	$ 58,698	92%	$ 5,118	8%	$ 63,816	100%	$ 63,816	$ -	-	$ 36,822	96%	$ 1,551	4%	$ 38,373	100%	$ 38,373	-	-	-37%	4%	-70%	-50%	-40%	-	-40%
Residential New Construction Multi Family (4-8 story	$ -	-	$ 149,030	95%	$ 7,140	5%	$ 156,170	100%	$ 156,170	$ -	-	$ 113,129	95%	$ 6,009	5%	$ 119,138	100%	$ 119,138	-	-	-24%	0%	-16%	10%	-24%	-	-24%
Residential New Construction Lighting Design statew	$ -	-	$ 3,000	100%	$ -	-	$ 3,000	100%	$ 3,000	$ -	-	$ 5,312	100%	$ -	-	$ 5,312	100%	$ 5,312	-	-	77%	-	-	-	77%	-	77%
Residential New Construction V3 Energy Star Home	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Heat Pump Water Heater Pilot	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Community Based Pilot	$ 27,370	7%	$ 363,492	97%	$ 11,759	3%	$ 375,251	93%	$ 402,621	$ 18,495	8%	$ 205,150	95%	$ 9,706	5%	$ 214,856	92%	$ 233,351	-32%	17%	-44%	-1%	-17%	44%	-43%	-1%	-42%
Statewide Marketing & Education	$ -	-	$ 765,000	100%	$ -	-	$ 765,000	100%	$ 765,000	$ -	-	$ 646,650	100%	$ -	-	$ 646,650	100%	$ 646,650	-	-	-15%	-	-	-	-15%	-	-15%
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment	$ -	-	$ -	-	$ 261,942	100%	$ 261,942	100%	$ 261,942	$ -	-	$ -	-	$ 351,379	100%	$ 351,379	100%	$ 351,379	-	-	-	-	34%	-	34%	-	34%
Sponsorships & Subscriptions	$ -	-	$ -	-	$ 72,655	100%	$ 72,655	100%	$ 72,655	$ -	-	$ -	-	$ 69,954	100%	$ 69,954	100%	$ 69,954	-	-	-	-	-4%	-	-4%	-	-4%
Low Income (total)	**$ 855,265**	**19%**	**$ 1,661,095**	**47%**	**$ 1,880,751**	**53%**	**$ 3,541,846**	**81%**	**$ 4,397,111**	**$ 575,601**	**15%**	**$ 1,269,649**	**39%**	**$ 1,951,823**	**61%**	**$ 3,221,472**	**85%**	**$ 3,797,073**	**-33%**	**-22%**	**-24%**	**-16%**	**4%**	**14%**	**-9%**	**5%**	**-14%**
Low-Income Residential New Construction	$ 72,198	61%	$ 42,519	92%	$ 3,580	8%	$ 46,099	39%	$ 118,297	$ 48,379	54%	$ 40,197	96%	$ 1,472	4%	$ 41,669	46%	$ 90,048	-33%	-12%	-5%	5%	-59%	-55%	-10%	19%	-24%
Low-Income Retrofit	$ 783,067	21%	$ 1,538,576	52%	$ 1,439,857	48%	$ 2,978,433	79%	$ 3,761,500	$ 527,222	15%	$ 1,162,736	40%	$ 1,732,089	60%	$ 2,894,825	85%	$ 3,422,047	-33%	-26%	-24%	-22%	20%	24%	-3%	7%	-9%
Statewide Marketing & Education	$ -	-	$ 80,000	100%	$ -	-	$ 80,000	100%	$ 80,000	$ -	-	$ 66,716	100%	$ -	-	$ 66,716	100%	$ 66,716	-	-	-17%	-	-	-	-17%	-	-17%
Low-Income Energy Affordability Network Funding	$ -	-	$ -	-	$ 350,000	100%	$ 350,000	100%	$ 350,000	$ -	-	$ -	-	$ 101,136	100%	$ 101,136	100%	$ 101,136	-	-	-	-	-71%	-	-71%	-	-71%
DOER Assessment	$ -	-	$ -	-	$ 87,314	100%	$ 87,314	100%	$ 87,314	$ -	-	$ -	-	$ 117,126	100%	$ 117,126	100%	$ 117,126	-	-	-	-	34%	-	34%	-	34%
Commercial & Industrial (total)	**$ 15,842,391**	**43%**	**$ 18,644,676**	**89%**	**$ 2,349,588**	**11%**	**$ 20,994,264**	**57%**	**$ 36,836,655**	**$ 11,577,683**	**54%**	**$ 8,496,604**	**85%**	**$ 1,548,458**	**15%**	**$ 10,045,062**	**46%**	**$ 21,622,745**	**-27%**	**25%**	**-54%**	**-5%**	**-34%**	**38%**	**-52%**	**-18%**	**-41%**
C&I New Construction and Maj Reno	$ 3,751,831	46%	$ 4,020,717	91%	$ 380,925	9%	$ 4,401,642	54%	$ 8,153,473	$ 2,710,546	64%	$ 1,345,442	90%	$ 150,039	10%	$ 1,495,481	36%	$ 4,206,027	-28%	40%	-67%	-2%	-61%	16%	-66%	-34%	-48%
C&I New Construction and Maj Reno - Gvmt	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
C&I Large Retrofit	$ 10,989,683	56%	$ 7,646,949	90%	$ 840,895	10%	$ 8,487,844	44%	$ 19,477,527	$ 8,113,745	79%	$ 1,974,042	90%	$ 212,567	10%	$ 2,186,609	21%	$ 10,300,354	-26%	40%	-74%	0%	-75%	-2%	-74%	-51%	-47%
Large C&I Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
C&I Small Retrofit	$ 945,444	13%	$ 6,162,610	98%	$ 108,705	2%	$ 6,271,315	87%	$ 7,216,759	$ 644,486	12%	$ 4,624,109	99%	$ 61,643	1%	$ 4,685,752	88%	$ 5,330,238	-32%	-8%	-25%	0%	-43%	-24%	-25%	1%	-26%
C&I Small Retrofit - Government	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
Community based Pilot	$ 155,433	32%	$ 314,400	96%	$ 12,076	4%	$ 326,476	68%	$ 481,909	$ 108,906	72%	$ 41,515	98%	$ 841	2%	$ 42,356	28%	$ 151,262	-30%	123%	-87%	2%	-93%	-46%	-87%	-59%	-69%
Statewide Marketing & Education	$ -	-	$ 500,000	100%	$ -	-	$ 500,000	100%	$ 500,000	$ -	-	$ 511,495	100%	$ -	-	$ 511,495	100%	$ 511,495	-	-	2%	-	-	-	2%	-	2%
EEAC Consultants	$ -	-	$ -	-	$ -	-	$ -	-	$ -	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	-	-	-	-	-	-	-	-
DOER Assessment	$ -	-	$ -	-	$ 523,884	100%	$ 523,884	100%	$ 523,884	$ -	-	$ -	-	$ 702,757	100%	$ 702,757	100%	$ 702,757	-	-	-	-	34%	-	34%	-	34%
Sponsorships & Subscriptions	$ -	-	$ -	-	$ 483,103	100%	$ 483,103	100%	$ 483,103	$ -	-	$ -	-	$ 420,612	100%	$ 420,612	100%	$ 420,612	-	-	-	-	-13%	-	-13%	-	-13%
TOTAL	**$ 19,162,077**	**33%**	**$ 33,776,141**	**87%**	**$ 5,013,216**	**13%**	**$ 38,789,357**	**67%**	**$ 57,951,434**	**$ 13,888,115**	**35%**	**$ 21,659,698**	**83%**	**$ 4,294,886**	**17%**	**$ 25,954,584**	**65%**	**$ 39,842,699**	**-28%**	**5%**	**-36%**	**-4%**	**-14%**	**28%**	**-33%**	**-3%**	**-31%**

VII. WMECo Appendix
B.1. Master Summary

Electric PA's Master Summary of Energy Efficiency Activities

Customer Sector	Benefits ($)						TRC Costs ($)			TRC B/C Ratio	Net Benefits
	Capacity	Energy	DRIPE (Capacity & Energy)	Non-Elec. Resource	Non-Resource	Total Benefits	PA	Customer	TOTAL		
Planned											
Residential	5,567,713	11,999,732	5,641,313	26,770,461	29,860,715	79,839,934	10,845,612	2,074,923	12,920,535	6.2	66,919,399
Low Income	511,801	2,697,123	915,504	3,029,381	6,050,459	13,204,268	4,591,735	(21,020)	4,570,715	2.9	8,633,553
C&I	14,058,639	56,577,165	23,738,918	(7,080,828)	823,357	88,117,250	19,592,722	8,887,582	28,480,304	3.1	59,636,946
TOTAL	20,138,152	71,274,021	30,295,734	22,719,014	36,734,532	181,161,453	35,030,070	10,941,485	45,971,555	3.9	135,189,898
Evaluated											
Residential	2,822,997	14,247,929	5,706,753	14,721,560	17,454,881	54,954,121	11,396,514	3,512,162	14,908,676	3.7	40,045,444
Low Income	538,486	2,576,517	841,659	5,324,166	6,389,329	15,670,157	4,794,258	46,159	4,840,416	3.2	10,829,741
C&I	9,105,310	40,838,286	16,409,039	(1,821,077)	9,218,760	73,750,319	17,392,532	2,988,981	20,381,513	3.6	53,368,806
TOTAL	12,466,794	57,662,732	22,957,450	18,224,650	33,062,970	144,374,596	33,583,305	6,547,301	40,130,606	3.6	104,243,990
Percent Variance											
Residential	-49%	19%	1%	-45%	-42%	-31%	5%	69%	15%	(2.0)	(0)
Low Income	5%	-4%	-8%	76%	6%	19%	4%	-320%	6%	3.2	0
C&I	-35%	-28%	-31%	-74%	1020%	-16%	-11%	-66%	-28%	0.6	0
TOTAL	-38%	-19%	-24%	-20%	-10%	-20%	-4%	-40%	-13%	1.6	(0)

Notes:

(1) GHG for information purposes only; it is not included in TRC test

VII. Appendix
B.1. Master Summary

Electric PA's Master Summary of Energy Efficiency Activities

Customer Sector	Savings						Avg Measure Life (yrs.)	TR Summer Demand Cost ($/MW)	TR Energy Cost ($/Lifetime-MWh saved)	Emissions Reductions (Short Tons) (1)				Participants
	Capacity (KW) (1)		Electric Energy (MWh) (1)		Non-Electric Resources (MMBTU)					NOx	SOx	CO2 (MA Only)	CO2 (Regional)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime								
Planned														
Residential	3,409	41,200	24,880	167,743	46,053	310,499	7	$313.61	$77.03	$52.01	$143.09	$110,562	$99,469	143,997
Low Income	350	3,896	3,507	37,088	6,908	73,063	11	$1,173.23	$123.24	$11.50	$31.64	$25,656	$23,204	2,996
C&I	7,887	107,605	51,875	706,386	(37,545)	(511,264)	14	$264.67	$40.32	$219.00	$602.58	$343,012	$296,299	898
TOTAL	11,646	152,701	80,261	911,217	15,416	(127,702)	11	$301.06	$50.45	$282.51	$777.31	$479,229	$418,971	147,891
Evaluated														
Residential	2,644	22,701	25,625	199,282	28,904	224,782	8	$656.75	$74.81	$61.78	$170.00	$121,257	$108,078	220,038
Low Income	313	3,917	3,378	34,982	11,280	116,826	10	$1,235.71	$138.37	$10.85	$29.84	$28,193	$25,880	2,625
C&I	5,719	71,432	38,969	511,880	(17,158)	(225,386)	13	$285.33	$39.82	$158.70	$436.66	$261,120	$227,270	883
TOTAL	8,676	98,050	67,971	746,144	23,026	116,223	11	$409.29	$53.78	$231.33	$636.50	$410,569	$361,227	223,546
Percent Variance														
Residential	-22%	-45%	3%	19%	-37%	-28%	15%	109%	-3%	19%	19%	10%	9%	53%
Low Income	-10%	1%	-4%	-6%	63%	60%	-2%	5%	12%	-6%	-6%	10%	12%	-12%
C&I	-27%	-34%	-25%	-28%	-54%	-56%	-4%	8%	-1%	-28%	-28%	-24%	-23%	-2%
TOTAL	-25%	-36%	-15%	-18%	49%	-191%	-3%	36%	7%	-18%	-18%	-14%	-14%	51%

Notes:
(1) KW and MWh units are consistent with the 08-50 Tables.

Annual Emmision Reduction

Sector	Emissions Reductions (Short Tons)			NOTES
	NOx	SO2	CO2	
Planned				Please note that the PAs are working with DEP to try to determine the best method for properly and precisely capturing the full impact of energy efficiency measures on GHG emissions. As part of this process, the PAs have included this additional table on Emissions Reductions, based on continuing discussions with the DEP. These reductions are calculated using new factors proposed by DEP, which are based on annual gas, oil, and electric savings. The PAs look forward to discussing these proposed factors with DEP and are committed to ensuring that the full impact of energy efficiency measures on GHG emissions are captured.
Residential	6	16	12,821	
Low Income	1	2	1,811	
C&I	12	33	26,589	
TOTAL	19	51	41,221	
Evaluated				
Residential	6	16	13,202	
Low Income	1	2	1,743	
C&I	9	25	19,961	
TOTAL	16	43	34,906	

APPENDIX B
COST-EFFECTIVENESS SUPPORTING TABLES AND DOCUMENTATION

SECTION 2
SCREENING TOOL

Please see the CD-ROM included within this binder for the Screening Tool in Microsoft Excel format.

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APPENDIX B

COST-EFFECTIVENESS SUPPORTING TABLES AND DOCUMENTATION

SECTION 3

TECHNICAL REFERENCE MANUAL

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Technical Reference Manual

The Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures ("TRM") documents how the Program Administrators consistently, reliably, and transparently calculate savings resulting from the installation of prescriptive energy efficiency measures. The TRM provides methods, formulas, and default assumptions for estimating energy, peak demand, and other resource impacts from energy efficiency measures.

Each TRM is associated with a specific program year and version. There are two versions for each program year: the "Plan Version," which is filed with the PA plans prior to the program year, and the "Report Version," which includes updates to the "Plan Version" and is filed with the PAs' annual reports. Changes between the 2012 - Plan Version and 2012 - Report Version of the TRM are made primarily to incorporate the results of EM&V studies that were finalized in 2012 following the submission of the 2012 - Plan Version TRM, and in advance of the filing of the 2012 Annual Report. The EM&V studies included in the 2012 TRM - Report Version are included herewith as Appendix C (Program and Pilot Program EM&V Studies) and are summarized in Section III (describing EM&V activities). In addition to a summary of each of the evaluation studies, Section III includes a statewide summary that highlights evaluation studies that had significant impacts on final evaluated data.

Each measure included in the TRM is associated with one or more programs. Section II, Program Performance, includes a discussion of the impact to evaluated program results as a result of the EM&V studies in Appendix C.

The table below shows the EM&V studies discussed in the TRM - Report Version and included herewith that affected evaluated results, along with the relevant programs that were impacted.

Studies	Gas/Electric or Both	Program
Net-to-Gross Evaluation of Cool Smart and High -Efficiency Heating and Water Heating Equipment Programs	Both	Residential Cooling and Heating Equipment, Residential Heating and Water Heating
HES Realization Rate Results Memo	Both	Home Energy Services, Gas Weatherization
Results of the Massachusetts Onsite Lighting Inventory	Electric	ENERGY STAR Lighting, Residential New Construction & Major Renovation, Low-Income Residential New Construction
Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report	Both	Behavior/Feedback Program
Massachusetts Small Business Direct Install: 2010-2012 Impact Evaluations	Both	C&I Small Retrofit
Impact Evaluation of 2011-2012 Prescriptive VSDs	Electric	C&I New Construction & Major Renovation, C&I Large Retrofit, C&I Small Retrofit
Impact Evaluation of 2010 Prescriptive Lighting Installations	Electric	C&I New Construction & Major Renovation, C&I Large Retrofit, C&I Small Retrofit
Impact Evaluation of 2011 Custom Refrigeration, Motor and Other Installations	Electric	C&I New Construction & Major Renovation, C&I Large Retrofit
Process Evaluation of the 2012 Bright Opportunities Program	Electric	C&I New Construction & Major Renovation
Impact Evaluation of 2011 Prescriptive Gas Measures	Gas	C&I New Construction & Major Renovation
Impact Evaluation of 2011 Custom Gas Installations	Gas	C&I New Construction & Major Renovation, C&I Large Retrofit

Massachusetts
Technical Reference Manual

for Estimating Savings from Energy Efficiency Measures

2012 Program Year – Report Version

August 2013

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Introduction

This *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures* ("TRM") documents for regulatory agencies, customers, and other stakeholders how the energy efficiency Program Administrators ("PAs") consistently, reliably, and transparently calculate savings from the installation of efficient equipment, collectively called "measures." This reference manual provides methods, formulas and default assumptions for estimating energy, peak demand and other resource impacts from efficiency measures.

Within this TRM, efficiency measures are organized by the sector for which the measure is eligible and by the primary energy source associated with the measure. The two sectors are Residential and Commercial & Industrial ("C&I").[1] The primary energy sources addressed in this TRM are electricity and natural gas.

Each measure is presented in its own section as a "measure characterization." The measure characterizations provide mathematical equations for determining savings (algorithms), as well as default assumptions and sources, where applicable. In addition, any descriptions of calculation methods or baselines are provided as appropriate. The parameters for calculating savings are listed in the same order for each measure.

Algorithms are provided for estimating annual energy and peak demand impacts for primary and secondary energy sources if appropriate. In addition, algorithms or calculated results may be provided for other non-energy impacts (such as water savings or operation and maintenance cost savings). Data assumptions are based on Massachusetts PA data where available. Where Massachusetts-specific data is not available, assumptions may be based on , 1) manufacturer and industry data, 2) a combination of the best available data from jurisdictions in the same region, or 3) credible and realistic factors developed using engineering judgment.

The TRM will be reviewed and updated annually to reflect changes in technology, baselines and evaluation results.

[1] In this document, the Residential and Low Income programs are represented in a single "Residential" sector due to the degree of overlap in savings assumptions for similar measures in the standard income programs.

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TRM Update Process

Overview

This section describes the process for updating the TRM. The update process is synchronized with the filing of program plans and Annual Reports by the PAs with the DPU.

Updates to the TRM can include:

- additions of new measures,
- updates to existing TRM measures due to:
  - changes in baseline equipment or practices, affecting measure savings
  - changes in efficient equipment or practices, affecting measure savings
  - changes to deemed savings due the revised assumptions for algorithm parameter values (e.g., due to new market research or evaluation studies)
  - other similar types of changes,
- updates to impact factors (e.g., due to new impact evaluation studies),
- discontinuance of existing TRM measures, and
- updates to the glossary and other background material included in the TRM.

Each TRM is associated with a specific program year, which corresponds to the calendar year. This results in two main versions of the TRM for each program year:

- the "Plan Version" is filed with the PA program plans prior to the program year, and
- the "Report Version" includes updates to the "Plan Version" document as needed and is filed with the PA Annual Reports, with the final savings algorithms and factors used to report actual savings.

The TRM for each program year is updated over time as needed to both plan for future program savings and to report actual savings.

Key Stakeholders and Responsibilities

Key stakeholders and their responsibilities for the TRM updates are detailed in the following table.

Stakeholder	Responsibilities
TRM Coordinating Committee	▪ Administrative coordination of TRM activities, including: ▪ Assure collaboration and consensus by the PAs regarding TRM updates ▪ Assure updates are compiled from the PAs and incorporated into the TRM ▪ Coordinate with related program activities (e.g., evaluation and program reporting processes)

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Stakeholder	Responsibilities
Program Administrators	▪ Provide one or two representatives each to the TRM Coordinating Committee, either by direct representation or through a proxy (e.g., GasNetworks). Both the planning and evaluation functions should be represented on the Committee. ▪ Identify needed updates to the TRM ▪ Coordinate with other PAs on all TRM updates ▪ File TRM updates with the DPU
Department of Energy Resources	▪ Provide one representative to the TRM Coordinating Committee ▪ Assure coordination with PA submissions of program plans and reported savings

TRM Update Cycle

The timeline below shows the main milestones of the TRM update cycle over a period of two years. The milestones for the program year ("PY") 2012 TRM Plan and Report versions are described below the timeline.

OCTOBER 2011: The 2012 PY – Plan Version TRM is filed with the PAs' program plans.

The 2012 Program Year – Plan Version TRM is filed with the DPU jointly with the PAs' energy efficiency program plans. With regard to the program plans, the TRM is considered a "planning document" in that it provides the documentation for how the PAs *plan* to count savings for that program year. The TRM is not intended to fully document how the PAs develop their plan estimates for savings.

OCTOBER 2011 - JULY 2013: The 2012 Program Year TRM will be updated as needed based on evaluation studies and any other updates that will affect reported savings for PY 2012.

After the 2012 Program Year – Plan Version TRM has been filed, there may be updates to the TRM to reflect how savings are actually calculated for PY 2012. The most common updates to the TRM will result from new evaluation studies. Results of evaluation studies will be integrated into the working version of the TRM as the studies are completed. Other updates may include the results of working group discussions to achieve greater consistency among PA assumptions.

JANUARY 2012: PAs begin to track savings based on the 2012 TRM

Beginning in January 2012, the PAs will track savings for PY 2012 based on the 2012 Program Year – Plan Version TRM.

JULY 2013: The 2012 Program Year – Report Version TRM will be filed with the PY 2012 Annual Reports

The 2012 Program Year – Report Version TRM, including any updates relative to the Program Plan version, will be filed with the PAs' Annual Reports. Updates from the Plan Version may include new evaluation results or changes based on working group discussions, and will be clearly identified in the Report Version

AUGUST 2012 - OCTOBER 2012: The PAs prepare the 2013 Program Year – Plan Version TRM for filing with their 2013 program plans

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The 2013 Program Year – Plan Version TRM will be based on previous program year versions of the TRM, updated as appropriate for the 2012 program year in preparation for filing with the 2013 program plans. Updates may include results of new evaluations or working group discussions and the addition or removal of energy efficiency measures.

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Measure Characterization Structure

This section describes the common entries or inputs that make up each measure characterization. A formatted template follows the descriptions of each section of the measure characterization.

Source citations: The source of each assumption or default parameter value should be properly referenced in a footnote. New source citations should be added to Appendix E: Table of Referenced Documents, which serves as a cross-reference to digital versions of the referenced documents.

Measure Name

A single device or behavior may be analyzed as a range of measures depending on a variety of factors which largely translate to where it is and who is using it. Such factors include hours of use, location, and baseline (equipment replaced or behavior modified). For example, the same screw-in compact fluorescent lamp will produce different savings if installed in an emergency room waiting area than if installed in a bedside lamp.

Version Date and Revision History

This section will include information regarding the history of the measure entry including when the data for that measure is effective, and the last date that the measure is offered.

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

This section will include a plain text description of the efficient and baseline technology and the benefit(s) of its installation, as well as subfields of supporting information including:

Description: <Description of the energy efficiency measure>
Primary Energy Impact: <Electric or Natural Gas>
Secondary Energy Impact: <e.g., Natural Gas, Propane, Oil, Electric, None>
Non-Energy Impact: <e.g., Water Resource, O&M, Non-Resource, None>
Sector: <Residential, Low Income or Commercial and Industrial>
Market: <Lost Opportunity, Retrofit and/or Products and Services>
End-Use: <Per PARIS database definition – see list below>
Program: <Per PA definition>

The PARIS database includes the following possible End-Uses:

Lighting	Compressed Air	Demand Response
HVAC	Behavior	Photovoltaic Panels
Motors /Drives	Insulation	Process
Refrigeration	Combined Heat and Power	
Hot Water	Solar Hot Water	

Notes

This is an optional section for additional notes regarding anticipated changes going forward. For example, this section would not if there were upcoming statewide evaluations affecting the measure, or any plans for development of statewide tool for calculating measure savings.

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Algorithms for Calculating Primary Energy Impacts

This section will describe the method for calculating the primary energy savings in appropriate units, i.e., kWh for electric energy savings or MMBtu for natural gas energy savings. The savings algorithm will be provided in a form similar to the following:

$$\Delta kWh = \Delta kW \times Hours$$

Similarly, the method for calculating electric demand savings will be provided in a form similar to the following:

$$\Delta kW = (Watts_{BASE} - Watts_{EE})/1000$$

Below the savings algorithms, a table contains the definitions (and, in some cases, default values) of each input in the equation(s). The inputs for a particular measure may vary and will be reflected as such in this table (see example below).

ΔkWh	=	gross annual kWh savings from the measure
ΔkW	=	gross connected kW savings from the measure
Hours	=	average hours of use per year
$Watts_{BASE}$	=	baseline connected kW
$Watts_{EE}$	=	energy efficient connected kW

Baseline Efficiency

This section will include a statement of the assumed equipment/operation efficiency in the absence of program intervention. Multiple baselines will be provided as needed, e.g., for different markets. Baselines may refer to reference tables or may be presented as a table for more complex measures.

High Efficiency

This section will describe the high efficiency case from which the energy and demand savings are determined. The high efficiency case may be based on specific details of the measure installation, minimum requirements for inclusion in the program, or an energy efficiency case based on historical participation. It may refer to tables within the measure characterization or in the appendices or efficiency standards set by organizations such as ENERGY STAR® and the Consortium for Energy Efficiency.

Hours

This section will note operating hours for equipment that is either on or off, or equivalent full load hours for technologies that operate at partial loads, or reduced hours for controls. Reference tables will be used as needed to avoid repetitive entries.

Measure Life

Measure Life includes equipment life and the effects of measure persistence. Equipment life is the number of years that a measure is installed and will operate until failure. Measure persistence takes into account business turnover, early retirement of installed equipment, and other reasons measures might be removed or discontinued.

Secondary Energy Impacts

This section described any secondary energy impacts associated with the energy efficiency measure, including all assumptions and the method of calculation.

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Non-Energy Impacts

This section describes any non-energy impacts associated with the energy efficiency measure, including all assumptions and the method of calculation.

Impact Factors for Calculating Adjusted Gross Savings

The section includes a table of impact factor values for adjusting gross savings. Impact factors for calculating net savings (free ridership, spillover and/or net-to-gross ratio) are in Appendix C: Net to Gross Impact Factors. Further descriptions of the impacts factors and the sources on which they are based are described below the table.

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}

Abbreviated program names may be used in the above table. The mapping of full program names to abbreviated names is given below.

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	Full Program Name	Abbreviation
Residential-Electric	Residential New Construction & Major Renovation	RNC
	Residential Cooling & Heating Equipment	RHVAC
	Multi-Family Retrofit	MF Retrofit
	MassSAVE	MassSAVE
	Behavior/Feedback Program	Behavior/Feedback
	ENERGY STAR Lighting	ES Lighting
	ENERGY STAR Appliances	ES Appliances
Low Income-Electric	Low-Income Residential New Construction	LI RNC
	Low-Income 1-4 Family Retrofit	LI Retrofit 1-4
	Low-Income Multifamily Retrofit	LI MF Retrofit
C&I – Electric	C&I New Construction and Major Renovation	NC
	C&I Large Retrofit	Large Retrofit
	C&I Small Retrofit	Small Retrofit
Residential – Gas	Residential New Construction & Major Renovation	RNC
	Residential Heating and Water Savings	Residential Heating and Water Savings
	MassSAVE	MassSAVE
	Multifamily Retrofit	MF Retrofit
	Behavior/Feedback Program	Behavior/Feedback
Low Income – Gas	Low-Income Single Family Retrofit	Low-Income Single Family Retrofit
C&I - Gas	C&I New Construction & Major Renovation	C&I NC
	C&I Retrofit	C&I Retrofit
	C&I Direct Install	C&I Direct Install

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Impact Factors for Calculating Adjusted Gross and Net Savings

PAs use the algorithms in the Measure Characterization sections to calculate the gross savings for energy efficiency measures. Impact factors are then applied to make various adjustments to the gross savings estimate to account for the performance of individual measures or energy efficiency programs as a whole in achieving energy reductions as assessed through evaluation studies. Impacts factors address both the technical performance of energy efficiency measures and programs, accounting for the measured energy and demand reductions realized compared to the gross estimated reductions, as well as the programs' effect on the market for energy efficient products and services.

This section describes the types of impact factors used to make such adjustments, and how those impacts are applies to gross savings estimates. Definitions of the impact factors and other terms are also provided in Appendix G: Glossary.

Types of Impact Factors

The impact factors used to adjust savings fall into one of two categories:

Impact factors used to adjust gross savings:

- In-Service Rate ("ISR")
- Savings Persistence Factor ("SPF")
- Realization Rate ("RR")
- Summer and Winter Peak Demand Coincidence Factors ("CF").

Impact factors used to calculate net savings:

- Free-Ridership ("FR") and Spillover ("SO") Rates
- Net-to-Gross Ratios ("NTG").

The **in-service rate** is the actual portion of efficient units that are installed. For example, efficient lamps may have an in-service rate less than 1.00 since some lamps are purchased as replacement units and are not immediately installed. The ISR is 1.00 for most measures.

The **savings persistence factor** is the portion of first-year energy or demand savings expected to persist over the life of the energy efficiency measure. The SPF is developed by conducting surveys of installed equipment several years after installation to determine the actual operational capability of the equipment. The SPF is 1.00 for most measures.

In contrast to savings persistence, *measure persistence* takes into account business turnover, early retirement of installed equipment, and other reasons the installed equipment might be removed or discontinued. Measure persistence is generally incorporated as part of the measure life, and therefore is not included as a separate impact factor.

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The **realization rate** is used to adjust the gross savings (as calculated by the savings algorithms) based on impact evaluation studies. The realization rate is equal to the ratio of measure savings developed from an impact evaluation to the estimated measure savings derived from the savings algorithms. The realization rate does not include the effects of any other impact factors. Depending on the impact evaluation study, there may be separate realization rates for energy (kWh), peak demand (kW), or fossil fuel energy (MMBtu).

A **coincidence factor** adjusts the connected load kW savings derived from the savings algorithm. A coincidence factor represents the fraction of the connected load reduction expected to occur at the same time as a particular system peak period. The coincidence factor includes both coincidence and diversity factors combined into one number, thus there is no need for a separate diversity factor in this TRM.

Coincidence factors are provided for both the on-peak and seasonal peak periods as defined by the ISO New England for the Forward Capacity Market ("FCM"), and are calculated consistently with the FCM methodology. Electric demand reduction during the ISO New England peak periods is defined as follows:

On-Peak Definition:
- Summer On-Peak: average demand reduction from 1:00-5:00 PM on non-holiday weekdays in June July, and August
- Winter On-Peak: average demand reduction from 5:00-7:00 PM on non-holiday weekdays in December and January

Seasonal Peak Definition:
- Summer Seasonal Peak: demand reduction when the real-time system hourly load is equal to or greater than 90% of the most recent "50/50" system peak forecast for June-August
- Winter Seasonal Peak: demand reduction when the real-time system hourly load is equal to or greater than 90% of the most recent "50/50" system peak load forecast for December-January.

The values described as Coincidence Factors in the TRM are not always consistent with the strict definition of a Coincidence Factor (CF). It would be more accurate to define the Coincidence Factor as "the value that is multiplied by the Gross kW value to calculate the average kW reduction coincident with the peak periods." A coincidence factor of 1.00 may be used because the coincidence is already included in the estimate of Gross kW; this is often the case when the "Max kW Reduction" is not calculated and instead the "Gross kW" is estimated using the annual kWh reduction estimate and a loadshape model.

A **free-rider** is a customer who participates in an energy efficiency program (and gets an incentive) but who would have installed some or all of the same measure(s) on their own, with no change in timing of the installation, if the program had not been available. The **free-ridership rate** is the percentage of savings attributable to participants who would have installed the measures in the absence of program intervention.

The **spillover rate** is the percentage of savings attributable to a measure or program, but additional to the gross (tracked) savings of a program. Spillover includes the effects of 1) participants in the program who install additional energy efficient measures outside of the program as a result of participating in the program, and 2) non-participants who install or influence the installation of energy efficient measures as a result of being aware of the program. These two components are the **participant spillover** (SO_P) and **non-participant spillover** (SO_{NP}).

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The **net savings** value is the final value of savings that is attributable to a measure or program. Net savings differs from gross savings because it includes the effects of the free-ridership and/or spillover rates.

The **net-to-gross** ratio is the ratio of net savings to the gross savings adjusted by any impact factors (i.e., the "adjusted" gross savings). Depending on the evaluation study, the NTG ratio may be determined from the free-ridership and spillover rates, if available, or it may be a distinct value with no separate specification of FR and SO values.

Standard Net–to–Gross Formulas

The TRM measure entries provide algorithms for calculating the gross savings for those efficiency measures. The following standard formulas show how the impact factors are applied to calculate the adjusted gross savings, which in turn are used to calculate the net savings. These are the calculations used by the PAs to track and report gross and net savings. The gross savings reported by the PAs are the unadjusted gross savings without the application of any impact factors.

Calculation of Net Annual Electric Energy Savings

$$adj_gross_kWh = gross_kWh \times RR_E \times SPF \times ISR$$
$$net_kWh = adj_gross_kWh \times NTG$$

Calculation of Net Summer Electric Peak Demand Coincident kW Savings

$$adj_gross_kW_{SP} = gross_kW \times RR_{SP} \times SPF \times ISR \times CF_{SP}$$
$$net_kW_{SP} = adj_gross_kW_{SP} \times NTG$$

Calculation of Net Winter Electric Peak Demand Coincident kW Savings

$$adj_gross_kW_{WP} = gross_kW \times RR_{WP} \times SPF \times ISR \times CF_{WP}$$
$$net_kW_{WP} = adj_gross_kW_{WP} \times NTG$$

Calculation of Net Annual Natural Gas Energy Savings

$$adj_gross_MMBtu = gross_MMBtu \times RR_E \times SPF \times ISR$$
$$net_MMbtu = adj_gross_MMBtu \times NTG$$

Depending on the evaluation study methodology:

- NTG is equal to $(1 - FR + SO_P + SO_{NP})$, or
- NTG is a single value with no distinction of FR, SO_P, SO_{NP}, and/or other factors that cannot be reliably isolated.

Where:

Gross_kWh	=	Gross Annual kWh Savings
adj_gross_kWh	=	Adjusted Gross Annual kWh Savings
net_kWh	=	Net Annual kWh Savings
$Gross_kW_{SP}$	=	Gross Connected kW Savings (summer peak)
$adj_gross_kW_{SP}$	=	Adjusted Gross Connected kW Savings (summer peak)
$Gross_kW_{WP}$	=	Gross Connected kW Savings (winter peak)
$adj_gross_kW_{WP}$	=	Adjusted Gross Connected kW Savings (summer peak)

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net_kW_{SP}	=	Adjusted Gross Connected kW Savings (winter peak)
net_kW_{WP}	=	Net Coincident kW Savings (winter peak)
Gross_MMBtu	=	Gross Annual MMBtu Savings
adj_gross_MMBtu	=	Adjusted Gross Annual MMBtu Savings
net_MMBtu	=	Net Annual MMBtu Savings
SPF	=	Savings Persistence Factor
ISR	=	In-Service Rate
CF_{SP}	=	Peak Coincidence Factor (summer peak)
CF_{WP}	=	Peak Coincidence Factor (winter peak)
RR_E	=	Realization Rate for electric energy (kWh)
RR_{SP}	=	Realization Rate for summer peak kW
RR_{WP}	=	Realization Rate for winter peak kW
NTG	=	Net-to-Gross Ratio
FR	=	Free-Ridership Factor
SO_P	=	Participant Spillover Factor
SO_{NP}	=	Non-Participant Spillover Factor

Calculations of Coincident Peak Demand kW Using "Seasonal Peak" Coincidence Factors

The formulas above for peak demand kW savings use the "on-peak" coincidence factors (CF_{SP}, CF_{WP}), which apply the "on-peak" coincidence methodology as allowed for submission to the FCM. The alternative methodology is the "seasonal peak" methodology, which uses the identical formulas, but substituting the "seasonal peak" coincidence factors for the "on-peak" coincidence factors:

CF_{SSP}	=	Peak Coincidence Factor for Summer Seasonal Peak
CF_{WSP}	=	Peak Coincidence Factor for Winter Seasonal Peak

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Residential Electric Efficiency Measures

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Behavior – Basic Educational Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of basic educational measures during an audit to help customers become more aware of energy efficiency.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Behavior
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \max(\Delta kW_{SP}, \Delta kW_{WP})$$

Where:
Unit = Completed audit
ΔkWh = Average annual kWh savings per unit: 18 kWh[2]
ΔkW = Max kW Reduction: 0.004 kW[3]

Cape Light Compact savings:
Unit = Completed audit TLC kit includes 2 faucet aerators, LED night light, drip gauge, hot water thermometer and 12 wall plate stoppers.
ΔkWh = Average annual kWh savings per unit: 126 kWh[4]
ΔkW = Max kW Reduction: 0.027 kW[5]

Baseline Efficiency

The baseline efficiency case assumes no measures installed.

High Efficiency

The high efficiency case includes basic educational measures such as LED nightlights, refrigerator thermostats, hot water thermostats, refrigerator coil brush, wall plate stoppers, and low flow showerheads and aerators for CLC.

[2] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[3] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[4] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts use sum of measures offered in kit from table 42.
[5] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators

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Hours

Not applicable.

Measure Life

The measure life is 5 years.[6]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Basic Educational Measures	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00
Basic Educational Measures	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.73	1.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[7]

[6] Massachusetts Common Assumption.
[7] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Behavior – Energy Use Reports

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: The Behavior/Feedback programs send energy use reports to participating electric customers in order to change customers' energy-use behavior.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Products and Services
End Use: Behavior
Program: Behavior/Feedback Program

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = (kWh_{BASE})(\%SAVE)$$
$$\Delta kW = \Delta kWh / 4000$$

Where:

Unit	=	One participant household.
kWh_{BASE}	=	Baseline consumption of kWh. See Table 1.
%SAVE	=	Energy savings percent per program participant. See Table 1.
kW	=	kWh/4000 hours[8]

Table 1: Savings Factors for OPOWER Electric[9]

PA	Measure Name	kWh_{BASE}	%SAVE	ΔkWh	ΔkW
National Grid	OPOWER Group 2009	10,824	2.21%	239.21	0.06
National Grid	OPOWER Group 2010	12,033	2.12%	255.10	0.06
National Grid	OPOWER Group 2010 Added	15,132	2.12%	320.80	0.08
National Grid	OPOWER Group 2011	9,765	2.47%	241.20	0.06
National Grid	OPOWER Group 2011 Added	6,028	2.47%	148.89	0.04
National Grid	OPOWER Group 2012	6,033	0.98%	59.12	0.01
National Grid	OPOWER Group 2012 Dual	6,262	0.89%	55.73	0.01
NSTAR	Wave III	13,786	1.08%	110	0.03
NSTAR	Wave IV	10,768	1.02%	54	0.01
WMECo	Initial Wave, Passive	8,093	1.07%	86.59	0.02
WMECo	Initial Wave, Activated	5,994	0.91%	54.55	0.01
WMECo	Expansion Wave, Passive	3,025	0.04%	1.21	0.00
WMECo	Expansion Wave, Activated	8,053	1.03%	82.94	0.02
WMECo	Opt-In	9,255	1.93%	178.62	0.04

[8] Staff estimate
[9] Opinion Dynamics Corporation and Navigant Consulting (2013). *Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report.*

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Baseline Efficiency

The baseline efficiency case for NSTAR and National Grid is a customer who does not receive OPOWER reports. For the WMECo C3 program, the baseline efficiency is a customer who does not receive an energy savings report and has not activated on the online web portal.

High Efficiency

The high efficiency case for NSTAR and National Grid is a customer who receives an OPOWER report. For the WMECo C3 program, the high efficiency case for passive participants are customers that receive an energy savings mailer. For activated customers, the high efficiency case is a customer that has opted-in to the web portal.

Hours

Not applicable.

Measure Life

The measure life is 1 year.

Secondary Energy Impacts

The impacts described in this section are specific to NSTAR's Opower program. See Behavior – OPOWER Gas in the Residential Gas section for information about National Grid's program.

Measure	Energy Type	% Savings[10]	ΔMMBtu/Unit
Dual Fuel (Gas) – Wave I	NG - Res Gas Old Bldg	0.94%	0.74
Dual Fuel (Gas) – Wave II	NG - Res Gas Old Bldg	1.52%	1.10

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
OPOWER Group	Behavior/Feedback	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00

In-Service Rates

In-services rates are 100% since the program tracks all participating customers.

Savings Persistence Factor

Savings persistence is 100% since the measure life for each participant is 1 year.

Realization Rates

Realization rates are 100% because deemed savings are based on assumptions from year-to-date vendor findings

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[11]

[10] Ibid
[11] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Lighting – CFL Bulbs

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Compact fluorescent lamps offer comparable luminosity to incandescent lamps at significantly less wattage and significantly longer lamp lifetimes.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Lost Opportunity
End Use: Lighting
Program: ENERGY STAR Lighting, Residential New Construction & Major Renovation, Home Energy Services, Multi-Family Retrofit, Low-Income Residential New Construction, Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated CFL Bulb
ΔkWh	=	Average annual kWh reduction. See Table 2.
ΔkW	=	Average kW reduction. See Table 2.

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Table 2: Savings for Residential CFL Bulbs

Measure	Program	ΔkW[12]	Hours	ΔkWh
CFL Bulb	ES Lighting	0.046	1,022	47
CFL Bulb (Hard to Reach)	ES Lighting	0.046	1,022	47
CFL Bulb (School Fundraiser)	ES Lighting	0.046	1,022	47
CFL Bulb (Specialty Bulbs)	ES Lighting	0.046	1,022	47
CFL Bulb	RNC, LI RNC	0.046	1,022	47
CFL Bulb	HES	0.011[13]	n/a	37[14]
CFL Bulb (piggyback)	HES	0.011	n/a	37
CFL Bulb	MF Retrofit	0.046	1,022	47
Common Area Fixtures	MF Retrofit, LI MF Retrofit	0.046	1,022	47
CFL Bulb	LI 1-4 Retrofit	0.013[15]	n/a	43[16]
CFL Bulb	LI MF Retrofit	0.013	n/a	43

Baseline Efficiency

The baseline efficiency case is an incandescent bulb.

High Efficiency

The high efficiency case is an ENERGY STAR® rated CFL bulb.

Hours

Average annual operating hours for bulbs are 1,022 hours/year (2.8 hours/day[17] * 365 days/year).

Measure Life

The adjusted measure life is 7 years for CFL bulbs. [18]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

[12] Nexus Market Research, RLW Analytics and GDS Associates (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT; Page 56.
[13] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[14] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[15] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[16] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[17] Nexus Market Research and RLW Analytics (2008). *Residential Lighting Measure Life Study*. Prepared for New England Residential Lighting Program Sponsors.
[18] The calculated measure life for screw-in bulbs is 8, based on a component life of 8,000 and hours of use of 1,022. The adjusted measure life accounts for changes in the baseline due to EISA standards as shown in the MA Lighting Worksheet.

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CFL Bulb	ES Lighting	All	0.97	1.00	1.00	1.00	1.00	0.11	0.22
CFL Bulb (Hard to Reach)	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22
CFL Bulb (School Fundraiser)	ES Lighting	All	0.50	1.00	1.00	1.00	1.00	0.11	0.22
CFL Bulb (Specialty Bulbs)	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22
CFL Bulb	RNC, LI RNC	All	0.99	1.00	1.00	1.00	1.00	0.11	0.22
CFL Bulb	HES	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
CFL Bulb (piggyback)	HES	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
CFL Bulb	MF Retrofit	All (not NGRID)	0.97	1.00	1.00	1.00	1.00	0.11	0.22
Common Area Fixtures	MF Retrofit	All (not NGRID)	0.97	1.00	1.00	1.00	1.00	0.11	0.22
CFL Bulb	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
CFL Bulb	LI MF Retrofit	All (not NGRID)	1.00	1.00	1.00	1.00	1.00	0.17	1.00

In-Service Rate

- ES Lighting: 2004 Impact Evaluation of MA, RI, VT Residential Lighting Program[19]
- RNC, LI RNC: 2006 ENERGY STAR® Homes New Homebuyer Survey Report[20]
- HES: Impact evaluation of the HES program[21]
- MF Retrofit: Impact assessment of the MF Retrofit program[22]
- LI 1-4 Retrofit, LI MF Retrofit: PAs assume a 100% installation rate for direct install programs.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are 100% since savings estimates are based on evaluation results.

Coincidence Factors

- ES Lighting, RNC, LI RNC, MF Retrofit: Coincidence factors are based on the 2009 Lighting Markdown Study.[23]
- HES, LI MF Retrofit, LI 1-4 Retrofit: Coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[24]

[19] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 11.
[20] Nexus Market Research & Dorothy Conant (2006). *Massachusetts ENERGY STAR® Homes: 2005 Baseline Study: Part II: Homeowner Survey Analysis Incorporating Inspection Data Final Report.* Prepared for the Massachusetts Joint Management Committee.
[21] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[22] The Cadmus Group, Inc. (2012). *Massachusetts 2011 residential Retrofit Multifamily Program Impact Analysis.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[23] Nexus Market Research, RLW Analytics and GDS Associates (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.
[24] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Lighting – Indoor Fixtures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of ENERGY STAR® compact fluorescent (CFL) indoor fixtures. Compact fluorescent fixtures offer comparable luminosity to incandescent fixtures at significantly less wattage and significantly longer lifetimes. Hardwired fluorescent fixtures offer comparable luminosity to incandescent fixtures at significantly lower wattage and offer significantly longer lifespan.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Lost Opportunity, Retrofit
End Use: Lighting
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit, ENERGY STAR Lighting, Residential New Construction & Major Renovation, Low-Income Residential New Construction, Multi-Family Retrofit

Algorithms for Calculating Primary Energy Impact

For Low-Income 1-4 Family Retrofit and Low-Income Multifamily Retrofit (NSTAR, WMECO) unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of CFL fixture
ΔkWh	=	Average annual kWh savings per unit. See Table 3
ΔkW	=	Max kW reduction. See Table 3

For ENERGY STAR Lighting, Residential New Construction & Major Renovation and Low-Income Residential New Construction unit savings are calculated based on the following algorithms which use averaged inputs:

$$\Delta kWh = Bulbs \times SAVE_{kW} \times HOURS$$
$$\Delta kW = Bulbs \times SAVE_{kW}$$

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Where:
Unit = Installation of CFL fixture
Bulbs = Average # of bulbs per unit: 1.49[25]
$SAVE_{KW}$ = Average kW savings per bulb: 0.049[26]
HOURS = Annual hours of use: 912.5

Table 3: Savings for Residential Indoor Fixtures

Measure	Program	ΔkW	ΔkWh
Indoor Fixture	ES Lighting	0.073	66
Indoor Fixture	RNC, LI RNC	0.073	66
Indoor Fixture	MF Retrofit	0.049	44
CFL Fixture	LI 1-4 Retrofit	0.042[27]	140 [28]
CFL Fixture	LI MF Retrofit	0.042	140

Baseline Efficiency

The baseline efficiency case is an incandescent, screw-based fixture with an incandescent lamp.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified compact fluorescent light fixture wired for exclusive use with pin-based CFLs.

Hours

The average annual operating hours are 912.5 hours/year (2.5 hours/day[29] * 365 days/year).

Measure Life

The adjusted measure life is 7 years for indoor fixtures.[30]

Secondary Energy Impact

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

[25] NMR Group, Inc. (2013). *Results of the Massachusetts Onsite Lighting Inventory.* Prepared for the Massachusetts PAs.
[26] Ibid.
[27] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[28] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts
[29] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 104.
[30] The adjusted measure life accounts for changes in the baseline due to EISA standards as shown in the MA Lighting Worksheet

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Indoor Fixture	ES Lighting	All	0.95	1.00	1.00	1.00	1.00	0.11	0.22
Indoor Fixture	RNC, LI RNC	All	0.96	1.00	1.00	1.00	1.00	0.11	0.22
Indoor Fixture	MF Retrofit	All (not National Grid)	0.97	1.00	1.00	1.00	1.00	0.11	0.22
CFL Fixture	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
CFL Fixture	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.17	1.00

In-Service Rates

- ES Lighting: 2004 Impact Evaluation of MA, RI, VT Residential Lighting Program[31]
- RNC, LI RNC: 2006 ENERGY STAR® Homes New Homebuyer Survey Report[32]
- MF Retrofit: Impact assessment of the MF Retrofit program[33]
- LI 1-4 Retrofit, LI MF Retrofit: PAs assume 100% in-service rates.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

- Coincidence factors for indoor fixtures are based on the 2009 Lighting Markdown Study.[34]
- Summer and winter coincidence factors for CFL Fixtures in LI 1-4 Retrofit and LI MF Retrofit are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[35]

[31] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 11.
[32] Nexus Market Research & Dorothy Conant (2006). *Massachusetts ENERGY STAR® Homes: 2005 Baseline Study: Part II: Homeowner Survey Analysis Incorporating Inspection Data Final Repor*t. Prepared for the Massachusetts Joint Management Committee; Table 8.1
[33] The Cadmus Group, Inc. (2012). *Massachusetts 2011 residential Retrofit Multifamily Program Impact Analysis*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[34] Nexus Market Research, RLW Analytics and GDS Associates (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.
[35] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators..

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Lighting – Outdoor Fixtures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of hardwired ENERGY STAR® fluorescent outdoor fixtures with pin-based bulbs. Savings for this measure are attributable to high efficiency outdoor lighting fixtures and are treated similarly to indoor fixtures.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity, Retrofit
End Use: Lighting
Program: ENERGY STAR Lighting, MF Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kW \times Hours$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated outdoor fixture
ΔkWh	=	Average annual kWh reduction: 156 kWh (calculated)
ΔkW	=	Average connected kW reduction: 0.095 kW[36]
Hours	=	Average annual operating hours

Baseline Efficiency

The baseline efficiency case is an incandescent, screw-based fixture with an incandescent bulb.

High Efficiency

The high efficiency case is an ENERGY STAR® fixture wired for exclusive use with a pin based CFL.

Hours

The average annual operating hours are 1,642.5 hours/year (4.5 hours per day[37] * 365 days per year).

Measure Life

The measure life is 6 years for markdown outdoor fixtures.[38]

[36] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Table 1-8.
[37] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 104
[38] Nexus Market Research and RLW Analytics (2008). *Residential Lighting Measure Life Study*. Prepared for New England Residential Lighting Program Sponsors; Page 1.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Outdoor Fixture	ES Lighting	All	0.87	1.00	1.00	1.00	1.00	0.11	0.22
Outdoor Fixture	MF Retrofit	All (not National Grid)	0.97	1.00	1.00	1.00	1.00	0.11	0.22

In-Service Rates

- ES Lighting: 2004 Impact Evaluation of MA, RI, VT Residential Lighting Program[39]
- MF Retrofit: Impact assessment of the MF Retrofit program[40]

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on the 2009 Lighting Markdown Study.[41]

[39] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 11.
[40] The Cadmus Group, Inc. (2012). *Massachusetts 2011 residential Retrofit Multifamily Program Impact Analysis*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[41] Nexus Market Research, RLW Analytics and GDS Associates (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.

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Lighting – Torchieres

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of high-efficiency ENERGY STAR® torchieres. High efficiency torchieres use fluorescent in place of halogen or incandescent bulbs to provide comparable luminosity at significantly reduced wattage.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Lost Opportunity, Retrofit
End Use: Lighting
Program: ENERGY STAR Lighting, HES, MF Retrofit, Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

For Low-Income 1-4 Family Retrofit and Low-Income Multifamily Retrofit unit savings are based on deemed savings:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
ΔkWh = Average annual kWh reduction: 211 kWh[42]
ΔkW = Average connected kW reduction: 0.064 kW[43]

For ENERGY STAR Lighting, HES and MF Retrofit unit savings are based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kW \times Hours$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Rebated ENERGY STAR® Torchiere
ΔkWh = Average annual kWh reduction: 106 kWh (calculated)
ΔkW = Average connected kW reduction: 0.088 kW[44]
Hours = Average annual operating hours

[42] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[43] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[44] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Table 1-8. Adjusted to account for changes to the baseline technology.

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Baseline Efficiency

The baseline efficiency case is a halogen or incandescent torchiere fixture.

High Efficiency

The high efficiency case is a fluorescent torchiere fixture.

Hours

The average annual operating hours are 1,204.5 hours/year (3.3 hours/day[45] * 365 days/year).

Measure Life

The measure life is 8 years.[46]

Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Torchieres	ES Lighting	All	0.83	1.00	1.00	1.00	1.00	0.11	0.22
Torchieres	HES	All	0.83	1.00	1.00	1.00	1.00	0.11	0.22
Torchieres	RNC	All	0.83	1.00	1.00	1.00	1.00	0.11	0.22
Torchieres	MF Retrofit	CLC only	0.83	1.00	1.00	1.00	1.00	0.11	0.22
Torchieres	LI 1-4 Retrofit	CLC only	1.00	1.00	1.00	1.00	1.00	0.11	0.22
Torchieres	LI MF Retrofit	CLC only	1.00	1.00	1.00	1.00	1.00	0.11	0.22

In-Service Rates

- ES Lighting, HES: 2004 Impact Evaluation of MA, RI, VT Residential Lighting Program[47]
- Low Income: Assumed to be 100% for Low-Income customers.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on the 2009 Lighting Markdown Study.[48]

[45] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 104

[46] Ibid.

[47] Nexus Market Research and RLW Analytics (2004). *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR and Unitil Energy Systems, Inc.; Page 11.

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Lighting – LED Lighting

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a Light-Emitting Diode (LED) screw-in bulb or fixture. LEDs offer comparable luminosity to incandescent bulbs at significantly less wattage and significantly longer lamp lifetimes.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity
End Use: Lighting
Program: ENERGY STAR Lighting, Residential New Construction & Major Renovation, Low-Income Residential New Construction, Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit (not National Grid)

Algorithms for Calculating Primary Energy Impact

Unit savings for LED bulbs are based on the following algorithms which use averaged inputs:

$$\Delta kWh = \left(kW_{BASE} - kW_{LED}\right) \times Hours$$

$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated LED lamp
ΔkWh	=	Average annual energy savings: 48 kWh[49]
kW_{BASE}	=	Average connected kW of baseline bulb: 65 Watts
kW_{LED}	=	Average connected kW of LED bulb: 18 Watts
ΔkW	=	Average connected kW reduction: 0.014 kW[50]
Hours	=	Average annual operating hours

Unit savings for LED fixtures are based on the following algorithms:

ΔkWh = *Average # of bulbs per unit x* ΔkWh *per bulb.*
$\Delta kW = \Delta kW$

[48] Nexus Market Research, RLW Analytics and GDS Associates (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.
[49] Homes: Energy Star. *LED Light Bulbs for Consumers. http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=ILB. Accessed on 10/15/10.*
[50] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Where:

Unit	=	Installation of LED fixture
ΔkWh per bulb	=	Average annual energy savings: 48 kWh[51]
Avg # of bulbs	=	1.49 bulbs[52]
ΔkWh	=	Average annual energy savings: 72 kWh
ΔkW	=	Average connected kW reduction: 0.022 kW[53]

Baseline Efficiency

The baseline efficiency case is an incandescent bulb in a screw-based socket or an incandescent, screw-based fixture with an incandescent lamp.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified screw-in LED bulb or fixture.

Hours

The average annual operating hours are 1, 022 hours/year (2.8 hours/day[54] * 365 days/year).

Measure Life

The measure life is 20 years.[55]

Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

No operations and maintenance cost adjustments are claimed for this measure. At this time, the incremental cost is unclear given the continual changes in LED technology. In addition, the measure life savings from not replacing incandescent bulbs are also unclear.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
LED Bulb	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
LED Fixture	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
LED Fixture	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
LED Bulb	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.17	1.00
LED Bulb	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.17	1.00

[51] Homes: Energy Star. *LED Light Bulbs for Consumers. http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=ILB. Accessed on 10/15/10.*
[52] NMR Group, Inc. (2013). *Results of the Massachusetts Onsite Lighting Inventory.* Prepared for the Massachusetts PAs.
[53] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[54] Nexus Market Research, RLW Analytics and GDS Associates (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT; Page 6.
[55] Expected lifetime from ENERGY STAR ®.

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In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[56]

[56] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators..

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Lighting – Occupancy Sensors

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of occupancy sensors for lighting fixtures. Energy savings are achieved by reducing the annual operating hours of the connected lighting fixtures.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Retrofit
End Use: Lighting
Program: Multi-Family Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are based on the following algorithms which use averaged inputs[57]:

$$\Delta kWh = kW \times Hours \times \%Unoccupied$$
$$\Delta kW = 0$$

Where:

Unit	=	Rebated occupancy sensor
ΔkWh	=	Annual energy savings: 99 kWh
ΔkW	=	Average kW reduction is 0 during peak periods
kW	=	Average connected kW: 0.094 kW[58]
Hours	=	Average annual operating hours for connected lighting wattage without controls
%Unoccupied	=	Average % of time that controlled space is unoccupied: 35%[59]

Baseline Efficiency

The baseline efficiency case is a lighting fixture that operates without controls.

High Efficiency

The high efficiency case is a lighting fixture that operates with connected occupancy sensors.

Hours

The average annual operating hours before the measure installation is 3,000 hours per year.[60]

Measure Life

The measure life is 10 years.[61]

[57] Waste Reduction Partners (2004). *Occupancy Sensors - Utility Savings Initiative - Fact Sheet*; Page 2, algorithm based on the Lighting Fixture Basis formula.
[58] Ibid; Page 2, based on the savings for a 3-lamp T8.
[59] Ibid; Page 2, assumption based on the U.S. EPA Prediction for Corridors.
[60] Ibid; assumption from the Lighting Fixture Basis formula.

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Secondary-Energy Impacts

There are no secondary energy impacts counted for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Common Area Occupancy Sensors	MF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are set to zero since demand savings typically occur during off- peak periods.

[61] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Hot Water – DHW Measures (Electric)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of domestic hot water (DHW) measures including low flow showerheads, faucet aerators, and tank and pipe wraps in homes with electric water heating.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Residential Water, Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Hot Water
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings estimates described in this section are only used for the Low-Income 1-4 Family Retrofit program (all PAs) and the Low-Income Multifamily Retrofit programs (all PAs except National Grid). The savings algorithms for similar measures installed through National Grid's Low-Income Multifamily program are described in the *Multifamily – DHW* sections.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Household with hot water efficiency measures installed
ΔkWh	=	Average annual energy savings per unit: 128 kWh[62]
ΔkW	=	Average demand reduction per unit: 0.019 kW[63]

Cape Light Compact:
Cape Light Compact only installs pipe wrap under the Domestic Hot Water Measure Category for the Low Income Program.

Where:

Unit	=	Household with hot water efficiency measures installed
ΔkWh	=	Average annual kWh savings per unit: 41 kWh[64]
ΔkW	=	Average annual kW reduction per unit: 0.006[65]

[62] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[63] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[64] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.

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Baseline Efficiency

The baseline efficiency case is the existing hot water equipment.

High Efficiency

The high efficiency case includes low flow showerheads and faucet aerators as well as tank and pipe wraps.

Hours

Not applicable.

Measure Life

The measure life is 7 years.[66]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Residential water savings per participant[67]	4,028 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
DHW Measures (Electric)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	0.94
DHW Measures (Electric)	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	1.00	0.94

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[68]

[65] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[66] Massachusetts Common Assumption.
[67] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators
[68] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Hot Water – DHW Measures (Oil, Gas and Other)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of domestic hot water (DHW) measures including low flow showerheads, faucet aerators, and tank and pipe wraps in homes that have oil or gas water heaters.
Primary Energy Impact: Oil or Gas
Secondary Energy Impact: None
Non-Energy Impact: Residential Water, Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Hot Water
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings estimates described in this section are only used for the Low-Income 1-4 Family Retrofit program (all PAs) and the Low-Income Multifamily Retrofit programs (all PAs except National Grid). The savings algorithms for similar measures installed through National Grid's Low-Income Multifamily program are described in the *Multifamily – DHW* sections.

Algorithms for Calculating Primary Energy Impact

No electric savings are claimed for this measure.

Baseline Efficiency

The baseline efficiency case is the existing hot water equipment.

High Efficiency

The high efficiency case includes low flow showerheads and faucet aerators as well as tank and pipe wraps.

Hours

Not applicable.

Measure Life

The measure life is 7 years.[69]

[69] Massachusetts Common Assumption.

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Secondary Energy Impacts

Measure	PA	Energy Type	ΔMMBtu/Unit[70]
DHW Measures (Gas/Propane)	All expect CLC	NG – Residential DHW	0.5
DHW Measures (Gas/Propane)	CLC	NG – Residential DHW	0.4
DHW Measures (Oil)	All expect CLC	Oil	0.7
DHW Measures (Oil)	CLC	Oil	0.4

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Residential water savings per participant[71]	4,028 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
DHW Measures (Gas/Other)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
DHW Measures (Oil)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Coincidence factors are set to zero since there are no electric savings for this measure.

[70] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts..
[71] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators

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Hot Water – Showerheads

Version Date and Revision History

Effective Date: 7/1/2012
End Date: TBD

Measure Overview

Description: An existing showerhead with a high flow rate is replaced with a new low flow showerhead.
Primary Energy Impact: Electric
Secondary Energy Impact: Oil
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts, Residential Water
Sector: Residential
Market: Retrofit
End Use: Hot Water
Program: Home Energy Services

Algorithms for Calculating Primary Energy Impact

For electric water heating unit savings are deemed based on study results:

Where:
ΔkWh = Average annual kWh savings per unit: 237 kWh[72]
ΔkW = Average annual kW reduction per unit: 0.035 kW[73]

Baseline Efficiency

The baseline efficiency case is the existing showerhead with a high flow.

High Efficiency

The high efficiency case is a low flow showerhead.

Hours

Not applicable.

Measure Life

The measure life is 7 years[74]

Secondary Energy Impacts

For oil water heating unit savings are deemed based on study results:

ΔMMBtu = Annual MMBtu savings per unit. 1.3 MMBtu[75]

[72] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[73] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[74] Massachusetts common assumption based on various sources: Connecticut Program Savings Documentation for 2012 Program Year" (United Illuminating Co. and CT Light and Power Co., 2011) has 5 years for existing home retrofit. "Measure Life Report, Residential and Commercial/Industrial lighting and HVAC Measures" (GDS, 2007), reports 10 yr for retrofit per CA DEER, and 9 yr for retrofit or NC for VT.

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Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Gallons water saved per year per unit that received DHW measures[76]	3,696 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Showerhead	HES	All	1.00	1.00	1.00	1.00	1.00	1.00	0.94

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate.

Coincidence Factors
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[77]

[75] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[76] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators
[77] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Hot Water – Faucet Aerator

Version Date and Revision History

Effective Date: 7/1/2012
End Date: TBD

Measure Overview

Description: An existing faucet aerator with a high flow rate is replaced with a new low flow showerhead.
Primary Energy Impact: Electric
Secondary Energy Impact: Oil
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts, Residential Water
Sector: Residential
Market: Retrofit
End Use: Hot Water
Program: Home Energy Services

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

ΔkWh	=	Average annual kWh savings per unit: 49 kWh[78]
ΔkW	=	Average annual kW reduction per unit: 0.007 kW[79]

Baseline Efficiency

The baseline efficiency case is the existing faucet aerator with a high flow.

High Efficiency

The high efficiency case is a low flow faucet aerator.

Hours

Not applicable.

Measure Life

The measure life is 7 years[80]

[78] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[79] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[80] Massachusetts common assumption based on various sources: Connecticut Program Savings Documentation for 2012 Program Year" (United Illuminating Co. and CT Light and Power Co., 2011) has 5 years for existing home retrofit. "Measure Life Report, Residential and Commercial/Industrial lighting and HVAC Measures" (GDS, 2007), reports 10 yr for retrofit per CA DEER, and 9 yr for retrofit or NC for VT.

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Secondary Energy Impacts

For oil water heating unit savings are deemed based on study results:

ΔMMBtu = Annual MMBtu savings per unit. 0.3 MMBtu[81]

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Gallons water saved per year per unit that received DHW measures[82]	332 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Faucet Aerator	HES	All	1.00	1.00	1.00	1.00	1.00	1.00	0.94

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[83]

[81] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[82] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators
[83] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Hot Water – Indirect Water Heater

Version Date and Revision History

Effective Date: 7/1/2012
End Date: TBD

Measure Overview

Description: Installation of an indirect water heater attached to an oil boiler.
Primary Energy Impact: None
Secondary Energy Impact: Oil
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: Hot Water
Program: Home Energy Services

Algorithms for Calculating Primary Energy Impact

There are no electric savings associated with this measure.

Baseline Efficiency

The baseline efficiency case is the existing water heater.

High Efficiency

The high efficiency case is an indirect water heater attached to an ENERGY STAR® rated forced hot water oil boiler.

Hours

Not applicable.

Measure Life

The measure life is 20 years. [84]

Secondary Energy Impacts

ΔMMBtu = Annual savings per unit is 6.4 MMBtu[85]

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Indirect Water Heater	HES	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

[84] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[85] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.

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In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. Summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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Hot Water – Dishwashers

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of ENERGY STAR® qualified dishwashers in residential homes during new construction or major renovation. ENERGY STAR® dishwashers are on average, 10% more energy-efficient than non-qualified models.
Primary Energy Impact: Electric
Secondary Energy Impact: Natural Gas, Oil, Propane
Non-Energy Impact: Residential Water, Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity
End Use: Hot Water
Program: Residential New Construction & Major Renovation, Low-Income Residential New Construction

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on Energy Star calculations:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Installation of ENERGY® dishwasher
ΔkWh = Average annual energy reduction per unit: 74 kWh with electric water heating and 33 kWh with non-electric water heating; [86]
ΔkW = Average demand reduction per unit: 0.01 kW[87]

Baseline Efficiency

The baseline efficiency case is a conventional standard sized non-ENERGY STAR® qualified model meeting Federal Standards energy performance metric criteria effective January 1, 2010 for dishwashers with maximum energy consumption of less than or equal to 355 kwh/year and maximum water consumption of 6.5 gallons of water/cycle.[88]

High Efficiency

The high efficiency case is an ENERGY STAR® qualified standard sized dishwasher meeting the energy performance metric criteria effective July 1, 2011 for dishwashers with maximum energy consumption of greater than or equal to 307 kwh/year and maximum water consumption of 5.0 gallons/cycle.

Hours

Dishwashers are assumed to run 215 cycles per year.[89]

[86] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Residential Dishwasher*.
[87] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.
[88] Home: ENERGY STAR (2010). *Dishwasher Key Product Criteria.* http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers. Accessed on 10/20/10.
[89] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Residential Dishwasher*.

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Measure Life

The measure life is 10 years.[90]

Secondary Energy Impacts

Gas, Oil and Propane savings occur in homes where the water is heated by that fuel.

Measure	Energy Type	ΔMMBtu/Unit[91]
Dishwashers (Gas)	NG – Residential DHW	0.19
Dishwashers (Oil)	Oil	0.19
Dishwashers (Propane)	Propane	0.19

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Reduction in annual water usage compared to conventional unit [92]	430 Gallons/Unit
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Dishwashers	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	1.00	0.94

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[93]

[90] Ibid.
[91] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Residential Dishwasher*. Oil and Propane MMBtu savings are assumed to be the same as ENERGY STAR estimated gas savings.
[92] Ibid.
[93] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Hot Water – Waterbed Mattress Replacement

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Replacement of waterbed mattress with a standard mattress.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Hot Water
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Mattress replacement
ΔkWh	=	Average annual energy reduction per unit: 872 kWh[94]
ΔkW	=	Average demand reduction per unit: 0.186 kW for LI 1-4 Retrofit and 0.165 for LI MF Retrofit[95]

Baseline Efficiency

The baseline efficiency case is an existing waterbed mattress.

High Efficiency

The high efficiency case is a new standard mattress.

Hours

Not applicable.

Measure Life

The measure life is 10 years.[96]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[94] The Cadmus Group, Inc. (2009). *Impact Evaluation of the 2007 Appliance Management Program and Low Income Weatherization Program.* Prepared for National Grid.
[95] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[96] See the response to the question "How do I know when I need to buy a new mattress?" at the following link for more details: http://www.serta.com/#/best-mattress-FAQs-mattresses-Serta-Number-1-Best-Selling-Mattress.html (8/19/2010).

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Waterbed	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00
Waterbed	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.67	1.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[97]

[97] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Hot Water – Heat Pump Water Heater (Electric)

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of a heat pump water heater (HPWH) instead of an electric resistance water heater.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity, Low Income
End Use: Hot Water
Program: Residential Cooling & Heating Equipment, Low-Income 1-4 Family Retrofit, Low Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on preliminary study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit = Household with heat pump water heater installed
ΔkWh = Average annual energy savings per unit. See table below.
ΔkW = Average demand reduction per unit. See table below.

HPWH Size	ΔkW[98]	ΔkWh[99]
50 gallon	0.37	1,775
80 gallon	0.37	2,672

Baseline Efficiency

The baseline efficiency case is a new, standard efficiency electric resistance hot water heater.

High Efficiency

The high efficiency case is a high efficiency heat pump water heater.

Hours

Not applicable.

Measure Life

The measure life is 10 years.[100]

[98] Steven Winter Associates, Inc (2012). *Heat Pump Water Heaters Evaluation of Field Installed Performance*. Sponsored by National Grid and NSTAR. Table 1.
[99] Ibid.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
HPWH (Electric)	HVAC	All	1.00	1.00	1.00	1.00	1.00	0.47	1.00
HPWH (Electric)	RNC	CLC	1.00	1.00	1.00	1.00	1.00	0.47	1.00
HPWH (Electric)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.47	1.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are based on evaluation results.[101] Winter coincidence equal to 1 since gross kW savings are equal to winter peak demand savings.

[100] Based on warranty of equipment.
[101] Steven Winter Associates, Inc (2012). *Heat Pump Water Heaters Evaluation of Field Installed Performance*. Sponsored by National Grid and NSTAR.

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Hot Water – Heat Pump Water Heater (Oil and Other FF)

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of a heat pump water heater (HPWH) instead of an oil or propane water heater.
Primary Energy Impact: Oil and Other FF
Secondary Energy Impact: Electric
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Hot Water
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

HPWH Size	Energy Type	ΔMMBtu/Unit[102]
80 Gallon	Oil	10.36
50 Gallon	Propane	10.43
80 Gallon	Propane	14.68

Baseline Efficiency

The baseline efficiency case is a new, standard efficiency fuel oil or propane hot water heater.

High Efficiency

The high efficiency case is a heat pump water heater.

Hours

Not applicable.

Measure Life

The measure life is 10 years.[103]

Secondary Energy Impacts

There is an electric penalty for this measure since the HPWH uses more electricity than the baseline oil or propane water heater, see table below.

[102] Steven Winter Associates, Inc. (2012). *Heat Pump Water Heaters Evaluation of Field Installation Performance.* Sponsored by National Grid and NSTAR.
[103] Based on warranty of equipment.

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HPWH Size	kWh Penalty[104]	kW Penalty[105]
80 Gallon	-1,643	-1.18
50 Gallon	-1,579	-1.18

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
HPWH (Oil and Other FF)	RHVAC	All	1.00	1.00	0.00	0.00	0.00	0.47	1.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are based on evaluation results.[106]

[104] Steven Winter Associates, Inc (2012). *Heat Pump Water Heaters Evaluation of Field Installed Performance*. Sponsored by National Grid and NSTAR.
[105] Ibid.
[106] Ibid

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HVAC – Central Air Conditioning

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of high efficiency Central AC systems.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}} \right) \times Hours$$

$$\Delta kW = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}} \right)$$

Where:

Unit	=	Installation of central AC system
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons[107]
$SEER_{BASE}$	=	Seasonal Energy Efficiency Ratio of baseline AC equipment
$SEER_{EE}$	=	Seasonal Energy Efficiency Ratio of new efficient AC equipment
EER_{BASE}	=	Energy Efficiency Ratio of base AC equipment
EER_{EE}	=	Energy Efficiency Ratio of new efficient AC equipment
Hours	=	Equivalent full load hours

Baseline Efficiency

The baseline efficiency case is a central air-conditioning system with SEER = 13 and EER = 11 for replace on failure and SEER =10 and EER = 8.5 for early retirement.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified Central AC system. Average rated efficiency by measure is shown in the table below.

[107] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.

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Savings for Residential Central Air Conditioners[108]

Measure	ΔkW	ΔkWh
CoolSmart AC (SEER 14.5 / EER 12.0)	0.41	145.6
CoolSmart AC (SEER 15.0 / EER 12.5)	0.53	175.4
CoolSmart AC (SEER 16.0 / EER 13.0)	0.64	229.4

Hours

The equivalent full load cooling hours are 360 hours per year.[109]

Measure Life

Measure	Measure Life (years) [110]
CoolSmart AC (SEER 14.5 / EER 12.0)	14
CoolSmart AC (SEER 15.0 / EER 12.5)	15
CoolSmart AC (SEER 16.0 / EER 13.0)	16

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart AC	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results.[111]

[108] Savings have been adjusted to reflect the mix of replace on failure and early replacement. Percentage of early retirement is from The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 Cool Smart Application of Results Excel Workbook

[109] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.

[110] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1. Lifetime has been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 Cool Smart Application of Results Excel Workbook

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HVAC – Air Source Heat Pump

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of high efficiency Air Source Heat Pumps.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left[\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}} \right) \times Hours_C + \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}} \right) \times Hours_H \right]$$

$$\Delta kW = \max(\Delta kW_{COOL}, \Delta kW_{HEAT})$$

$$\Delta kW_{COOL} = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}} \right)$$

$$\Delta kW_{H} = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}} \right)$$

Where:

Unit	=	Installation of heat pump system
Tons	=	Capacity of HP equipment: Current default is 3 tons[112]
$SEER_{BASE}$	=	Seasonal efficiency of baseline HP equipment
$SEER_{EE}$	=	Seasonal efficiency of new efficient HP equipment
EER_{BASE}	=	Peak efficiency of base HP equipment
EER_{EE}	=	Peak efficiency of new efficient HP equipment
$HSPF_{BASE}$	=	Heating efficiency of baseline HP equipment
$HSPF_{EE}$	=	Heating efficiency of new efficient HP equipment
$Hours_C$	=	EFLH for cooling
$Hours_H$	=	EFLH for heating

[111] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.
[112] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.

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Baseline Efficiency

The baseline efficiency case is an air-source heat pump with SEER = 13, EER = 11and HSPF = 7. 7 for replace on failure and SEER =10, EER= 8.5 and HSPF = 7.0 for early retirement.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified Air Source Heat Pump.

Savings for Residential Air-Source Heat Pumps[113]

Measure	ΔkW_C	ΔkW_H	ΔkWh
CoolSmart HP (SEER 14.5 / EER 12.0 / HSPF 8.2)	0.41	0.40	630.7
CoolSmart HP (SEER 15.0 / EER 12.5 / HSPF 8.5)	0.53	0.56	846.4

Hours

Equivalent full load hours are 1200 hours/year for heating[114] and 360 hours/year for cooling.[115]

Measure Life

The measure life is 16 years.[116]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart HP	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.23	0.53

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

[113] Savings have been adjusted to reflect the mix of replace on failure and early replacement. Percentage of early retirement is from The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 Cool Smart Application of Results Excel Workbook.
[114] Massachusetts Common Assumption.
[115] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[116] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.* Prepared for The New England State Program Working Group; Page 1-3, Table 1. Lifetime has been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 Cool Smart Application of Results Excel Workbook.

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Coincidence Factors

Coincidence factors are based on evaluation study results and Massachusetts Common Assumptions.[117]

[117] The coincidence factors included in the BC model do not match the coincidence factors that are in the TRM because the B/C model only allows for a single max kW reduction to be entered for each measure and the TRM provides separate summer and winter kW reductions for some measures. An adjustment was made to the coincidence factors in the BC model in order to get the model to calculate the correct summer and winter kW reductions.

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HVAC – Ductless MiniSplit Heat Pump

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a more efficient ENERGY STAR® rated Ductless Mini Split HP system.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh_{HP} = Tons \times \frac{12\ kBtu/hr}{Ton}\left[\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right) \times Hours_C + \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right) \times Hours_H\right]$$

$$\Delta kW_{COOL} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

$$\Delta kW_{HEAT} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right)$$

Where:

Unit	=	Installation of high efficiency ductless Mini Split System
ΔkWh_{HP}	=	Reduction in annual kWh consumption of HP equipment
ΔkW_{HP}	=	Reduction in electric demand of HP equipment
Tons	=	Capacity of HP equipment: Current default is 1 tons [118]
$SEER_{BASE}$	=	Seasonal efficiency of baseline HP equipment, SEER 13 [119]
$SEER_{EE}$	=	Seasonal efficiency of new efficient HP equipment, see Table 4
EER_{BASE}	=	Peak efficiency of base HP equipment, 10 [120]
EER_{EE}	=	Peak efficiency of new efficient HP equipment, see Table 4
$HSPF_{BASE}$	=	Heating efficiency of baseline HP equipment, 7.7 [121]
$HSPF_{EE}$	=	Heating efficiency of new efficient HP equipment, see Table 4
$Hours_C$	=	EFLH for cooling
$Hours_H$	=	EFLH for heating

[118] About 75% of the mini-splits installed are 1 ton, regardless of SEER, per CSG.
[119] National Appliance Energy Conservation Act (NAECA) (2006)
[120] AHRI (Air Conditioning, Heating, and Refrigeration Institute) (2011). Average EER of current in-market equipment with a SEER of 13 from website at http://www.ahridirectory.org/ahridirectory/pages/home.aspx. Under Directory of Certified Product Performance>Residential>Variable Speed Mini-Split and Multi-Split Air Conditioners. Specified Model Status = Active, Indoor Type = Mini-Splits, and SEER Min and Max of 13.
[121] National Appliance Energy Conservation Act (NAECA) (2006).

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Baseline Efficiency

The baseline efficiency case is a non- ENERGY STAR® rated ductless mini split heat pump with SEER 13, EER 10 and HSPF 7.7.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified Ductless Mini Split System.

Table 4: Savings for Residential Ductless MiniSplit Heat Pumps

Measure	$SEER_{EE}$	EER_{EE}	$HSPF_{EE}$	ΔkW_C	ΔkW_H	ΔkWh
Ductless MS HP (SEER 14.5 / EER 12.0 / HSPF 8.2)	14.5	12.0	8.2	0.200	0.095	148
Ductless MS HP (SEER 19, EER 12.83, HSPF 10.0)	19	12.83	10.0	0.265	0.358	535
Ductless MS HP (SEER 23, EER 13, HSPF 10.6)	23	13	10.6	0.277	0.426	656

Hours

The equivalent full load hours are 1200 hours/year for heating[122] and 360 hours/year for cooling.[123]

Measure Life

The measure life is 18 years.[124]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Ductless Mini Split HP	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.50

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results and Massachusetts Common Assumptions.[125]

[122] Massachusetts Common Assumption.
[123] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[124] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
[125] The coincidence factors included in the BC model do not match the coincidence factors that are in the TRM because the B/C model only allows for a single max kW reduction to be entered for each measure and the TRM provides separate summer and

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HVAC – Ductless MiniSplit Air Conditioner

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of an ENERGY STAR® rated Ductless Mini Split AC system.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}} \right) \times Hours + \Delta kWh_{DuctSealing}$$

$$\Delta kW = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}} \right) + \Delta kW_{DuctSealing}$$

Where:

Unit	=	Installation of central AC system
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons[126]
$SEER_{BASE}$	=	Seasonal efficiency of baseline AC equipment
$SEER_{EE}$	=	Seasonal efficiency of new efficient AC equipment
EER_{BASE}	=	Peak efficiency of base AC equipment
EER_{EE}	=	Peak efficiency of new efficient AC equipment
Hours	=	Equivalent full load hours
$\Delta kWh_{DuctSealing}$	=	Annual energy savings from duct sealing: See *HVAC – Duct Sealing*
$\Delta kW_{DuctSealing}$	=	Annual demand reduction from duct sealing: See *HVAC – Duct Sealing*

Baseline Efficiency

The baseline efficiency case is a central air-conditioning system with SEER = 13 and EER = 11.

High Efficiency

The high efficiency case is a Ductless Mini Split system with SEER = 14 and EER = 11.5, and with duct sealing measures implemented.

winter kW reductions for some measures. An adjustment was made to the coincidence factors in the BC model in order to get the model to calculate the correct summer and winter kW reductions.

[126] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.

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Measure	EER_{EE}	$SEER_{EE}$	ΔkW	ΔkWh
Ductless Mini Split AC	11.5	14	0.442	283
Ductless Mini Split AC	13.0	16	0.577	398

Hours

Equivalent full load cooling hours are 360 hours per year.[127]

Measure Life

The measure life is 18 years.[128]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Ductless Mini Split AC	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results.[129]

[127] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[128] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
[129] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Central AC Quality Installation Verification (QIV)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The verification of proper charge and airflow during installation of new Central AC system.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\,kBtu/hr}{Ton} \times \frac{1}{SEER} \times Hours \times 5\%$$

$$\Delta kW = Tons \times \frac{12\,kBtu/hr}{Ton} \times \frac{1}{EER} \times 5\%$$

Where:

Units	=	Completed QIV
ΔkW	=	Average demand reduction per unit: 0.164 kW (calculated)
ΔkWh	=	Average annual energy reduction per unit: 50 kWh (calculated)
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons [130]
SEER	=	Seasonal efficiency of AC equipment: Default = 13
EER	=	Peak efficiency of AC equipment: Default = 11
Hours	=	Equivalent full load hours
5%	=	Average percent demand reduction: 5.0%[131]

Baseline Efficiency

The baseline efficiency case is a baseline cooling system (SEER = 13 and EER = 11) whose installation is inconsistent with manufacturer specifications.

High Efficiency

The high efficiency case is the same baseline cooling system whose installation is consistent with manufacturer specifications.

[130] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.
[131] Massachusetts Common Assumption.

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Hours

Equivalent full load cooling hours are 360 hours per year.[132]

Measure Life

The measure life is 18 years.[133]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart AC QIV	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results[134].

[132] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[133] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
[134] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Heat Pump Quality Installation Verification (QIV)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The verification of proper charge and airflow during installation of new Heat Pump systems.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{SEER} \times Hours_C + \frac{1}{HSPF} \times Hours_H \right) \times 5\%$$

$$\Delta kW = \max(\Delta kW_{COOL}, \Delta kW_{HEAT})$$

$$\Delta kW_{COOL} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{EER} \right) \times 5\%$$

$$\Delta kW_{HEAT} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{HSPF} \right) \times 5\%$$

Where:

Unit	=	Completed QIV
ΔkW	=	Average demand reduction per unit: 0.237 kW (calculated)
ΔkWh	=	Average annual energy reduction per unit: 334 kWh (calculated)
Tons	=	Cooling capacity of HP equipment: Current default is 3 tons [135]
SEER	=	Seasonal cooling efficiency of HP equipment
EER	=	Peak cooling efficiency of HP equipment
HSPF	=	Heating efficiency of HP equipment
$Hours_C$	=	EFLH for cooling
$Hours_H$	=	EFLH for heating
5%	=	Average demand reduction: 5%[136]

Baseline Efficiency

The baseline efficiency case is a baseline heating and cooling system (SEER = 13, EER = 11 and HSPF = 7.6) whose installation is inconsistent with manufacturer specifications.

[135] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.
[136] Massachusetts Common Assumption.

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High Efficiency

The high efficiency case is the same heating and cooling system whose installation is consistent with manufacturer specifications.

Hours

The equivalent full load heating hours are 1,200 hours per year and the equivalent full load cooling hours are 360 hours per year.[137]

Measure Life

The measure life is 18 years.[138]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart HP QIV	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.50

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on Massachusetts Common Assumptions.[139]

[137] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[138] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
[139] The coincidence factors included in the BC model do not match the coincidence factors that are in the TRM because the B/C model only allows for a single max kW reduction to be entered for each measure and the TRM provides separate summer and winter kW reductions for some measures. An adjustment was made to the coincidence factors in the BC model in order to get the model to calculate the correct summer and winter kW reductions.

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HVAC – Central AC Digital Check-up/Tune–up

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Tune-up of an existing central AC system.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\,kBtu/hr}{Ton} \times \frac{1}{SEER} \times Hours \times 5\%$$

$$\Delta kW = Tons \times \frac{12\,kBtu/hr}{Ton} \times \frac{1}{EER} \times 5\%$$

Where:

Unit	=	Completed tune-up
ΔkWh	=	Average annual energy reduction per unit: 65 kWh (calculated)
ΔkW	=	Average demand reduction per unit: 0.212 kW (calculated)
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons[140]
SEER	=	Seasonal efficiency of AC equipment
EER	=	Peak efficiency of AC equipment
Hours	=	Equivalent full load hours
5%	=	Average demand reduction: 5%[141]

Baseline Efficiency

The baseline efficiency case is a baseline cooling system (SEER = 13 and EER = 11) that does not operate according to manufacturer specifications.

High Efficiency

The high efficiency case is the same cooling system that operates according to manufacturer specifications.

Hours

The equivalent full load cooling hours are 360 hours per year.[142]

[140] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.
[141] Massachusetts Common Assumption.

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Measure Life

The measure life is 5 years.[143]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart AC Digital Check-up/Tune-up	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results[144].

[142] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[143] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
[144] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Heat Pump Digital Check-up/Tune-up

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Tune-up of an existing heat pump system.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{SEER} \times Hours_C + \frac{1}{HSPF} \times Hours_H \right) \times 5\%$$

$$\Delta kW = \max(\Delta kW_{COOL}, \Delta kW_{HEAT})$$

$$\Delta kW_{COOL} = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{EER} \right) \times 5\%$$

$$\Delta kW_{HEAT} = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{HSPF} \right) \times 5\%$$

Where:

Unit	=	Completed tune-up
ΔkWh	=	Average annual energy reduction per unit: 373 kWh (calculated)
ΔkW	=	Average demand reduction per unit: 0.257 kW (calculated)
Tons	=	Cooling capacity of HP equipment: Current default is 3 tons[145]
SEER	=	Seasonal cooling efficiency of HP equipment
EER	=	Peak cooling efficiency of HP equipment
HSPF	=	Heating efficiency of HP equipment
$Hours_C$	=	EFLH for cooling
$Hours_H$	=	EFLH for heating
5%	=	Average demand reduction: 5%[146]

Baseline Efficiency

The baseline efficiency case is a system baseline heating and cooling system (SEER = 13, EER = 11 and HSPF = 76) that does not operating according to manufacturer specifications.

[145] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.
[146] Massachusetts Common Assumption.

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High Efficiency

The high efficiency case is the same heating and cooling system that does operate according to manufacturer specifications.

Hours

The equivalent full load hours are 1200 hours per year for heating[147] and 360 hours per year for cooling.[148]

Measure Life

The measure life is 5 years[149]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart HP Digital Check-up/Tune-up	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.50

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results and Massachusetts Common Assumptions.[150]

[147] Massachusetts Common Assumption.
[148] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[149] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
[150] The coincidence factors included in the BC model do not match the coincidence factors that are in the TRM because the B/C model only allows for a single max kW reduction to be entered for each measure and the TRM provides separate summer and winter kW reductions for some measures. An adjustment was made to the coincidence factors in the BC model in order to get the model to calculate the correct summer and winter kW reductions.

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HVAC – Duct Sealing

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: A 66% reduction in duct leakage from 15% to 5% of supplied CFM.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on results of DOE2 modeling:

$$\Delta kWh = \Delta kWh$$

$$\Delta kW = \Delta kW$$

Where:

Unit	=	Completed job
ΔkW	=	Average demand reduction per unit: 0.300 kW[151]
ΔkWh	=	Average annual energy reduction per unit: 212 kWh[152]

Baseline Efficiency

The baseline efficiency case is assumes a 15% leakage.

High Efficiency

The high efficiency case is a system with duct leakage reduced by 66% to 5% leakage.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[153]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[151] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market*. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating; Page 3, Table 2.
[152] Ibid.
[153] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Sealing	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are based on evaluation study results[154].

[154] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Down Size ½ Ton

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Reduction in system size consistent with manual J calculations.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on results of DOE2 modeling:

$$\Delta kWh = \Delta kWh / Ton \times \tfrac{1}{2} Ton$$
$$\Delta kW = \Delta kW / Ton \times \tfrac{1}{2} Ton$$

Where:

Units	=	Completed job
ΔkW/Ton	=	Average demand reduction per ton: 0.295 kW[155]
ΔkWh/Ton	=	Average annual energy reduction per ton: 203 kWh[156]

Baseline Efficiency

The baseline efficiency case is a system that is not sized in accordance with manual J calculation.

High Efficiency

The high efficiency case is a system that is sized in accordance with manual J calculation.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[157]

Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

[155] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market*. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating; Page 3, Table 2
[156] Ibid.
[157] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Down Size ½ Ton	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are based on evaluation study results.[158]

[158] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Right Sizing

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Documentation that system size is in compliance with manual J calculations.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on results of DOE2 modeling:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Units = completed job
ΔkWh = Average annual energy reduction per unit: 123 kWh[159]
ΔkW = Average demand reduction per unit: 0.150 kW[160]

Baseline Efficiency

The baseline efficiency case is a system that is not sized in accordance with manual J calculation.

High Efficiency

The high efficiency case is a system that is sized in accordance with manual J calculation.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[161]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[159] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market*. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating; Page 3, Table 2.
[160] Ibid.
[161] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Right Sizing Tier 1	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00
Right Sizing Tier 2	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are based on evaluation study results.[162]

[162] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Early Replacement of Central AC or Heat Pump Unit

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Early replacement of Central Air Conditioning or Heat Pump Unit. This measure represents the additional savings achieved for the early replacement of existing inefficient AC or heat pump units over the remaining life of the existing equipment.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left[\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}} \right) \times Hours_C + \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}} \right) \times Hours_H \right]$$

$$\Delta kW = \max(\Delta kW_{COOL}, \Delta kW_{HEAT})$$

$$\Delta kW_{COOL} = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}} \right)$$

$$\Delta kW_{HEAT} = Tons \times \frac{12\,kBtu/hr}{Ton} \times \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}} \right)$$

Where:

Unit	=	Replacement of existing inefficient system with new efficient system
Tons	=	Capacity of AC/HP equipment: Current default is 3 tons[163]
$SEER_{BASE}$	=	Seasonal efficiency of baseline AC equipment
$SEER_{EE}$	=	Seasonal efficiency of new efficient AC equipment
EER_{BASE}	=	Peak efficiency of base AC equipment
EER_{EE}	=	Peak efficiency of new efficient AC equipment
$HSPF_{BASE}$	=	Heating efficiency of baseline HP equipment
$HSPF_{EE}$	=	Heating efficiency of new efficient HP equipment
$Hours_C$	=	EFLH for cooling
$Hours_H$	=	EFLH for heating

[163] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.

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Baseline Efficiency

The baseline efficiency case is assumed to be a typical 10-12 year-old central air-conditioning or heat pump unit with SEER 10, EER 8.5, HSPF 7.0.

High Efficiency

For the retirement savings over the remaining life of existing AC unit, the efficient case is a SEER 13, EER 11, HSPF 7.6 unit. For the high efficiency savings over lifetime of the new AC unit, the efficient case is a new high efficiency SEER 14.5, EER 12, 8.2 HSPF unit.

Measure	EER_{BASE}	$SEER_{BASE}$	$HSPF_{BASE}$	EER_{EE}	$SEER_{EE}$	$HSPF_{EE}$	ΔkW_C	ΔkW_H	ΔkWh
Early Replacement AC_{RETIRE}	8.5	10	n/a	11	13	n/a	0.963	0.000	299
Early Replacement AC_{EE}	11	13	n/a	12	14.5	n/a	0.273	0.000	103
Early Replacement HP_{RETIRE}	8.5	10	7.0	11	13	7.6	0.963	0.406	786
Early Replacement HP_{EE}	11	13	7.6	12	14.5	8.2	0.273	0.347	519

Hours

The equivalent full load hours are 1,200 hours per year for heating[164] and 360 hours per year for cooling.[165]

Measure Life

The remaining life for the existing unit is 7 years[166], and the measure life of new equipment is 18 years.[167]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Early Replacement AC	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00
Early Replacement HP	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.50

[164] Massachusetts Common Assumption.
[165] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-5, Table 4-3.
[166] Massachusetts Common Assumption: The early replacement measure life of 7 years was determined by subtracting the estimated target age range of existing equipment between 10 and 12 years old from the 18 year measure life for new equipment.
[167] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.

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In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are based on evaluation study results[168] and Massachusetts Common Assumptions. [169]

[168] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.
[169] The coincidence factors included in the BC model do not match the coincidence factors that are in the TRM because the B/C model only allows for a single max kW reduction to be entered for each measure and the TRM provides separate summer and winter kW reductions for some measures. An adjustment was made to the coincidence factors in the BC model in order to get the model to calculate the correct summer and winter kW reductions.

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HVAC – Quality Installation with Duct Modification

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: 50% reduction in duct leakage from 20% to 10%. This measure may also include duct modifications.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on results of DOE2 modeling:

$$\Delta kWh = \Delta kWh$$

$$\Delta kW = \Delta kW$$

Where:

Unit	=	Completed job
ΔkWh	=	Average annual energy reduction per unit: 513 kWh with duct modifications, 212 kWh without duct modifications[170]
ΔkW	=	Average demand reduction per unit: 0. 850 kW with duct modifications, 0.300 kW without duct modifications[171]

Baseline Efficiency

The baseline efficiency case is a system with an installation that is inconsistent with manufacturer specifications and may include leaky ducts.

High Efficiency

The high efficiency case is a system with an installation that is consistent with manufacturer specifications and may have reduced duct leakage.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[172]

[170] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market*. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating; Page 3, Table 2.
[171] Ibid.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Energy Star QI	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00
Energy Star QI w/ Duct Modifications	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results.[173]

[172] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page 1-3, Table 1.

[173] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – TXV Valve Replacement of Fixed Orifice

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The replacement of a fixed orifice with a Thermostatic eXpansion Valve (TXV).
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = Tons \times \frac{12\ kBtu/hr}{Ton} \times \frac{1}{SEER} \times Hours \times 10.5\%$$

$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of TXV valve
ΔkWh	=	Average annual energy reduction per unit: 105 k Wh (calculated)
ΔkW	=	Average annual kW reduction: 0.156[174]
Tons	=	Cooling capacity of AC equipment: Default is 3 tons[175]
SEER	=	Seasonal efficiency of AC equipment
Hours	=	Annual operating hours
10.5%	=	Average percent demand reduction: 10.5%[176]

Baseline Efficiency

The baseline efficiency case is a system with a fixed orifice expansion and SEER = 13.

High Efficiency

The high efficiency case is a system with a Thermostatic eXpansion Valve (TXV) and SEER = 13.

Hours

Not applicable.

[174] Estimated using demand allocation methodology described in: Quantec, LLC (2000). *Impact Evaluation: Single-Family EnergyWise Program.* Prepared for National Grid.
[175] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation.* Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12, Table 4-9.
[176] Northeast Energy Efficiency Partnerships (2006). *Strategies to Increase Residential HVAC Efficiency in the Northeast*. Prepared for NASEO; Appendix B.

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Measure Life

The measure life is 7 years.[177]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
TXV Replacement of Fixed Orifice	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.25	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based on evaluation study results.[178]

[177] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

[178] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation*. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; Page 4-12 Table 4-9.

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HVAC – Furnace Fan Motors (ECM)

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of high efficiency motors on residential furnace fans, including electronically commutated variable speed air supply motors.
Primary Energy Impact: Electric
Secondary Energy Impact: Natural Gas (Residential Heat)
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment, Home Energy Services (CLC)

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of high efficiency furnace fan motor
ΔkWh	=	Average annual energy reduction per unit: 168 kWh[179]
ΔkW	=	Average demand reduction per unit: 0.124 kW[180]

Baseline Efficiency

The baseline efficiency case is the installation of a furnace with a standard efficiency steady state motor.

High Efficiency

The high efficiency case is the installation of a furnace with an electronically commutated motor.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[181]

[179] ERS (2011) Pilot Evaluation of BFM DRAFT. Results as of 9/29/2011. The savings values for the BFM come from Page 1, Table 1 of the BFM impact evaluation filed with the Annual Report. While this report was only to provide savings for the BFM - -the original savings used by the PA's 600 kWh and .116 kW were used for both the BFM and ECM. When the BFM study was almost complete we asked the evaluation team if it were possible to come up with savings for the ECM motor; they calculated the 168 kWh using data from the BFM onsites, after several discussions the evaluation team determined the ECM motor was a different measure than the BFM so the calculations were not 100% accurate. They note that while the 600 kWh was too high, the 168 may be on the low side but could not confirm without an evaluation of the ECM. PA's determined while we did not have an evaluation for the 168 it was probably a more realistic number than the 600.
[180] Ibid
[181] Sachs, Harvey (2003). *Energy Savings from Efficient Furnace Air Handlers in Massachusetts.*

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Secondary Energy Impacts

A heating penalty results due to reduced heat loss of the efficient furnace motor.

Measure		Energy Type	ΔMMBtu/Unit[182]
CoolSmart Warm Air Furnace ECM	RHVAC	Natural Gas (Residential Heat)	-0.716
Furnace Fan Motors (ECM)	HES	Oil	-0.716
Furnace Fan Motors (ECM)	HES	Propane	-0.716

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CoolSmart Warm Air Furnace ECM	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0. 00	0.16

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are based evaluation results.[183]

[182] ERS (2011) Pilot Evaluation of BFM DRAFT. Results as of 9/29/2011.
[183] Ibid.

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HVAC – Brushless Fan Motors

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of high efficiency motors on residential furnace fans, including steady state brushless furnace fan motors.
Primary Energy Impact: Electric
Secondary Energy Impact: Natural Gas (Residential Heat)
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Cooling & Heating Equipment

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of high efficiency furnace fan motor
ΔkWh	=	Average annual energy reduction per unit: 246 kWh[184]
ΔkW	=	Average demand reduction per unit: 0.182 kW[185]

Baseline Efficiency

The baseline efficiency case is the installation of a furnace with a standard efficiency steady state motor.

High Efficiency

The high efficiency case is the installation of a furnace with a brushless fan motor.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[186]

Secondary Energy Impacts

A heating penalty results due to reduced heat loss of the efficient furnace motor.

[184] The Cadmus Group (2012). *Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation.* Prepared for The Electric and Gas Program Administrators of Massachusetts
[185] Ibid.
[186] Sachs, Harvey (2003). *Energy Savings from Efficient Furnace Air Handlers in Massachusetts.*

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Measure	Energy Type	ΔMMBtu/Unit[187]
Brushless Furnace Fan Motor	Natural Gas (Residential Heat)	-0.676

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Brushless Furnace Fan Motor	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.26	0.25

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are based on evaluation results.[188]

[187] The Cadmus Group (2012). Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation. Prepared for The Electric and Gas Program Administrators of Massachusetts June 2012.
[188] Ibid.

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HVAC – Room Air Conditioner (Lost Opportunity)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of ENERGY STAR® qualified room air conditioners. ENERGY STAR® qualified air conditioners are typically 10% more efficient than models meeting federal standards.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity, Retrofit
End Use: HVAC
Program: ENERGY STAR Appliances, Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated room AC unit
ΔkWh	=	Average annual energy savings per unit: 43 kWh[189]
ΔkW	=	Average demand reduction per unit: 0.12 kW[190]

Baseline Efficiency

The baseline efficiency case is a window AC unit that meets the minimum federal efficiency standard for efficiency which currently is EER 9.8.

High Efficiency

The high efficiency level is a room AC unit meeting or exceeding the federal efficiency standard by 10% or more. Average size is 10,000 Btu and average EERs is 10.8.

Hours

N/A

Measure Life

The measure life is 9 years.[191]

[189] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerRoomAC.xls.
[190] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[191] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner.*

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Room AC	ES Appliances	All except WMECO	1.00	1.00	1.00	1.00	1.00	1.00	0.00	n/a	n/a
Room AC	MF Retrofit	All except WMECO	1.00	1.00	1.00	1.00	1.00	1.00	0.00	n/a	n/a
Room AC	ES Appliances	WMECO	1.00	1.00	1.00	1.00	1.00	n/a	n/a	0.30	0.00
Room AC	MF Retrofit	WMECO	1.00	1.00	1.00	1.00	1.00	n/a	n/a	0.30	0.00

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[192]

[192] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Room Air Conditioner (Retrofit)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Replacement of existing inefficient room air conditioners with more efficient models. This is only offered as a measure when an AC timer would not reduce usage during the peak period.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: HVAC
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Replacement of an existing window AC unit with a new efficient window AC unit
ΔkWh = Average annual kWh savings per unit: 204 kWh[193]
ΔkW = Max load kW reduction: 0.582 kW[194]

Baseline Efficiency

The baseline efficiency case is the existing air conditioning unit.

High Efficiency

The high efficiency case is the high efficiency room air conditioning unit.

Hours

Not applicable.

Measure Life

The measure life is 9 years. [195]

[193] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts..
[194] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[195] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner.* Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerRoomAC.xls.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Window AC Replacement	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Window AC Replacement	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	1.00	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[196]

[196] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Dehumidifiers

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Early retirement of existing dehumidifiers and replacement with high efficiency dehumidifiers
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Lost Opportunity, Retrofit
End Use: HVAC
Program: ENERGY STAR Appliances, Low-Income 1-4 Family Retrofit

Notes

Cape Light Compact is the only PA to offer this measure

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh_{EE} = Capacity \times \frac{0.473}{24} \times \left(\frac{1}{Eff_{BASE}} - \frac{1}{Eff_{EE}} \right) \times Hours$$

$$\Delta kWh_{RETIRE} = Capacity \times \frac{0.473}{24} \times \left(\frac{1}{Eff_{RETIRE}} - \frac{1}{Eff_{BASE}} \right) \times Hours$$

$$\Delta kW_{EE} = \Delta kWh_{EE} \,/\, Hours$$

$$\Delta kW_{RETIRE} = \Delta kWh_{RETIRE} \,/\, Hours$$

Where:

Unit	=	Replacement of existing dehumidifier with new ENERGY STAR® dehumidifier
ΔkWh_{EE}	=	Annual energy savings due to ES unit compared to new baseline unit: 66 kWh
ΔkWh_{RETIRE}	=	Annual energy savings of baseline units compared to existing unit: 77 kWh
ΔkW_{EE}	=	ES replacement demand load savings: 0.038 kW
ΔkW_{RETIRE}	=	Retired demand load savings: 0.044 kW
Capacity	=	Average capacity of dehumidifier in Pints/24 Hours: 35 Pints/Day[197]
Eff_{BASE}	=	Average efficiency of conventional model in Liters/kWh
Eff_{EE}	=	Average efficiency of ENERGY STAR® model in Liters/kWh
Eff_{RETIRE}	=	Average efficiency of existing model in Liters/kWh
Hours	=	Dehumidifier annual operating hours
0.473	=	Conversion factor: 0.473 Liters/Pint
24	=	Conversion factor: 24 Hours/Day

[197] 35 pints per day was the average turn in at the Cape Light Compact's May 2010 event. This event retired 125 units.

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Baseline Efficiency

The baseline efficiency case for a retired dehumidifier ($Eff_{RETIRED}$) is 1.20 L/kWh[198], which is the pre-EPACT 2005 efficiency for a 35 pint/day unit. The baseline efficiency for an existing unit (Eff_{BASE}) is 1.30 L/kWh[199], which is the current federal standard for a 35 pint/day unit.

High Efficiency

The high efficiency case is an ENERGY STAR® replacement unit with an efficiency of 1.40 L/kWh[200].

Hours

Average annual operating hours are 1,706 hours, calculated as the sum of average operating hours in the summer, winter and spring/fall seasons, where seasonal hours are calculated at the number of days in that season multiplies by the mean operating hours/day.

Season	Mean Hours/Day[201]	% Days in Season[202]	Seasonal Operating Hours
Summer	7.8	25%	712
Winter	2.3	25%	210
Spring/Fall	4.3	50%	785
All	-	-	1,706*

*Cape Light Compact Annual Hours are adjusted by a factor of 1.02 to account for longer operating hours for Cape Light Compact customers compared to customers in other program territories. The adjustment factor represents the weighted average increase in operating hours compared to PA-average hours over all seasons.

Measure Life

The measure life of a replacement unit is 12 years.[203] The remaining measure life of a retired unit is 5 years.[204]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Dehumidifiers	ES Appliances	CLC	1.00	1.00	1.00	1.00	1.00	0.85	0. 00

[198] Environmental Protection Agency (2002). *Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers*.
[199] Appliance Standards Awareness Project (2007). *Dehumidifiers*. Website accessed on 6/30/10.
[200] Environmental Protection Agency (2002). *Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers*.
[201] Opinion Dynamics Corporation (2009). *Massachusetts Residential Saturation Survey (RASS) - Volume 1: Summary Results and Analysis*. Prepared for Cape Light Compact, National Grid, NSTAR Electric, Unitil and Western Massachusetts Electric Company; Page 94, Table 17.
[202] Simplifying assumption.
[203] Environmental Protection Agency (2002). *Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers*.
[204] On average, turn-in units at the Cape Light Compact's May 2010 event were 7 years old. The full measure life of 12 years minus the average age of the retired equipment of 7 years equals a remaining life of 5 years.

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Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Dehumidifiers	LI 1-4 Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	0.85	0.00

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Coincidence factors are based on Massachusetts Common Assumptions.

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HVAC – Thermostats

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Replacement of existing thermostats with programmable thermostats in oil heated homes.
Primary Energy Impact: Electric
Secondary Energy Impact: Oil
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: HVAC
Program: Home Energy Services, Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

For electrically heated homes in Home Energy Services unit savings are deemed based on study results:

$\Delta kWh = \Delta kWh$
$\Delta kW = \Delta kW$

Where:
ΔkWh = Average annual kWh reduction: 330 kWh[205]
ΔkW = Average annual kW reduction: 0.176 kW[206]

Baseline Efficiency

The baseline efficiency case is a non-programmable thermostat.

High Efficiency

The high efficiency case is a programmable thermostat.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[207]

[205] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[206] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[207] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat*..

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Secondary Energy Impacts

Measure	Program	ΔMMBtu/Unit
Programmable Thermostat (Oil)	HES	3.4[208]
Programmable Thermostat (Other FF) CLC Only	HES	3.4
Programmable Thermostat (Oil)	LI 1-4 Retrofit	3.1[209]

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Programmable Thermostat (Electric)	HES	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Programmable Thermostat (Oil)	LI 1-4 Retrofit, LI MF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[210]

[208] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[209] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[210] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Boiler Reset Controls

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of weather responsive controls on oil or propane boilers.
Primary Energy Impact: Oil, Propane
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: HES, Low-Income 1-4 Family Retrofit

Algorithms for Calculating Primary Energy Impact

No electric savings are claimed for this measure.

Baseline Efficiency

The baseline efficiency case has boiler controls installed.

High Efficiency

The high efficiency case includes weather responsive controls installed on the boiler.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[211]

Secondary Energy Impacts

Measure	Program	ΔMMBtu/Unit
Boiler Reset Controls (Oil)	HES	4.7[212]
Boiler Reset Controls (Propane)	HES	4.7[213]
Boiler Reset Controls (Oil)	LI 1-4 Retrofit	4.4[214]

[211] ACEEE (2006). *Emerging Technologies Report: Advanced Boiler Controls*. Prepared for ACEEE; Page 2.
[212] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[213] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[214] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Boiler Reset Controls	HES	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Boiler Reset Controls	LI 1-4 Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Coincidence factors are set to zero since there are no electric savings for this measure.

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HVAC – Weatherization (Electric)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of weatherization measures such as air sealing and insulation in electrically heated homes.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Envelope
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings estimates described in this section are only used for the Low-Income 1-4 Family Retrofit program (all PAs) and the Low-Income Multifamily Retrofit programs (all PAs except National Grid). The savings algorithms for similar measures installed through National Grid's Low-Income Multifamily program are described in the *Multifamily – Insulation* and *Multifamily – Air Sealing* sections.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Electrically-heated household with weatherization measures installed
ΔkWh	=	Average annual energy reduction: 1,616 kWh[215]
ΔkW	=	Average demand reduction: 0.863 kW[216]

Baseline Efficiency

The baseline efficiency case is any existing home shell measures.

High Efficiency

The high efficiency case includes increased weatherization insulation levels.

Hours

Not applicable.

[215] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[216] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Measure Life

The measure life is 20 years.[217]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Weatherization (Electric)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Weatherization (Electric)	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[218]

[217] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page A-2.
[218] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Weatherization (Oil and Other FF)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of weatherization measures such as air sealing and insulation in oil or propane heated homes. Electric savings are achieved from reduced fan run time for heating and cooling systems.
Primary Energy Impact: Oil and Other FF
Secondary Energy Impact: Electric
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Envelope
Program: Low-Income 1-4 Family Retrofit, Low-Income Multi-Family Retrofit (CLC)

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Oil or propane heated household with weatherization measures installed
ΔkWh	=	Average annual energy reduction per unit: it: 377 kWh[219]
ΔkW	=	Average demand reduction per unit: 0.12 kW_{heat} and 0.34 kW_{cool}[220]

Baseline Efficiency

The baseline efficiency case is any existing home shell measures.

High Efficiency

The high efficiency case includes increased weatherization insulation levels.

Hours

Not applicable.

Measure Life

The measure life is 20 years.[221]

[219] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[220] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[221] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Page A-2.

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Secondary Energy Impacts

Measure	Energy Type	ΔMMBtu/Unit[222]
Weatherization (Oil)	Oil	28.1
Weatherization (Other FF)	Propane	28.1

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Weatherization (Oil and Other FF)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[223,224]

[222] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[223] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.
[224] The coincidence factors included in the BC model do not match the coincidence factors that are in the TRM because the BC model only allows for a single max kW reduction to be entered for each measure and the TRM provides separate summer and winter kW reductions for some measures. An adjustment was made to the coincidence factors in the BC model in order to get the model to calculate the correct summer and winter kW reductions.

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HVAC – Heating System Replacement (Oil and other FF)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Replacement of existing oil or propane heating system with a new high efficiency system. Electric savings can be attributed to reduced fan run time and reduced usage of electric space heaters.
Primary Energy Impact: Oil and Propane
Secondary Energy Impact: Electric
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: HVAC
Program: Home Energy Services, Low-Income 1-4 Family Retrofit

Algorithms for Calculating Primary Energy Impact

For HES unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of new high efficiency oil furnace
ΔkWh	=	Average annual energy reduction per unit: 98 kWh[225]
ΔkW	=	Average demand reduction per unit: 0.05 kW[226]

For Low Income 1-4 Family Retrofit unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of new high efficiency oil or propane heating system
ΔkWh	=	Average annual energy reduction per unit: 132 kWh[227]
ΔkW	=	Average demand reduction per unit: 0.07 kW[228]

[225] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[226] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[227] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[228] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Baseline Efficiency

For Low Income 1-4 the baseline efficiency case is the existing inefficient heating equipment. For HES the baseline is a standard efficiency oil heating system.

High Efficiency

The high efficiency case is the new efficient heating equipment.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[229]

Secondary Energy Impacts

Measure	Program	ΔMMBtu/Unit
Heating System Replacement (Oil/Propane)	Low Income 1-4	18.4[230]
Heating System Replacement (Oil Furnace)	HES	8.4
Heating System Replacement (Oil Boiler)	HES	6.0

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System Replacement	HES	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Heating System Replacement	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[231]

[229] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace*.
[230] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[231] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Early Replacement Boiler (Oil and Propane)

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Early retirement of inefficient oil or propane fired boiler and installation of new high efficiency oil or propane fired boiler.
Primary Energy Impact: Oil, Propane
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Home Energy Services

Algorithms for Calculating Primary Energy Impact

Unit savings for the early replacement of an existing boiler with a high efficiency boiler are counted in two parts: (1) early retirement savings for a code-compliant boiler compared to the existing boiler over the remaining lifetime of the existing boiler, and (2) efficiency savings for the high efficiency boiler compared to a code-compliant boiler for the full life of the new high efficiency boiler:

$$\Delta MMBtu = \Delta MMBtu_{RETIRE} + \Delta MMBtu_{EE}$$

Where:

	$\Delta MMBtu_{RETIRE}$[232]	$\Delta MMBtu_{EE}$[233]
Oil Forced Hot Water	25.4	8.5
Oil Steam	26.3	3.5
Propane Forced Hot Water	24.0	16.0
Propane Steam	26.3	3.5

Baseline Efficiency

For the retirement savings over the remaining life of existing boiler, the baseline is the existing inefficient boiler estimated to be 65% AFUE. For the high efficiency unit savings over lifetime of the new boiler, the baseline is a code-compliant boiler with an AFUE = 80%.

High Efficiency

For the retirement savings over the remaining life of existing boiler, the efficient case is a code-compliant boiler (AFUE = 80%). For the high efficiency savings over lifetime of the new boiler, the efficient case is a new high efficiency (AFUE >= 85% for forced hot water oil, 90% for forced hot water propane and 82% for steam boilers).

Hours

Not applicable.

[232] Calculated using information from GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks
[233] Calculated using information from GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks

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Measure Life

The remaining life for the existing unit is 10 years[234], and the measure life of new equipment is 20 years.[235]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Early Replacement Boiler (Retire)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Early Replacement Boiler (EE)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[234] Agreed upon with EEAC consultants as a reasonable approximation for the number of years an existing boiler would continue to operate if it had not been replaced early due to the program.
[235] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers.*

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Process – Computer Monitors

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates for ENERGY STAR® Computer Monitors
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Process
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated ENERGY STAR® computer monitor
ΔkWh	=	Average annual kWh savings per unit: 35 kWh[236]
ΔkW	=	Average annual kW savings per unit: 0.01 kW[237]

Baseline Efficiency

The baseline efficiency case is a conventional computer monitor.

High Efficiency

The high efficiency case is an ENERGY STAR® rated LCD monitor.

Hours

Not applicable.

Measure Life

The measure life is 5 years.[238]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[236] Deemed savings developed based on assumptions in Consortium for Energy Efficiency (2008). *Consumer Electronics Program Guide: Information on Voluntary Approaches for the Promotion of Energy Efficient Consumer Electronics - Products and Practices*; Page 9, Table 1.
[237] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[238] Consortium for Energy Efficiency (2008). *Consumer Electronics Program Guide: Information on Voluntary Approaches for the Promotion of Energy Efficient Consumer Electronics - Products and Practices.*

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Computer Monitors	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1. 00

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[239]

[239] The Cadmus Group (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators

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Process – Computers

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates for ENERGY STAR® computers.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Process
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are based on engineering estimate of delta kW between computers that are idle, in sleep mode, or off:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Rebated ENERGY STAR® desktop computer
ΔkWh = Average annual kWh reduction per unit: 70 kWh[240]
ΔkW = Average kW savings per unit: 0.02 kW[241]

Baseline Efficiency

The baseline efficiency case is a conventional desktop computer.

High Efficiency

The high efficiency case is an ENERGY STAR® rated desktop computer.

Hours

The operational hours include: 3,322 annual idle hours, 399 annual sleep hours, and 5,039 annual off hours.[242]

Measure Life

The measure life is 4 years.[243]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[240] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Office Equipment.*
[241] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[242] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Office Equipment.*
[243] Ibid.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Desktop Computers	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1. 00

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[244]

[244] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators

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Process – Pool Pump

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a 2-speed or variable speed drive pool pump. Operating a pool pump for a longer period of time at a lower wattage can move the same amount of water using significantly less energy.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Process
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms which use averaged inputs:

$$\Delta kWh = (kW_{BASE} \times Hours) \times 55\%$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated 2-speed or variable speed pool pump
ΔkWh	=	Average annual kWh reduction: 400 kWh[245]
ΔkW	=	Average annual kW reduction: 0.275 kW[246]
Hours	=	Average annual operating hours of pump
kW_{BASE}	=	connected kW of baseline pump
55%	=	average percent energy reduction from switch to 2-speed or variable speed pump[247]

Baseline Efficiency

The baseline efficiency case is a single speed pump.

High Efficiency

The high efficiency case is a 2-speed or variable speed pump.

Hours

Hours are considered on a case-by-case basis since they are dependent on seasonal factors, pool size, and treatment conditions.

[245] Estimated using the difference between a Standard Efficiency Single Speed Pump and a Two-Speed with both Speeds Combined * Number of Days in the NE summer season ((13.8 kWh – 9.4 kWh) * 91). Pacific Gas and Electric *The Multi-Speed Pool Pump Fact Sheet.*
[246] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[247] Davis Energy Group (2008). *Proposal Information Template for Residential Pool Pump Measure Revisions*. Prepared for Pacific Gas and Electric Company; Page 2.

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Measure Life

The measure life is 10 years.[248]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pool Pumps	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factor

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[249]

[248] Davis Energy Group (2008). *Proposal Information Template for Residential Pool Pump Measure Revisions*. Prepared for Pacific Gas and Electric Company.
[249] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators

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Process – Room Air Cleaner

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates provided for the purchase of an ENERGY STAR® qualified room air cleaner. ENERGY STAR® air cleaners are 40% more energy-efficient than standard models.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Process
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed and based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh / Hours$$

Where:

Unit	=	Rebated room air cleaner
ΔkWh	=	Average annual kWh savings per unit: 268 kWh[250]
ΔkW	=	Average connected load reduction: 0.06 kW[251]
Hours	=	Annual operating hours

Baseline Efficiency

The baseline efficiency case is a conventional unit with clean air delivery rate (CADR) of 51-100.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified air cleaner with a CADR of 51-100.

Hours

The savings are based on 8,760 operating hours per year.

Measure Life

The measure life is 9 years.[252]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[250] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Cleaner.*
[251] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[252] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Cleaner.*

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Room Air Cleaner	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model[253]

[253] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators

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Process – Set Top Boxes

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates for ENERGY STAR® Set Top Boxes.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Process
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated set-top box
ΔkWh	=	Average annual kWh savings per unit: 36 kWh[254]
ΔkW	=	Average connected load reduction: 0.01 kW[255]

Baseline Efficiency

The baseline efficiency case is a conventional set-top box that is not ENERGY STAR ® rated.

High Efficiency

The high efficiency case is an ENERGY STAR ® rated set-top box that is 30% more efficient than conventional models.

Hours

The savings are based on 8,760 operational hours per year.

Measure Life

The measure life is 4 years.[256]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[254] Home: ENERGY STAR (2010). *Set-top Boxes & Cable Boxes for Consumers.* http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=ST. Accessed on 10/11/11; savings found by taking 30% of the average Total Energy Consumption from the Qualified Set-top Box Product List.
[255] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[256] Massachusetts Common Assumption.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Set Top Box	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[257]

[257] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators

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Process – Smart Strips

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Switches off plug load using current sensors and switching devices which turn off plug load when electrical current drops below threshold low levels. Smart Strips can be used on electrical home appliances or in the workplace.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Lost Opportunity, Retrofit
End Use: Process
Program: ENERGY STAR Appliances, HES, Low-Income 1-4 Family Retrofit, Multi-Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Unit = Rebated smart strip
ΔkWh = Average annual kWh savings per unit: 79 kWh[258]
ΔkW = Max kW savings per unit: 0.02 kW[259]

Baseline Efficiency

The baseline efficiency case is no power strip and leaving peripherals on or using a power surge protector.

High Efficiency

The high efficiency case is a Smart Strip Energy Efficient Power Bar

Hours

Since the power strip is assumed to be plugged in all year, the savings are based on 8,760 operational hours per year.

Measure Life

The measure life is 5 years[260]

Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

[258] ECOS 2009 Smart Plug Strips: Draft Report.
[259] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[260] Massachusetts Common Assumption.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Smart Strips	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1. 00
Smart Strips	HES	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00
Smart Strips	MF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00
Smart Strips	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00
Smart Strips	LI MF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[261]

[261] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.

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Process – Televisions

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates for ENERGY STAR® qualified televisions.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Process
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Rebated television
ΔkWh	=	Average annual kWh reduction per unit. See Table 5.
ΔkW	=	Average electric demand reduction per unit.[262] See Table 5

Baseline Efficiency

The baseline efficiency case is a CEE Tier 1 television.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified television, which uses about 40% less energy than standard units. Qualifying ENERGY STAR® TV products include standard TVs, HD-ready TVs, and the large flat-screen plasma TVs.[263] The savings, which are weighted between on and standby modes, for various models are given in the following table.

Table 5: Savings for Televisions

Television Size	ΔkW	ΔkWh
Energy Star Version 5.3 TV <60”	0.05	246
Energy Star Version 5.3 TV >=60”	0.12	544

Hours

Since the TV is assumed to be plugged in all year, the savings are based on 8,760 operational hours per year. The weighted savings are based on 5 hours on and 19 hours standby each day.

[262] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[263] Homes: Energy Star. *Televisions for Consumers.* http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TV. Accessed on 10/11/10.

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Measure Life

The measure life is 6 years.[264]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Version 5.3 TV < 60"	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00
Version 5.3 TV >= 60"	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.73	1.00

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[265]

[264] Environmental Protection Agency (2008). Life *Cycle Cost Estimate for ENERGY STAR Television.*
[265] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.

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Refrigeration – Refrigerators (Lost Opportunity)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates for purchase of ENERGY STAR® qualified refrigerators. ENERGY STAR® qualified refrigerators use at least 20% less energy than new, non-qualified models.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Lost Opportunity
End Use: Refrigeration
Program: ENERGY STAR Appliances, Residential New Construction & Major Renovation, Low-Income Residential New Construction

Algorithms for Calculating Primary Energy Impact

Unit savings are based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kWh_{BASE} - \Delta kWh_{ES}$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installed ENERGY STAR® refrigerator
ΔkWh	=	Annual savings over non-ES refrigerators averaged by model type: 107 kWh[266]
ΔkW	=	Average kW reduction over non-ES refrigerator: 0.01 kW[267]

Baseline Efficiency

The baseline efficiency case is a residential refrigerator that meets the Federal minimum standard for energy efficiency.

High Efficiency

The high efficiency case is an ENERGY STAR® residential refrigerator that uses 20% less energy than models not labeled with the ENERGY STAR® logo.

Hours

Not applicable.

Measure Life

The measure life is 12 years.[268]

[266] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator*. Interactive Excel Spreadsheet found at www.energystar.gov/.../business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls; average of savings form all refrigerator models.
[267] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigerator Rebate	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93
Refrigerators	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[269]

[268] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator*.
[269] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.

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Refrigeration – Refrigerators (Retrofit)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: This measure covers the replacement of an existing inefficient refrigerator with a new ENERGY STAR® rated refrigerator. ENERGY STAR® qualified refrigerators use at least 20% less energy than non-qualified models.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: Refrigeration
Program: Home Energy Services, Multi-Family Retrofit, Low-Income Multifamily Retrofit, Low-Income 1-4 Family Retrofit

Algorithms for Calculating Primary Energy Impact

For HES and Multi-Family Retrofit (not National Grid), Low-Income Multifamily Retrofit (not National Grid):

Unit savings are deemed based on the following algorithms and averaged inputs:

$$\Delta kWh = \Delta kWh_{RETIRE} + \Delta kWh_{EE}$$
$$\Delta kW = \Delta kW_{RETIRE} + \Delta kW_{EE}$$

Where:

Unit	=	Replacement of existing refrigerator with new ENERGY STAR® Refrigerator
ΔkWh_{RETIRE}	=	Annual energy savings over remaining life of existing equipment: 607 kWh[270]
ΔkWh_{EE}	=	Annual energy savings over full life of new ES refrigerator: 107 kWh[271]
ΔkW_{RETIRE}	=	Average demand reduction over remaining life of existing equipment: 0.075 kW[272]
ΔkW_{EE}	=	Average demand reduction over full life of new ES refrigerator: 0.013 kW[273]

For Low-Income 1-4 Family Retrofit:

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

[270] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts. 714 kWh minus 107 kWh = 607 kWh
[271] The PAs use the Lost Opportunity savings of 107 kWh as the annual savings over the life of the new ES refrigerator. See *Refrigerator(Lost Opportunity) section.*
[272] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[273] Ibid.

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Where:
Unit = Removal of existing refrigerator and installation of new efficient refrigerator
ΔkWh = Average annual kWh savings per unit: 762 kWh[274]
ΔkW = Max kW Reduction: 0.094 kW[275]

Baseline Efficiency

For HES, Multi-Family Retrofit and Low-Income Multifamily Retrofit:
The baseline efficiency case is an existing refrigerator for savings over the remaining life of existing equipment. The baseline efficiency case is a full-sized refrigerator (7.75 cubic feet) that meets the Federal minimum standard for energy efficiency for savings for the full life.[276]

For Low-Income 1-4 Family Retrofit:
The baseline efficiency case for both the replaced and baseline new refrigerator is an existing refrigerator. It is assumed that low-income customers would otherwise replace their refrigerators with a used inefficient unit.

High Efficiency

The high efficiency case is an ENERGY STAR® rated refrigerator that meets the ENERGY STAR® criteria for full-sized refrigerators (7.75 cubic feet), using at least 20% less energy than models meeting the minimum Federal government standard.

Hours

Savings are based on 8,760 operating hours per year.

Measure Life

For HES, Multi-Family Retrofit and Low-Income Multifamily Retrofit: The remaining life of the existing refrigerator is 1 year, and the measure life for the new refrigerator is 12 years. [277]

For Low-Income 1-4 Family Retrofit: The measure life is 19 years.[278]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

[274] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[275] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[276] Home: ENERGY STAR (2008). *ENERGY STAR Refrigerators & Freezers Key Product Criteria.* http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators. Accessed 10/11/10.
[277] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator.*
[278] Massachusetts Common Assumption.

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Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigerators	HES	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93
Refrigerators	MF Retrofit, LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	1.00	0.86
Refrigerator Replacement	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93

In-Service Rates
In-service rates are 100% as it is assumed all refrigerators are in-use.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
- HES, MF Retrofit, LI MF Retrofit: Realization rates are based on Massachusetts Common Assumptions.
- LI 1-4 Retrofit: Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[279]

[279] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.

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Refrigeration – Freezers (Lost Opportunity)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates provided for the purchase of ENERGY STAR® freezers. ENERGY STAR® qualified freezers use at least 10% less energy than new, non-qualified models and return even greater savings compared to old models.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: Refrigeration
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kWh_{BASE} - \Delta kWh_{ES}$$
$$\Delta kW = \Delta kWh / 8760 hours$$

Where:

Unit	=	Installed ENERGY STAR® freezer
ΔkWh	=	Annual savings over non-ES freezers averaged by model type: 54 kWh[280]
ΔkW	=	Average kW reduction over non-ES freezer: 0.01 kW[281]

Baseline Efficiency

The baseline efficiency case is a residential freezer that meets the Federal minimum standard for energy efficiency.

High Efficiency

The high efficiency case is based on an ENERGY STAR® rated freezer that uses 10% less energy than models not labeled with the ENERGY STAR® logo.

Hours

Not applicable.

Measure Life

The measure life is 11 years.[282]

[280] Environmental Protection Agency (2011). *Life Cycle Cost Estimate for ENERGY STAR Freezer*. Accessed 9/7/2011.
[281] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[282] Environmental Protection Agency (2011). *Life Cycle Cost Estimate for ENERGY STAR Freezer*. Accessed 9/7/2011.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Freezer Rebate	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[283]

[283] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.

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Refrigeration – Freezers (Retrofit)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: This measure covers the replacement of an existing inefficient freezer with a new energy efficient model.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Refrigeration
Program: Low-Income 1-4 Family Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Removal of existing freezer and installation of new efficient freezer
ΔkWh	=	Average annual kWh savings per unit: 239 kWh[284]
ΔkW	=	Max kW Reduction: 0.029 kW for LI 1-4 Retrofit and 0.033 for LI MF Retrofit[285]

Baseline Efficiency

The baseline efficiency case for both the replaced and baseline new freezer is represented by the existing freezer. It is assumed that low-income customers would replace their freezers with a used inefficient unit.

High Efficiency

The high efficiency case is a new high efficiency freezer.

Hours

Not applicable.

Measure Life

The measure life is 19 years[286]

[284] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[285] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[286] Massachusetts Common Assumption: It is assumed that low-income customers would replace with a used inefficient unit so the full savings are counted for the full lifetime.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Freezer Replacement	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93
Freezer Replacement	LI MF Retrofit	All (Not National Grid)	1.00	1.00	1.00	1.00	1.00	1.00	0.73

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[287]

[287] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Refrigeration – Refrigerator/Freezer Recycling

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The retirement of old, inefficient secondary refrigerators and freezers.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Retrofit
End Use: Refrigeration
Program: ENERGY STAR Appliances

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed and are obtained from the referenced study.

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh / 8760$$

Where:

Unit	=	Removed secondary refrigerator or freezer
ΔkWh	=	Average annual kWh savings per unit. See Table 6.
ΔkW	=	Average kW reduction per unit. See Table 6.

Table 6: Savings for Refrigerator/Freezer Recycling

Measure	Program	ΔkW[288]	ΔkWh[289]
Refrigerator Recycle Primary	Energy Star Products	0.07	533
Refrigerator Recycle Secondary Replaced	Energy Star Products	0.09	696
Refrigerator Recycle Secondary Not Replaced	Energy Start Products	0.10	835
Freezer Recycle	Energy Start Products	0.08	663
Refrigerator Recycle (combined)	Energy Star Products	0.09	755

Baseline Efficiency

The baseline efficiency case is an old, inefficient secondary working refrigerator or freezer. Estimated average usage is based on combined weight of freezer energy use and refrigerator energy use.

High Efficiency

The high efficiency case assumes no replacement of secondary unit.

Hours

Refrigerator and freezer operating hours are 8,760 hours/year.

[288] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[289] NMR Group, Inc. (2011). Massachusetts Appliance Turn-In Program Evaluation Integrated Report Findings – FINAL. Prepared for National Grid, NSTAR Electric, Cape Light Compact, and Western Massachusetts Electric Company.

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Measure Life

The measure life is 8 years.[290]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigerator Recycling	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93
Freezer Recycling	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model.[291]

[290] Ibid.
[291] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators

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Refrigeration – Appliance Removal

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Removal of second working refrigerator or freezer.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: Refrigeration
Program: Low-Income 1-4 Family Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Removal of secondary refrigerator or freezer with no replacement
ΔkWh	=	Average annual kWh savings per unit: 1,180 kWh[292]
ΔkW	=	Max kW reduction: 0.146 kW [293]

Baseline Efficiency

The baseline efficiency case is the old, inefficient secondary working refrigerator or freezer.

High Efficiency

The high efficiency case assumes no replacement of secondary unit.

Hours

Not applicable.

Measure Life

The measure life is 5 years.[294]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[292] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[293] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[294] Massachusetts Common Assumption.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Appliance Removal	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	0.93

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[295]

[295] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Residential New Construction – Heating, Cooling, and DHW Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: To capture lost opportunities, encourage the construction of energy-efficient homes, and drive the market to one in which new homes are moving towards net-zero energy.
Primary Energy Impact: Electric
Secondary Energy Impact: Natural Gas, Oil, Propane
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Lost Opportunity
End Use: HVAC, Hot Water
Program: Residential New Construction & Major Renovation, Low-Income Residential New Construction

Algorithms for Calculating Primary Energy Impact

As part of the ENERGY STAR® certification process, projected energy use is calculated for each home completed through the program and a geometrically matching baseline home (User Defined Reference Home) using Beacon, an ICF International proprietary DOE-2 based building energy simulation tool. The difference between the projected energy consumption of these two homes represents the energy savings produced by the certified home. This process is used to calculate electric demand as well as electric and fossil fuel energy savings due to heating, cooling, and water heating for all homes, both single family and multifamily. This process is documented in "Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR® Homes Program."[296]

Baseline Efficiency

The User Defined Reference Home was revised for 2012as a result of the baseline study completed in 2012.[297] [298]

High Efficiency

The high efficiency case is represented by the specific energy characteristics of each "as-built" home completed through the program.

Hours

Not applicable.

[296] ICF International (2008). *Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR ® Homes Program*. Prepared for Joint Management Committee.
[297] NMR Group, Inc., The Cadmus Group, Inc., & Dorothy Conant (2012). *Massachusetts 2011 Baseline Study of Single Family Residential New Construction, Final Report*. Prepared for the Massachusetts Joint Management Committee.
[298] NMR Group, Inc., KEMA, Inc., & Dorothy Conant (2012). *Final UDRH Inputs: Addendum to Massachusetts 2011 Baseline Study of Single-Family Residential New Construction, Final Report*. Prepared for the Massachusetts Joint Management Committee.

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Measure Life

Measure Type	Measure Life (years)[299]
Cooling	25
Heating	25
Water Heating	15

Secondary Energy Impacts

Gas, Oil and Propane savings for heating and water heating measures are custom calculating using the same methodology described for the electric energy and demand savings.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
ES Homes – Cooling	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
ES Homes – Heating	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
ES Homes – Water Heating	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	0.75	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are 100% because energy and demand savings are custom calculated based on project specific detail.

Coincidence Factors

Coincidence factors are custom calculated based on project-specific detail.

[299] Massachusetts Common Assumption.

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Home Energy Services (MassSAVE) – Vendor Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Retrofit measures installed through the Home Energy Services (MassSAVE) program including: building envelope insulation and air sealing and duct sealing and insulation
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil, Propane
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: Envelope
Program: Home Energy Services

Algorithms for Calculating Primary Energy Impact

The Program Administrators currently use vendor calculated energy savings for these measures in the Residential Home Energy Services electric program. These savings values are calculated using vendor proprietary software where the user inputs a minimum set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The proprietary building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms. Infiltration savings use site-specific seasonal N-factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 as their basis. Lighting, appliance, and water heating savings are based on standard algorithms, taking into account operating conditions and pre- and post-retrofit energy consumption. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to incorrectly "adding" individual measure results.

The PAs calculate demand (kW) savings by applying a kW/kWh factor to the vendor-estimated electric energy savings. The kW/kWh factors are provided in Table 10.

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Table 7: kW Factors for HES Vendor Measures

Measure	kW/kWh Factor[300]
Air Sealing (Electric)	0.00053
Air Sealing (Gas, Oil, Other FF)	0.00222
Duct Insulation (Electric)	0.00053
Duct Insulation (Gas, Oil, Other FF)	0.00222
Duct Sealing (Electric)	0.00053
Duct Sealing (Gas, Oil, Other FF)	0.00222
Insulation (Electric)	0.00053
Insulation (Gas, Oil, Other FF)	0.00222

Baseline Efficiency

The baseline efficiency case is the existing conditions of the participating household.

High Efficiency

The high efficiency case includes installed energy efficiency measures that reduce heating, cooling and water heating energy use.

Hours

Hours are project-specific.

Measure Life

Measure Name	Measure Life (years)
Air Sealing	15
Duct Insulation	20
Duct Sealing	20
Insulation	25

Secondary Energy Impacts

Gas, Oil and Propane savings are project-specific and estimated by the program vendors as described above.

[300] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators. For electric measures the heating loadshape was used for non-electric the central AC loadshape was used.

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Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Residential water savings for DHW ISMs only[301]	4,028 Gallons /Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Electric)	HES	CLC	1.00	1.00	0.51	1.51	1.51	0.0	1.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Electric)	HES	NGRID	1.00	1.00	0.60	0.60	0.60	0.0	1.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Electric)	HES	NSTAR	1.00	1.00	0.54	0.54	0.54	0.0	1.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Electric)	HES	Unitil	1.00	1.00	1.00	1.00	1.00	0.0	1.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Electric)	HES	WMECO	1.00	1.00	1.00	1.00	1.00	0.0	1.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Oil)	HES	CLC	1.00	1.00	1.00	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Oil)	HES	NGRID	1.00	1.00	0.88	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Oil)	HES	NSTAR	1.00	1.00	0.85	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Oil)	HES	Unitil	1.00	1.00	0.36	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Oil)	HES	WMECO	1.00	1.00	0.55	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Propane)	HES	CLC	1.00	1.00	0.86	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Propane)	HES	NGRID	1.00	1.00	0.88	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Propane)	HES	NSTAR	1.00	1.00	0.95	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Propane)	HES	Unitil	1.00	1.00	0.20	1.00	1.00	1.0	0.00
Air Sealing, Insulation, Duct Insulation & Duct Sealing (Propane)	HES	WMECO	1.00	1.00	0.44	1.00	1.00	1.0	0.00

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

[301] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators

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Realization Rates
Realization rates are based on evaluation results[302].

Coincidence Factor
Summer and winter coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[303]

[302] The Cadmus Group (2013). *HES Realization Rate Results Memo*. June 2013
[303] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Multifamily – Vendor Measures

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Retrofit measures installed through the PAs Multi-Family programs including: building envelope insulation and air sealing, duct sealing and insulation, programmable thermostats, heating system replacement, windows and DHW measures.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil, Propane
Non-Energy Impact: Residential Water, Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: HVAC, Envelope, Hot Water
Program: Multi-Family Retrofit

This section applies to Cape Light Compact, NSTAR, Unitil, and Western Massachusetts Electric Company multi-family programs. The algorithms and assumptions for similar measures in National Grid's residential and low-income multi-family programs are described in the other Multifamily measure sections.

Algorithms for Calculating Primary Energy Impact

The Program Administrators currently use vendor calculated savings for these measures in the Residential Multifamily Retrofit programs for standard income residential customers. These savings values are calculated using vendor proprietary software where the user inputs a minimum set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The proprietary building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added, and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms. Infiltration savings use site-specific seasonal N-factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 as their basis. Lighting, appliance, and water heating savings are based on standard algorithms, taking into account operating conditions and pre- and post-retrofit energy consumption. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to incorrectly "adding" individual measure results.

Baseline Efficiency

The baseline efficiency case is the existing conditions of the participating facility.

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High Efficiency

The high efficiency case includes installed energy efficiency measures that reduce heating, cooling and water heating energy use.

Hours

Hours are project-specific.

Measure Life

Measure Name	Measure Life (years)
Air Sealing	15
DHW Measures	7
Insulation	25
Thermostats	10
Duct Sealing	20
Duct Insulation	20

Secondary Energy Impacts

Gas, Oil and Propane savings are project-specific.

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Residential water savings for DHW measures[304]	4,028 Gallons /Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing (Electric)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Air Sealing (FF)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Duct Sealing (Electric)	MF Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	0.72	0.28
DHW Measures (Electric)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.59	1.00
DHW Measures (FF)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Insulation (Electric)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.01	1.00
Insulation (FF)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Thermostats (Electric)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Thermostats (FF)	MF Retrofit	All (not NGrid)	1.00	1.00	1.00	1.00	1.00	0.00	0.00

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

[304] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators

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Realization Rates

Realization rates are set to 100% since this program has not been evaluated and similar evaluation support this assumption.[305]

Coincidence Factor

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[306]

[305] Massachusetts Common Assumption: Assumed 100% realization rate is supported by the results of multiple impact evaluations of National Grid's EnergyWise program.
[306] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Insulation (Walls, Roof, Floor) (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Insulation upgrades are applied in existing facilities.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: Envelope
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = SQFT \times kWh / SQFT \times \left(\frac{1}{R-VALUE_{BASE}} - \frac{1}{R-VALUE_{EE}} \right)$$

$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

SQFT	=	Square feet of insulation installed
$R\text{-}VALUE_{BASE}$	=	R-Value of the existing insulation
$R\text{-}VALUE_{EE}$	=	R-Value of the new installed insulation
kWh/SQFT	=	Average annual kWh reduction per SQFT of insulation. See Table below.
kW/kWh	=	Average annual kW reduction per kWh reduction: 0.000263 kW/kWh[307]

Insulation Type	kWh/Sqft[308]
Basement	10.62
Attic	38.803
WALL (N, S)	11.477
WALL (W, E)	10.025

Baseline Efficiency

The baseline efficiency case is the R-value of the existing insulation.

High Efficiency

The high efficiency case is insulation installed with a higher R-Value.

[307] Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[307]
[308] National Grid Multifamily Screening Tool. This was developed in the early 1990's. Documentation of the specific variables is unavailable. Evaluation results have consistently shown realization rates close to 100%.

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Hours

Not applicable.

Measure Life

The measure life is 25 years.[309]

Secondary Energy Impacts

There are no secondary energy impacts for this measure

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation (Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.00	1.00
Insulation (Non-Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.00	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation.[310]

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[311]

[309] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[310] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[311] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – DHW Measures (Showerheads and Aerators) (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: An existing showerhead or aerator with a high flow rate is replaced with a new low flow showerhead or aerator.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Residential Water, Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: Hot Water
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Unit	=	Showerhead or aerator installation.
ΔkWh	=	Average annual kWh reduction per unit: 80.3 kWh[312]
kW/kWh	=	Average kW reduction per kWh reduction: 0.000161 kW/kWh[313]

Baseline Efficiency

The baseline efficiency case is an existing shower head or faucet aerator with a high flow.

High Efficiency

High efficiency is a low flow showerhead or faucet aerator.

Hours

Not applicable.

[312] National Grid Multifamily Screening Tool. This was developed in the early 1990's. Documentation of the specific variables is unavailable. Evaluation results have consistently shown realization rates close to 100%.
[313] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Measure Life

The measure life is 7 years.[314] The measure persistence was estimated to be 93% for showerheads and 96% aerators[315] so the effective measure life is still 7 years.

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Benefits

Benefit Type	Description	Savings
Residential Water	Gallons water saved per year per unit that received DHW measures[316]	4,028 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Showerhead/Aerator (Electric)	MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.59	1.00
Showerhead/Aerator (Non-Electric)	MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.59	1.00
Showerhead/Aerator (Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.59	1.00
Showerhead/Aerator (Non-Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.59	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation[317].

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[318]

[314] Massachusetts Common Assumption.
[315] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[316] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators
[317] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[318] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – DHW Measures (Tank and Pipe Wrap) (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: A wrap is added to the water heater tank or pipes.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: Hot Water
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

Unit	=	Each installation for tank wraps, per linear foot for pipe wrap.
kWh	=	Average annual kWh reduction per unit: 55 kWh[319]
kW/kWh	=	Average annual kW reduction per kWh reduction: 0.000161 kW/kWh[320]

Baseline Efficiency

The baseline efficiency case is no wrap on the tank or pipes.

High Efficiency

High efficiency is the addition of a wrap.

Hours

Not applicable.

Measure Life

The measure life is 7 years.[321]

[319] National Grid Multifamily Screening Tool. This was developed in the early 1990's. Documentation of the specific variables is unavailable. Evaluation results have consistently shown realization rates close to 100%.
[320] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Tank/Pipe Wrap (Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.59	1.00
Tank/Pipe Wrap (Non-Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.59	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation.[322]

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[323]

[321] Massachusetts Common Assumption.
[322] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[323] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Programmable Thermostats (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of programmable thermostats
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

Unit	=	Installation of programmable thermostat.
ΔkWh	=	Average annual kWh reduction per unit: 288 kWh[324]
kW/kWh	=	Average annual kW reduction per kWh reduction: 0.000263 kW/kWh[325]

Baseline Efficiency

The baseline efficiency case is a system without a setback programmable thermostat.

High Efficiency

The high efficiency case is a system with a setback programmable and fixed set point (common areas) thermostats.

Hours

Not applicable.

[324] National Grid Multifamily Screening Tool. This was developed in the early 1990's. Documentation of the specific variables is unavailable. Evaluation results have consistently shown realization rates close to 100%.
[325] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Measure Life

The measure life is 15 years.[326] The measure persistence was estimated to be 69%[327] so the effective measure life is 10 years (15 years * 69%).

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Thermostat (Electric)	MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.00	1.00
Thermostat (Non-Electric)	MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.00	1.00
Thermostat (Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.00	1.00
Thermostat (Non-Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.00	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation[328].

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[329]

[326] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat*.
[327] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[328] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[329] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Heat Pump Tune-Up (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Heat pump tune-up for electrically-heated homes only.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

Unit	=	Heat pump tune-up performed
ΔkWh	=	Average annual kWh reduction per unit: 1162 kWh[330]
kW/kWh	=	Average kW reduction per kWh reduction: 0.000234 kW/kWh[331]

Baseline Efficiency

The baseline efficiency case is an existing heat pump that is not tuned up.

High Efficiency

The high efficiency case is an existing heat pump that is tuned up.

Hours

Not applicable.

Measure Life

The measure life is 5 years.[332]

[330] National Grid Multifamily Screening Tool. This was developed in the early 1990's. Documentation of the specific variables is unavailable. Evaluation results have consistently shown realization rates close to 100%.
[331] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[332] Massachusetts Common Assumption.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heat Pump Tune-up (Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.01	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation.[333]

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[334]

[333] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[334] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Air Sealing (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Thermal shell air leaks are sealed through strategic use and location of air-tight materials in electrically-heated facilities.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: Envelope
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are calculated using the following algorithms and assumptions:

$$\Delta kWh = Stories \times SQFT \times \left(CFM / SQFT_{PRE} - CFM / SQFT_{POST}\right) \times \Delta kWh / CFM$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

Stories	=	Total stories in the multi-family building
SQFT	=	Total SQFT of building
$CFM/SQFT_{PRE}$	=	Estimate of pre-retrofit air leakage in CFM/SQFT based on number of stories in the building and air-tightness ratings of the existing roof and floor.
$CFM/SQFT_{POST}$	=	Estimate of post-retrofit air leakage in CFM/SQFT based on number of stories in the building and air-tightness ratings of the improved roof and floor.
ΔkWh/CFM	=	Average annual kWh reduction per CFM: 2.48633 kWh/CFM[335]
kW/kWh	=	Average kW reduction per kWh reduction: 0.000263 kW/kWh[336]

Baseline Efficiency

The baseline efficiency case is a facility that has not received comprehensive air-sealing treatment.

High Efficiency

The high efficiency case is a facility with thermal shell air leaks that are sealed, leading to a reduction in air leakage.

[335] National Grid Multifamily Screening Tool. This was developed in the early 1990's. Documentation of the specific variables is unavailable. Evaluation results have consistently shown realization rates close to 100%.
[336] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Hours

Not applicable.

Measure Life

The measure life is 15 years.[337]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing (Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.00	1.00
Air Sealing (Non-Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.00	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates are from the National Grid Energy Wise 2008 Program Evaluation.[338]

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[339]

[337] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[338] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[339] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Refrigerators and Freezers (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Removal of old inefficient refrigerator or freezer with the installation of new efficient refrigerator or freezer.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: Refrigeration
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are calculated using the following algorithms and assumptions:

$$\Delta kWh = kWh_{PRE} - kWh_{POST}$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

Unit	=	Replacement of existing refrigerator with new ENERGY STAR® refrigerator
kWh_{PRE}	=	Annual kWh consumption of existing equipment. Value entered by the user.
kWh_{POST}	=	Annual kWh consumption of new installed equipment. Value entered by the user.
kW/kWh	=	Average kW reduction per kWh reduction: 0.00127 kW/kWh[340]

Baseline Efficiency

The baseline efficiency case is an existing refrigerator for which the annual kWh may be looked up in a refrigerator database. If the manufacturer and model number are not found, the refrigerator is metered for 1.5 hours in order to determine the annual kWh.

High Efficiency

The high efficiency case is a new more efficiency refrigerator. The manufacture and model number is looked up in a refrigerator database to determine annual kWh.

Measure Life

The measure life is 12 years for non low income[341] and 19 years for low income.[342]

[340] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Hours

Not applicable.

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrig/Freezers (Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	1.00	0.86
Refrig/Freezers (Non-Electric)	MF Retrofit, LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	1.00	0.86

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation.[343]

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[344]

[341] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator*.
[342] Massachusetts Common Assumption.
[343] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[344] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Fixtures and CFLs (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Removal of existing inefficient fixtures/bulbs with the installation of new efficient fixtures/bulbs
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Retrofit
End Use: Lighting
Program: Multi-Family Retrofit, Low-Income Multifamily Retrofit

Notes

The savings algorithms and assumptions described in this section are specific to National Grid's Multi-Family Retrofit and Low-Income Multifamily Retrofit programs. See the section *Multifamily – Vendor Measures* for information about other PAs' Multi-Family programs.

Algorithms for Calculating Primary Energy Impact

Unit savings are calculated using the following algorithms and assumptions:

$$\Delta kWh = \left[\left(QTY_{PRE} \times Watts_{PRE} \times Hours_{PRE}\right) - \left(QTY_{EE} \times Watts_{EE} \times Hours_{EE}\right)\right] / 1000 \times 52$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

Where:

QTY_{PRE}	=	Quantity of pre-retrofit fixtures/bulbs
QTY_{EE}	=	Quantity of efficient fixtures/bulbs installed
$Watts_{PRE}$	=	Rated watts of pre-retrofit fixtures/bulbs
$Watts_{EE}$	=	Rated watts of efficient fixtures/bulbs installed
$Hours_{PRE}$	=	Weekly hours of operation for pre-retrofit case lighting fixtures/bulbs
$Hours_{EE}$	=	Weekly hours of operation for efficient lighting fixtures/bulbs
52	=	Weeks per year
kW/kWh	=	Average kW reduction per kWh reduction: 0.000302 kW/kWh[345]

Baseline Efficiency

The baseline efficiency case is the existing fixture and bulbs.

High Efficiency

The high efficiency case is the new fixture and lamps.

Measure Life

The measure life is 7 years for CFLs and 7 years for fixtures.[346]

[345] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Hours

Operating hours are estimated by the vendor for each facility. Typical assumptions are 24 hours/day for common area lighting, 12 hours/day for exterior lighting, and 3 hours/day for in-unit lighting, but may be adjusted based on type of housing. Estimates are verified with facility maintenance staff when possible.

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CFLs (Electric)	MF Retrofit	National Grid	0.97	1.00	0.91	0.91	0.91	0.19	1.00
CFLs (Non-Electric)	MF Retrofit	National Grid	0.97	1.00	0.99	0.99	0.99	0.19	1.00
Fixtures (Electric)	MF Retrofit	National Grid	0.97	1.00	0.91	0.91	0.91	0.19	1.00
Fixtures (Non-Electric)	MF Retrofit	National Grid	0.97	1.00	0.99	0.99	0.99	0.19	1.00
CFLs (Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.19	1.00
CFLs (Non-Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.19	1.00
Fixtures (Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.91	0.91	0.91	0.19	1.00
Fixtures (Non-Electric)	LI MF Retrofit	National Grid	1.00	1.00	0.99	0.99	0.99	0.19	1.00

In-Service Rates

In Service rate for MF Retrofit is from an evaluation study[347].

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation.[348]

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[349]

[346] The adjusted measure life accounts for changes in the baseline due to EISA standards as shown in the MA Lighting Worksheet

[347] The Cadmus Group, Inc. (2012). *Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis.* Prepared for the Massachusetts Electric and Gas Administrators.

[348] The Cadmus Group, Inc. (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.

[349] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Custom Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of complex custom energy efficiency measures including solar hot water installations and fuel switching projects.
Primary Energy Impact: Electric
Secondary Energy Impact: Project-specific
Non-Energy Impact: Project-specific
Sector: Residential, Low Income
Market: Lost Opportunity, Retrofit
End Use: All
Program: All

Algorithms for Calculating Primary Energy Impact

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis with project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, end-use metering or other engineering analysis and include estimates of savings, costs, and an evaluation of the projects' cost-effectiveness.

Baseline Efficiency

The baseline efficiency case for Lost Opportunity projects assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code or industry accepted standard practice. The baseline efficiency case for retrofit projects is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency

The high efficiency case is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective in order to qualify for energy efficiency incentives.

Hours

All hours for custom savings analyses should be determined on a case-by-case basis.

Measure Life

For both lost-opportunity and retrofit custom applications, the measure life is determined based on specific project using the common measure life recommendations.

Secondary Energy Impacts

All secondary energy impacts should be determined on a case-by-case basis.

Non-Energy Impacts

All non-energy impacts should be determined on a case-by-case basis.

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Solar DHW	HES	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Solar DHW	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Fuel Switching	HES	All	1.00	1.00	1.00	1.00	1.00	custom	custom

In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
Realization rates are set to zero since project savings estimates are based on project-specific detail.

Coincidence Factors
Coincidence factors for summer and winter peak periods are custom-calculated based on project-specific detail.

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Commercial and Industrial Electric Efficiency Measures

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Lighting – Advanced Lighting Design (Performance Lighting)

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Advanced lighting design refers to the implementation of various lighting design principles aimed at creating a quality and appropriate lighting experience while reducing unnecessary light usage. This is often done by a professional in a new construction situation. Advanced lighting design uses techniques like maximizing task lighting and efficient fixtures to create a system of optimal energy efficiency and functionality.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil
Non-Energy Impact: O&M
Sector: Commercial and Industrial
Market: Lost Opportunity
End Use: Lighting
Program: ***C&I*** New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = \sum_{i=1}^{n}\left(\frac{LPD_{BASE,i} \times Area_i \times Hours_i}{1000}\right) - \sum_{j=1}^{m}\left(\frac{Count_{EE,j} \times Watts_{EE,j} \times Hours_j}{1000}\right)$$

$$\Delta kW = \sum_{i=1}^{n}\left(\frac{LPD_{BASE,i} \times Area_i}{1000}\right) - \sum_{j=1}^{m}\left(\frac{Count_{EE,j} \times Watts_{EE,j}}{1000}\right)$$

Where:

n	=	Total number of spaces in Space-by-Space Method or 1 for Building Area Method
m		Total number of efficient fixture types installed
$LPD_{BASE,i}$	=	Baseline lighting power density for building or space type i (Watts/ft^2)
$Area_i$	=	Area of building or space *i* (ft^2)
$Hours_i$	=	Annual hours of operation of the lighting equipment for building or space type *i*
$Count_{EE,j}$	=	Quantity of efficient fixture type j
$Watts_{EE,j}$	=	Wattage of fixture type j (Watts)
1000	=	Conversion factor: 1000 watts per 1 kW

Note on HVAC system interaction: Additional Electric savings from cooling system interaction are included in the calculation of adjusted gross savings for Lighting Systems projects. The HVAC interaction adjustment factor is determined from lighting project evaluations and is included in the energy realization rates and demand coincidence factors and realization rates.

Baseline Efficiency

The Baseline Efficiency assumes compliance with lighting power density requirements as mandated by Massachusetts State Building Code. As described in Chapter 13 of the aforementioned document, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009. IECC offers one compliance path, the Building Area Method. ASHRAE 90.1-2007 offers two compliance paths. For completeness, the lighting power density requirements for both the Building Area Method and

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the Space-by-Space Method are presented.[350] Table 34 and Table 35 in Appendix A: Common Lookup Tables detail the specific power requirements by compliance path.

High Efficiency

The high efficiency scenario assumes lighting systems that achieve lighting power densities below those required by Massachusetts State Building Code. Actual site lighting power densities should be determined on a case-by-case basis. Please refer to the current year application form for minimum percentage better than code efficiency requirements.

Hours

The annual hours of operation for lighting systems are site-specific and should be determined on a case-by-case basis. If site-specific hours are unavailable, refer to the default hours in Table 39 in Appendix A: Common Lookup Tables

Measure Life

The measure life for all new construction lighting installations is 15 years.[351]

Secondary Energy Impacts

Heating energy will be increased due to reduced lighting waste heat. This impact is estimated as an average impact in heating fossil fuel consumption per unit of energy saved.

Measure	Energy Type	Impact (MMBtu/ΔkWh)[352]
Interior Lighting	C&I Gas Heat	-0.000175

Non-Energy Impacts

Annual non-energy benefits are claimed due to the reduced operation and maintenance costs associated with the longer measure lived of lamps and ballasts as compared to the base or pre-retrofit case. See Appendix D: Non-Resource Impacts.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
All	NC	National Grid	1.00	1.00	0.98	1.16	0.85	custom	custom	n/a	n/a
All	NC	All Other PAs	1.00	1.00	1.25	1.01	1.01	0.52	0.44	0.48	0.44

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid: energy and demand RRs derived from impact evaluation of the PAs 2010 Custom Lighting programs. [353]

[350] IECC 2009 presents requirements consistent with ASHRAE 90.1-2007 for the Building Area Method but does not present requirements for the Space-by-Space Method.
[351] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[352] Optimal Energy, Inc. (2008). *MEMO: Non-Electric Benefits Analysis Update*. Prepared for NSTAR. Final savings values calculated in spreadsheet analysis as noted on pg 5 of the memo.
[353] KEMA, Inc.(2012). *Impact Evaluation of 2010 Custom Lighting Installations*. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council

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- All Other PAs: Energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs[354]. Demand RR is the connected demand RR; energy RR includes connected kWh RR, hours of use RR and HVAC Interactive adjustment.

Coincidence Factors

- National Grid, WMECO: CFs are custom calculated based on site-specific information.
- All Other PAs: All CFs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting program.[355]

[354] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council
[355] Ibid

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Lighting – Lighting Systems

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure promotes the installation of efficient lighting including, but not limited to, efficient fluorescent lamps, ballasts, and fixtures, solid state lighting, and efficient high intensity discharge (HID) lamps, ballasts, and fixtures.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil
Non-Energy Impact: O&M
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: Lighting
Program: C&I New Construction & Major Renovation, C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = \left[\sum_{i=1}^{n} \left(\frac{Count_i * Watts_i}{1000} \right)_{BASE} - \sum_{j=1}^{m} \left(\frac{Count_j * Watts_j}{1000} \right)_{EE} \right] (Hours)$$

$$\Delta kW = \sum_{i=1}^{n} \left(\frac{Count_i * Watts_i}{1000} \right)_{BASE} - \sum_{j=1}^{m} \left(\frac{Count_j * Watts_j}{1000} \right)_{EE}$$

Where:

n	=	Total number of fixture types in baseline or pre-retrofit case
m	=	Total number of installed fixture types
$Count_i$	=	Quantity of existing fixtures of type i (for lost-opportunity, $Count_i = Count_j$).
$Watts_i$	=	Existing fixture or baseline wattage for fixture type i
$Count_j$	=	Quantity of efficient fixtures of type j.
$Watts_j$	=	Efficient fixture wattage for fixture type j.
1000	=	Conversion factor: 1000 watts per kW.
Hours	=	Lighting annual hours of operation.

Note on HVAC system interaction: Additional Electric savings from cooling system interaction are included in the calculation of adjusted gross savings for Lighting Systems projects. The HVAC interaction adjustment factor is determined from lighting project evaluations and is included in the energy realization rates and demand coincidence factors and realization rates (See Impact Factors section).

Baseline Efficiency

For retrofit installations, the baseline efficiency case is project-specific and is determined using actual fixture counts from the existing space. Existing fixture wattages are provided in the MassSAVE Retrofit

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Lighting Wattage Tables[356]. For lost opportunity installations, the baseline efficiency case is determined using assumed baseline wattages for each of the installed fixtures[357].

High Efficiency

For both new construction and retrofit installations, the high efficiency case is project-specific and is determined using actual fixture counts for the project and the MassSave Wattage Tables[358] in Appendix A: Common Lookup Tables

Hours

The annual hours of operation for lighting systems are site-specific and should be determined on a case-by-case basis. If site-specific hours of operation are unavailable, refer to the default hours presented in Table 39 in Appendix A: Common Lookup Tables

Measure Life

Lighting system measure lives vary by market sector and equipment type.

Measure Lives for C&I Lighting Systems[359]

Equipment Type	Measure Life (years)	
	Retrofit	Lost Opportunity
Bulb – CFL screw base	5	N/A
Fluorescent Fixture	13	15
Hardwired CFL	13	15
LED Exit Signs	13	15
HID (interior and exterior)	13	15
LED Lighting Fixtures	13	15
LED Integral Replacement Lamps	13	15
LED Low Bay – Garage & Canopy Fixtures	13	15
Upstream Lighting – LED[360]	N/A	10
Upstream Lighting – T8/T5[361]	N/A	10

[356] MassSave (2010). *C&I Retrofit Lighting Wattage Tables.*
[357] Massachusetts Common Assumption: Baseline wattage per fixture type based on comparable code-compliant installations and standard practice.
[358] MassSave (2010). *C&I New Construction Lighting Wattage Tables* AND MassSave (2010). *C&I Retrofit Lighting Wattage Tables.*
[359] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1 AND GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Table 2
[360] Estimate based on average life of eligible products at retail operating hours.
[361] MA Common Assumption.

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Secondary Energy Impacts

Heating energy will be increased due to reduced lighting waste heat. This impact is estimated as an average impact in heating fossil fuel consumption per unit of energy saved.

Measure	Energy Type	Impact (MMBtu/ΔkWh)[362]
Interior Lighting	C&I Gas Heat	-0.00023
Interior Lighting	Oil	-0.00046
Small Retrofit	Gas Heat	-0.001075
Small Retrofit	Oil Heat	-0.000120

Non-Energy Impacts

Annual non-energy benefits are claimed due to the reduced operation and maintenance costs associated with the longer measure lived of lamps and ballasts as compared to the base or pre-retrofit case. See Appendix D: Non-Resource Impacts.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Large C&I New Construction and Large C&I Retrofit											
All	ALL	All PAs	1.00	1.00	1.12	0.997	0.997	0.83	0.66	0.84	0.67
Small C&I Retrofit											
All	Retrofit	CLC	1.00	1.00	1.02	0.99	0.99	0.73	0.44	n/a	n/a
All	Retrofit	National Grid	1.00	1.00	1.02	0.99	0.99	0.73	0.44	n/a	n/a
All	Retrofit	NSTAR	1.00	1.00	1.02	0.99	0.99	0.73	0.44	n/a	n/a
All	Retrofit	Unitil	1.00	1.00	1.02	0.99	0.99	0.73	0.44	n/a	n/a
All	Retrofit	WMECO	1.00	1.00	1.02	0.99	0.99	n/a	n/a	0.67	0.42

Note: Realization Rates and Coincidence Factors have the HVAC Interactive Effect incorporated, see note in Algorithm section.

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

New Construction & Major Renovation Commercial

All PAs energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[363]. Demand RR is the connected demand RR; energy RR includes connected kWh RR, hours of use RR and HVAC Interactive adjustment.

[362] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations (Percent split between gas and oil based on spreadsheet associated with Optimal 2008 MEMO: Non Electric Benefits Analysis Update).* AND *Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study*, The Cadmus Group, June 12, 2012.

[363] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council

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C&I Large Retrofit
All PAs energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[364]. Demand RR is the connected demand RR; energy RR includes connected kWh RR, hours of use RR and HVAC Interactive adjustment.

C&I Small Retrofit
- Energy RRs which include HVAC interactive effects are the statewide results from the 2011 Small C&I Non-Controlled Lighting impact evaluation.[365]
- All PAs: demand RRs are from the statewide results from the 2011 Small C&I Non-Controlled Lighting impact evaluation[366]

Coincidence Factors

New Construction & Major Renovation Commercial
All CFs are from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[367]

C&I Large Retrofit
All CFs are from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[368]

C&I Small Retrofit
All CF_{SP} and CF_{WP} values which include HVAC interactive effects are the statewide results from the 2011 Small C&I Non-Controlled Lighting impact evaluation[369].

[364] Ibid.
[365] Cadmus Group (2012). *Non-Controls Lighting Evaluation for the Massachusetts Small Commercial Direct Install Program: Multi-Season Study*. Prepared for Massachusetts Utilities.
[366] Ibid.
[367] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council
[368] Ibid.
[369] Cadmus Group (2011). *Non-Controls Lighting Evaluation for the Massachusetts Small Commercial Direct Install Program*. Prepared for Massachusetts Utilities.

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Lighting – Lighting Controls

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure promotes the installation of lighting controls in both lost-opportunity and retrofit applications. Promoted technologies include occupancy sensors and daylight dimming controls.
Primary Energy Impact: Electric
Secondary Energy Impact: Heating energy (non-electric)
Non-Energy Impacts: O&M
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: Lighting
Program: C&I New Construction & Major Renovation, C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kW = (Controlled\,kW)(Hours_{BASE} - Hours_{EE})$$

$$\Delta kW = (Controlled\ kW)$$

Where:

Controlled kW	=	Controlled fixture wattage
$Hours_{BASE}$	=	Total annual hours that the connected Watts operated in the pre-retrofit case (retrofit installations) or would have operated with code-compliance controls (new construction installations).
$Hours_{EE}$	=	Total annual hours that the connect Watts operate with the lighting controls implemented.

Note on HVAC system interaction: Additional Electric savings from cooling system interaction are included in the calculation of adjusted gross savings for Lighting Systems projects. The HVAC interaction adjustment factor is determined from lighting project evaluations and is included in the energy realization rates and demand coincidence factors and realization rates (See Impact Factors section).

Baseline Efficiency

The baseline efficiency case assumes no controls (retrofit) or code-compliant controls (new construction).

High Efficiency

The high efficiency case involves lighting fixtures connected to controls that reduce the pre-retrofit or baseline hours of operation.

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Hours

The annual hours of reduction for lighting controls are site-specific and should be determined on a case-by-case basis. If site-specific hours are unavailable, refer to the default hours in Table 39 in Appendix A: Common Lookup Tables

Measure Life

Lighting system measure lives vary by market sector and equipment type.

Measure Lives for C&I Lighting Controls[370]

Measure	Measure Life (years)	
	Retrofit	Lost Opportunity
Occupancy Sensors	9	10
Daylight Dimming	9	10

Secondary Energy Impacts

Heating energy will be increased due to reduced lighting waste heat. This impact is estimated as an average impact in heating fossil fuel consumption per unit of energy saved.

Measure	Energy Type	Impact (MMBtu/ΔkWh)[371]
Interior Lighting	C&I Gas Heat	-0.00092 MMBtu/kWh
Interior Lighting	Oil	-0.00180 MMBtu/kWh
Small Retrofit	C&I Gas Heat	-0.000743 MMBtu/kWh
Small Retrofit	Oil	-0.000132 MMBtu/kWh

Non-Energy Impacts

Annual non-energy benefits are claimed due to the reduced operation and maintenance costs associated with the longer measure lived of lamps and ballasts as compared to the base or pre-retrofit case. See Appendix D: Non-Resource Impacts.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Large C&I New Construction and Large C&I Retrofit											
ALL	All	ALL	1.00	1.00	0.72	0.94	0.94	0.15	0.13	0.14	0.14
Small C&I Retrofit											
Occupancy Sensors	All	National Grid	1.00	1.00	0.42	0.92	0.92	0.18	0.12	n/a	n/a
All	All	NSTAR, CLC	1.00	1.00	0.42	0.92	0.92	0.18	0.12	n/a	n/a
All	All	Unitil	1.00	1.00	0.42	0.92	0.92	0.18	0.12	n/a	n/a
All	All	WMECO	1.00	1.00	0.42	0.92	0.92	n/a	n/a	custom	custom

Note: Realization Rates and Coincidence Factors have the HVAC Interactive Effect incorporated, see note in Algorithm section.

[370] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[371] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council *(Percent split between gas and oil based on spreadsheet associated with Optimal 2008 MEMO: Non Electric Benefits Analysis Update)* AND The Cadmus Group (2012). *Final Report, Small Business Direct Install Program: Pre/Post Occupancy Sensor Study*

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In-Service Rates
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
- All PAs Large C&I energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[372]. Demand RR is the connected demand RR; energy RR includes connected kWh RR, hours of use RR and HVAC Interactive adjustment.
- All PAs: small retrofit realization rates which include HVAC interactive effects are from statewide pre/post occupancy sensor study[373]

Coincidence Factors
- All PAs Large C&I CFs are from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[374]
- NSTAR, National Grid, Unitil, CLC: small retrofit coincidence factors which include HVAC interactive effects are from statewide pre/post occupancy sensor study already referenced below.

[372] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council
[373] The Cadmus Group, Inc (2012). *Final Report, Small Business Direct Install Program: Pre/Post Occupancy Sensor Study*
[374] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council

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Lighting – Freezer/Cooler LEDs

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of LED lighting in freezer and/or cooler cases. The LED lighting consumes less energy, and results in less waste heat which reduces the cooling/freezing load.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Lighting
Program: C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = \Delta kWh_{LED} + \Delta kWh_{Heat}$$

$$\Delta kWh_{LED} = \sum_{i=1}^{n}\left(Count_i * kW_i * Hours_i\right)_{BASE} - \sum_{i=1}^{m}\left(Count_j * kW_j * Hours_j\right)_{LED}$$

$$\Delta kWh_{Heat} = \Delta kWh_{LED} * 0.28 * Eff_{RS}$$

$$\Delta kW = \Delta kWh / Hours_j$$

Where:

ΔkWh_{LED}	=	Reduction in lighting energy
ΔkWh_{Heat}	=	Reduction in refrigeration energy due to reduced heat loss from the lighting fixtures
N	=	Total number of lighting fixture types in the pre-retrofit case
M	=	Total number of lighting fixture types in the post-retrofit case
$Count_i$	=	Quantity of type i fixtures in the pre-retrofit case
kW_i	=	Power demand of pre-retrofit lighting fixture type i (kW/fixture)
$Hours_i$	=	Pre-retrofit annual operating hours of fixture type i
$Count_j$	=	Quantity of type j fixtures in the pre-retrofit case
kW_j	=	Power demand of lighting fixture type j (kW/fixture)
$Hours_j$	=	Post-retrofit annual operating hours of fixture type j
0.28	=	Unit conversion between kW and tons calculated as 3,413 Btuh/kW divided by 12,000 Btuh/ton
Eff_{RS}	=	Efficiency of typical refrigeration system: 1.6 kW/ton[375] for Small Retrofit; 1.9 kW/ton for Large C&I[376]

Baseline Efficiency

The baseline efficiency case is the existing lighting fixtures in the cooler or freezer cases.

[375] Select Energy (2004). *Cooler Control Measure Impact Spreadsheet Users' Manual.* Prepared for NSTAR.
[376] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council

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High Efficiency

The high efficiency case is the installation of LED lighting fixtures on the cooler or freezer cases, replacing the existing lighting fixtures.

Hours

Annual hours of operation are determined on a case-by-case basis and are typically 8760 hours/year. Post-retrofit operating hours are assumed to be the same as pre-retrofit hours unless lighting occupancy sensors were also implemented.

Measure Life

The measure life is 13 years.[377]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Freezer/Cooler LEDs	Large Retrofit	All PAs	1.00	1.00	0.94	1.01	1.01	0.99	1.00	1.00	1.00
Freezer/Cooler LEDs	Small Retrofit	National Grid	1.00	1.00	1.04	1.07	1.15	1.00	1.00	n/a	n/a
Freezer/Cooler LEDs	Small Retrofit	NSTAR,Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.37	n/a	n/a
Freezer/Cooler LEDs	Small Retrofit	WMECO	1.00	1.00	0.86	1.00	1.00	n/a	n/a	0.10	0.10
Freezer/Cooler LEDs	Small Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

[377] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities.

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Realization Rates

- All PAs Large C&I energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[378]
- National Grid: RRs for small retrofit installations based on impact evaluation of 2005 small retrofit custom measures[379].
- NSTAR, CLC, Unitil: Small Retrofit energy and demand RRs are 100% based on no evaluations
- WMECO Small Retrofit RRs are from impact evaluation of 2008 program[380].

Coincidence Factors

- All PAs Large C&I energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[381]
- National Grid, CLC: Small Retrofit CFs set to 100% because pre-retrofit unit operate 8760 hours/year.
- NSTAR, Unitil: Small Retrofit CFs from 2007 State Program Working Group study[382]
- WMECO: Small Retrofit CFs based on engineering estimates.

[378] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council
[379] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation.* Prepared for National Grid.
[380] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008.* Prepared for Western Massachusetts Electric Company.
[381] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council
[382] RLW Analytics (2007). *Coincidence Factor Study: Residential and Commercial Industrial Lighting Measures*. Prepared for the New England State Program Working Group (SPWG); Table i-29 & Table i-30 (On-Peak) and Table i-31 & Table i-32 (Seasonal Peak).

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HVAC – Single–Package and Split System Unitary Air Conditioners

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure promotes the installation of high efficiency unitary air conditioning equipment in lost opportunity applications. Air conditioning (AC) systems are a major consumer of electricity and systems that exceed baseline efficiencies can save considerable amounts of energy. This measure applies to air, water, and evaporatively-cooled unitary AC systems, both single-package and split systems.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

For units with cooling capacities less than 65 kBtu/h:

$$\Delta kWh = (kBtu/h)\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right)(EFLH_{Cool})$$

$$\Delta kW = (kBtu/h)\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWh = (kBtu/h)\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)(EFLH_{Cool})$$

$$\Delta kW = (kBtu/h)\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

Where:

ΔkWh	=	Gross annual kWh savings from the measure.
ΔkW	=	Gross connected kW savings from the measure.
kBtu/h	=	Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h)
$SEER_{BASE}$	=	Seasonal Energy Efficiency Ratio of the baseline equipment. See Table 8 for values.
$SEER_{EE}$	=	Seasonal Energy Efficiency Ratio of the energy efficient equipment.
$EFLH_{Cool}$	=	Cooling equivalent full load hours. See Appendix A: Common Lookup Tables for default values.

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EER_{BASE}		Energy Efficiency Ratio of the baseline equipment. See Table 8 for values. Since IECC 2009 does not provide EER requirements for air-cooled air conditioners < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1.
EER_{EE}	=	Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EER_{EE} is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.

Baseline Efficiency

The baseline efficiency case for new installations assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. As described in Chapter 13 of the aforementioned document, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009 with Massachusetts specific amendments. Replacement units are not required to meet IECC 2009 code. Instead, replacement installations use the Federal Manufacturing standards (indicated in the table with an asterisk) or the ASHREA 2004 standards as baseline, whichever is most rigorous. Table 8 details the specific efficiency requirements by equipment type and capacity.

Table 8: Unitary Air Conditioners Baseline Efficiency Levels[383]

Equipment Type	Size Category	Subcategory or Rating Condition	Baseline Efficiency	
			New Installations	Replacement Installations
Air conditioners, air cooled	<65,000 Btu/h[b]	Split system	13.0 SEER	13.0 SEER*
		Single package	13.0 SEER	12.0 SEER
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package	11.2 EER	10.1 EER[a]
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	11.0 EER	9.5 EER[a]
	≥240,000 Btu/h and <760,000 Btu/h	Split system and single package	10.0 EER	10.0 EER*[a]
	≥760,000 Btu/h	Split system and single package	9.7 EER	9.0 EER[a]
Air conditioners, Water and evaporatively cooled	<65,000 Btu/h	Split system and single package	12.1 EER	12.1 EER
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package	11.5 EER	11.3 EER[a]
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	11.0 EER	10.8 EER[a]
	≥240,000 Btu/h	Split system and single package	11.5 EER	10.8 EER[a]

a. Deduct 0.2 from the required EERs for units with a heating section other than electric heat.[384]
b. Single-phase air-cooled air conditioners <65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA); SEER values are those set by NAECA.

High Efficiency

The high efficiency case assumes the HVAC equipments meets or exceeds the Consortium for Energy Efficiency's (CEE) specification. This specification results in cost-effective energy savings by specifying higher efficiency HVAC equipment while ensuring that several manufacturers produce compliant equipment. The CEE specification is reviewed and updated annually to reflect changes to the ASHRAE

[383] International Code Council (2009). *2009 International Energy Conservation Code*; Page43, Table 503.2.3(1).
[384] The PAs do not differentiate between units by heating section types. To be conservative, the highest Baseline Efficiency is assumed for all heating section types in each equipment category.

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and IECC energy code baseline as well as improvements in the HVAC equipment technology. The minimum efficiency requirements for program participation are outlined on the Cool Choice rebate forms. Equipment efficiency is the rated efficiency of the installed equipment for each project.

Hours

If site-specific hours are unavailable, the equivalent cooling full load hours for unitary AC equipment are determined from the facility type. See Appendix A: Common Lookup Tables for cooling full load hours by building type.

Measure Life

The measure life is 15 years.[385]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Unitary AC	NC	CLC	1.00	1.00	1.00	0.74	0.00	0.45	0.00	n/a	n/a
Unitary AC	NC	National Grid	1.00	1.00	1.00	1.00	1.00	0.40	0.00	n/a	n/a
Unitary AC	NC	NSTAR	1.00	1.00	1.00	0.74	0.00	0.45	0.00	n/a	n/a
Unitary AC	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.33	0.00	n/a	n/a
Unitary AC	NC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	0.42	0.00

In-Service Rates

All installations have 100% in service rate since all programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- CLC, National Grid, NSTAR, Unitil: Energy RRs set to 1.00 based 2011 NEEP C&I Unitary AC Loadshape Project.[386] The PAs use average evaluation Cooling Hours in the kWh savings calculations.
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[387]

Coincidence Factors

CFs based 2011 NEEP C&I Unitary AC Loadshape Project.[388]

[385] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[386] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.
[387] KEMA, Inc. (2010). *2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures*. Prepared for Western Massachusetts Electric Company.
[388] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.

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HVAC – Single Package or Split System Heat Pump Systems

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure applies to the installation of high-efficiency air cooled, water source, ground water source, and ground source heat pump systems.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

For air cooled units with cooling capacities less than 65 kBtu/h:

$$\Delta kWh = \Delta kWh_{Cool} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Cool} = (kBtu/h)\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right)(EFLH_{COOL})$$

$$\Delta kWh_{Heat} = (kBtu/h)\left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right)(EFLH_{HEAT})$$

$$\Delta kW = (kBtu/h)_{Cool}\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

For all water source, groundwater source, ground source units, and air cooled units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWh = \Delta kWh_{Cool} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Cool} = (kBtu/h_{COOL})\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right)(EFLH_{COOL})$$

$$\Delta kWh_{Heat} = \frac{(kBtu/h_{HEAT})}{3.412}\left(\frac{1}{COP_{BASE}} - \frac{1}{COP_{EE}}\right)(EFLH_{HEAT})$$

$$\Delta kW = (kBtu/h)_{Cool}\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

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Where:

ΔkWh_{COOL}	=	Gross annual cooling mode kWh savings from the measure.
ΔkWh_{HEAT}	=	Gross annual heating mode kWh savings from the measure.
ΔkW_{COOL}	=	Gross annual kW savings from the measure. Heating kW savings are negligible.
kBtu/h[389]	=	Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
$SEER_{BASE}$	=	Seasonal Energy Efficiency Ratio of the baseline equipment. See Table 9 for values.
$SEER_{EE}$	=	Seasonal Energy Efficiency Ratio of the energy efficient equipment.
$EFLH_{COOL}$	=	Cooling mode equivalent full load hours.
$HSPF_{BASE}$	=	Heating Seasonal Performance Factor of the baseline equipment. See Table 9 for values.
$HSPF_{EE}$	=	Heating Seasonal Performance Factor of the energy efficient equipment.
$EFLH_{HEAT}$	=	Heating mode equivalent full load hours.
$kBtu/h_{COOL}$	=	Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
EER_{BASE}	=	Energy Efficiency Ratio of the baseline equipment. See Table 9 for values. Since IECC 2009 does not provide EER requirements for air-cooled heat pumps < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1.
EER_{EE}	=	Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EER_{EE} is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.
$kBtu/h_{HEAT}$	=	Capacity of the heating equipment in kBtu per hour. If the heating capacity is unknown, it can be calculated from the cooling capacity using the conversion factors defined below.
3.412	=	Conversion factor: 3.412 Btu per Wh.
COP_{BASE}	=	Coefficient of performance of the baseline equipment. See Table 9 for values.
COP_{EE}	=	Coefficient of performance of the energy efficient equipment.

Heating Capacity Conversion Factors:

Air Source HPs
Heating Capacity = Cooling Capacity * 13,900/12,000 (Ratio of heat produced in the heating mode divided by cooling produced in cooling mode)

Water/Ground Source HPs
Heating Capacity = Cooling Capacity * COP/EER (converts the rated cooling output to the rated heating output)

Baseline Efficiency

The baseline efficiency case for new installations assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. As described in Chapter 13 of the aforementioned document, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009 with Massachusetts specific amendments. Table 9 details the specific efficiency

[389] For equipment with cooling capacities less than 65 kBtu/h, it is assumed that the heating capacity and cooling capacity are equal.

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requirements by equipment type and capacity. The baseline efficiency case for replacement units are not required to meet the IECC 2009. Instead, replacement installations use the Federal Manufacturing standards (indicated in the table with an asterisk) or the ASHREA 2004 standards as baseline, whichever is most rigorous. details the specific efficiency requirements by equipment type and capacity.

Table 9: Unitary and Applied Heat Pumps Baseline Efficiency Levels[390]

Equipment Type	Size Category (Cooling Capacity)	Subcategory or Rating Condition	Baseline Efficiency (New / Replacement)	
			Cooling Mode	Heating Mode
Air cooled	<65,000 Btu/h[b]	Split system	13.0 SEER / 13.0 SEER*	7.7 HSPF / 6.6 HSPF
		Single package	13.0 SEER / 12.0 SEER	7.7 HSPF / 6.6 HSPF
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package / 47°F db/43°F wb outdoor air	11.0 EER[a] / 9.9 EER	3.3 COP / 3.2 COP
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package / 47°F db/43°F wb outdoor air	10.6 EER[a] / 10.6 EER*	3.2 COP / 3.1 COP
	≥240,000 Btu/h	Split system and single package / 47°F db/43°F wb outdoor air	9.5 EER[a] / 9.5 EER	3.2 COP / 3.1 COP
Water source	<17,000 Btu/h	86°F entering water (Cooling Mode) / 68°F entering water (Heating Mode)	11.2 EER / 11.2 EER	4.2 COP / 4.2 COP
	≥17,000 Btu/h and <135,000 Btu/h	86°F entering water / 68°F entering water (Heating Mode)	12.0 EER / 12.0 EER	4.2 COP / 4.2 COP
Groundwater source	<135,000 Btu/h	59°F entering water (Cooling Mode) / 50°F entering water (Heating Mode)	16.2 EER / 16.2 EER	3.6 COP / 3.6 COP
Ground source	<135,000 Btu/h	77°F entering water / 32°F entering water (Heating Mode)	13.4 EER / 13.4 EER	3.1 COP / 3.1 COP

db = dry-bulb temperature, °F; wb = wet-bulb temperature, °F.
a. Deduct 0.2 from the required EERs for units with a heating section other than electric heat[391].
b. Single-phase air-cooled air conditioners <65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA); SEER values are those set by NAECA.

High Efficiency

The high efficiency case assumes the HVAC equipments meets or exceeds the Consortium for Energy Efficiency's (CEE) specification. This specification results in cost-effective energy savings by specifying higher efficiency HVAC equipment while ensuring that several manufacturers produce compliant equipment. The CEE specification is reviewed and updated annually to reflect changes to the ASHRAE and IECC energy code baseline as well as improvements in the HVAC equipment technology.

[390] International Code Council (2009). *2009 International Energy Conservation Code*; Page 44, Table 503.2.3(2).
[391] The PAs do not differentiate between units by heating section types. To be conservative, the highest baseline efficiency is assumed for all heating section types in each equipment category.

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The minimum efficiency requirements for program participation are outlined on the Cool Choice rebate forms. Equipment efficiency is the rated efficiency of the installed equipment for each project.

Hours

The annual equivalent full load hours for single package or split system heat pump systems are site-specific and should be determined on a case-by-case basis. If site-specific hours are unavailable, refer to the default hours presented in Appendix A: Common Lookup Tables.

Measure Life

The measure life is 15 years.[392]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Heat Pumps	NC	National Grid	1.00	1.00	1.05	1.00	1.00	0.40	0.00	n/a	n/a
Heat Pumps	NC	NSTAR	1.00	1.00	1.01	1.09	1.57	0.45	0.00	n/a	n/a
Heat Pumps	NC	CLC	1.00	1.00	1.00	1.09	1.57	0.55	0.00	n/a	n/a
Heat Pumps	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.33	0.00	n/a	n/a
Heat Pumps	NC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	0.42	0.00

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- National Grid and energy and demand RRs based on a 1994 study of HVAC and process cooling equipment.[393]
- NSTAR energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[394]
- CLC realization rates same as Unitary AC.
- Unitil realization rates same as Unitary AC.
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[395]

Coincidence Factors

- CFs based 2011 NEEP C&I Unitary AC Loadshape Project.[396]

[392] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[393] The Fleming Group (1994). *Persistence of Commercial/Industrial Non-Lighting Measures, Volume 2, Energy Efficient HVAC and Process Cooling Equipment*. Prepared for New England Power Service Company.
[394] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[395] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*
[396] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.

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HVAC – Demand Control Ventilation (DCV)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The measure, offered through the CoolChoice program, is to control quantity of outside air to an air handling system based on detected space CO_2 levels. The installed systems monitor the CO_2 in the spaces or return air and reduce the outside air use when possible to save energy while meeting indoor air quality standards.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I Large Retrofit and C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

Gross energy and demand savings for implementation of demand control ventilation are custom calculated using the PA's DCV savings calculation tools. These tools are used to calculate energy and demand savings based on site-specific project details including hours of operation, HVAC system efficiency and total air flow, and enthalpy and temperature set points.[397] Alternatively, the energy and demand savings may be calculated using the following algorithms and inputs:

$$\Delta kWh = (kBtu/h)\left(\frac{1\,Ton}{12\,kBtu/h}\right)(SAVE_{kWh})$$

$$\Delta kW = (kBtu/h)\left(\frac{1\,Ton}{12\,kBtu/h}\right)(SAVE_{kW})$$

Where:
kBtu/h = Capacity of the cooling equipment in kBtu per hour
$SAVE_{kWh}$ = Average annual kWh reduction per ton of cooling capacity: 170 kWh/ton[398]
$SAVE_{kW}$ = Average kW reduction per ton of cooling capacity: 0.15 kW/ton[399]

Baseline Efficiency

The baseline efficiency case for this measure assumes the relevant HVAC equipment has no ventilation control.

High Efficiency

The high efficiency case is the installation of an outside air intake control based on CO_2 sensors.

[397] Detailed descriptions of the DCV Savings Calculation Tools are included in the TRM Library under the "C&I Spreadsheet Tools" folder.
[398] Keena, Kevin (2008). *Analysis of CO2 Control Energy Savings on Unitary HVAC Units.* Prepared for National Grid.
[399] Ibid.

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Hours

The operating hours are site-specific for custom savings calculations.

Measure Life

The measure life is 10 years.[400]

Secondary Energy Impacts

Gas and oil heat impacts are counted for DCV measures for reduction in space heating. If these impacts are not custom calculated, they can be approximated using the interaction factors described below:

Measure	Energy Type	Savings[401]
DCV	C&I Gas Heat	0.001277 MMBtu/kWh
DCV	Oil	0.002496 MMBtu/kWh

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
DCV	NC	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	0.00	n/a	n/a
DCV	NC	NSTAR, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
DCV	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.82	0.05	n/a	n/a
DCV	NC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	0.82	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- National Grid: RRs based on engineering estimates.
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[402]
- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[403]

Coincidence Factors

- National Grid: CFs based on engineering estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs from 2005 coincidence factor study.[404]

[400] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1. Measure life is assumed to be the same as Enthalpy Economizer.
[401] Optimal Energy, Inc. (2008). *Non-Electric Benefits Analysis Update*. Memo Prepared for National Grid.
[402] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[403] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.
[404] RLW Analytics (2007). *Final Report, 2005 Coincidence Factor Study*. Prepared for United Illuminating Company and Connecticut Lighting & Power.

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HVAC – Dual Enthalpy Economizer Controls (DEEC)

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: The measure is to upgrade the outside-air dry-bulb economizer to a dual enthalpy economizer. The system will continuously monitor the enthalpy of both the outside air and return air. The system will control the system dampers adjust the outside quantity based on the two readings.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: HVAC
Program: C&I New Construction and Major Renovation

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (kBtu/h)\left(\frac{1\,Ton}{12\,kBtu/h}\right)(SAVE_{kWh})$$

$$\Delta kW = (kBtu/h)\left(\frac{1\,Ton}{12\,kBtu/h}\right)(SAVE_{kW})$$

Where:

kBtu/h	=	Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
$SAVE_{kWh}$	=	Average annual kWh reduction per ton of cooling capacity: 289 kWh/ton[405]
$SAVE_{kW}$	=	Average kW reduction per ton of cooling capacity: 0.289 kW/ton[406]

Baseline Efficiency

The baseline efficiency case for this measure assumes the relevant HVAC equipment is operating with a fixed dry-bulb economizer.

High Efficiency

The high efficiency case is the installation of an outside air economizer utilizing two enthalpy sensors, one for outdoor air and one for return air.

Hours

Not applicable.

[405] Patel, Dinesh (2001). *Energy Analysis: Dual Enthalpy Control*. Prepared for NSTAR.
[406] Ibid.

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Measure Life

The measure life is 10 years for lost-opportunity applications.[407] The measure life is 7 years for retrofit installations.[408]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
DEEC	NC	National Grid	1.00	1.00	1.00	1.00	1.00	0.40	0.00	n/a	n/a
DEEC	NC	NSTAR	1.00	1.00	1.01	1.09	1.57	0.45	0.00	n/a	n/a
DEEC	NC	CLC	1.00	1.00	1.00	1.09	1.57	0.55	0.00	n/a	n/a
DEEC	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.332	0.00	n/a	n/a
DEEC	NC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	0.00	0.00

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

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Realization Rates

- National Grid RRs are 1.0 since there have been no impact evaluations of the prescriptive savings calculations.
- NSTAR energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[409]
- CLC realization rates same as Unitary AC.
- Unitil realization rates same as *Unitary AC*.
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation.[410]

Coincidence Factors

- National Grid, NSTAR, CLC, Unitil: CFs based 2011 NEEP C&I Unitary AC Loadshape Project[411].
- WMECO: CFs set to 0.00 since no DEEC savings are occur during seasonal peak periods.

[407] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1
[408] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group; Table 2.
[409] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[410] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*
[411] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.

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HVAC – ECM Fan Motors

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure is offered through the Cool Choice program and promotes the installation of electronically commutated motors (ECMs) on fan powered terminal boxes, fan coils, and HVAC supply fans on small unitary equipment.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Electric Energy Impact

$$\Delta kWh = (DesignCFM)(BoxSizeFactor)(\%Flow_{ANNUAL})(Hours)$$
$$\Delta kW_{SP} = (DesignCFM)(BoxSizeFactor)(\%Flow_{SP})$$
$$\Delta kW_{WP} = (DesignCFM)(BoxSizeFactor)(\%Flow_{WP})$$

Where:

Design CFM	=	Capacity of the VAV box in cubic feet per minute
Box Size Factor	=	Savings factor in Watts/CFM. See Table 10 for values.
$\%Flow_{ANNUAL}$	=	Average % of design flow over all operating hours. See Table 10 for values.
$\%Flow_{SP}$	=	Average % of design flow during summer peak period. See Table 10 for values.
$\%Flow_{WP}$	=	Average % of design flow during summer peak period. See Table 10 for values.
Hours	=	Annual operating hours for VAV box fans

Table 10: ECM Fan Motor Savings Factors [412]

Factor	Box Size	Value	Units
Box Size Factor	<1000 CFM	0.32	Watts/CFM
Box Size Factor	≥1000 CFM	0.21	Watts/CFM
$\%Flow_{ANNUAL}$	All	0.52	-
$\%Flow_{SP}$	All	0.63	-
$\%Flow_{WP}$	All	0.33	-

Baseline Efficiency

The baseline efficiency case for this measure assumes the VAV box fans are powered by a single speed fractional horsepower permanent split capacitor (PSC) induction motor.

[412] Factors based on engineering analysis developed at National Grid.

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High Efficiency

The high efficiency case must have a motor installed on new, qualifying HVAC equipment.

Hours

The annual operating hours for ECMs on VAV box fans are site-specific and should be determined on a case-by-case basis.

Measure Life

The measure life is 20 years for lost-opportunity applications.[413]

Algorithms for Calculating Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
ECM Fan Motors	NC	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
ECM Fan Motors	NC	NSTAR, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
ECM Fan Motors	NC	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.82	n/a	n/a
ECM Fan Motors	NC	WMECO	1.00	1.00	1.31	0.85	0.60	n/a	n/a	0.72	0.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- National Grid: RRs based on engineering estimates
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[414]
- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[415]

Coincidence Factors

- National Grid: CFs based on engineering estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs from 2005 coincidence factor study.[416]

[413] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[414] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[415] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*
[416] RLW Analytics (2007). *Final Report, 2005 Coincidence Factor Study*. Prepared for Connecticut Energy Conservation Management Board, United Illuminating and Connecticut Light & Power.

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HVAC – Energy Management System

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: The measure is the installation of a new building energy management system (EMS) or the expansion of an existing energy management system for control of non-lighting electric and gas end-uses in an existing building on existing equipment.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I New Construction & Major Renovation, C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

Gross energy and demand savings for energy management systems (EMS) are custom calculated using the PA's EMS savings calculation tools. These tools are used to calculate energy and demand savings based on project-specific details including hours of operation, HVAC system equipment and efficiency and points controlled.[417]

Baseline Efficiency

The baseline for this measure assumes the relevant HVAC equipment has no control.

High Efficiency

The high efficiency case is the installation of a new EMS or the expansion of an existing EMS to control additional non-lighting electric or gas equipment. The EMS must be installed in an existing building on existing equipment.

Hours

Not applicable.

Measure Life

For lost-opportunity applications, the measure life is 15 years[418]. For retrofit applications, the measure life is 10 years[419].

Secondary Energy Impacts

Heating Impacts: Gas and oil heat impacts are counted for EMS measures for reduction in space heating. If the heating system impacts are not calculated in the EMS savings calculation tool, they can be approximated using the interaction factors described below:

[417] Descriptions of the EMS savings calculation tools are included in the TRM Library "C&I Spreadsheet Tools" folder.
[418] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[419] Ibid.

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Measure	Energy Type	Impact (MMBtu/ΔkWh)[420]
EMS	C&I Gas Heat	0.001277
EMS	Oil	0.002496

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
EMS	Large Retrofit	National Grid	1.00	1.00	1.04	1.03	1.03	custom	custom	n/a	n/a
EMS	Large Retrofit	NSTAR, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
EMS	Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.82	0.05	n/a	n/a
EMS	Large Retrofit	WMECO	1.00	1.00	0.57	0.78	0.81	n/a	n/a	custom	custom
EMS	Small Retrofit	CLC	1.00	1.00	1.01	1.09	0.57	0.82	0.05	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- National Grid RRs derived from a 1994 study of HVAC and process cooling equipment.[421]
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[422]
- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: RRs are based on end use from 2007/2008 Large C&I Programs impact evaluation[423]

Coincidence Factors

- National Grid, WMECO: CFs are custom calculated.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.

[420] Optimal Energy, Inc. (2008). *MEMO: Non-Electric Benefits Analysis Update*. Prepared for NSTAR. Final savings values calculated in spreadsheet analysis as noted on pg 5 of the memo.
[421] The Fleming Group (1994). *Persistence of Commercial/Industrial Non-Lighting Measures, Volume 3, Energy Management Control Systems*. Prepared for New England Power Service Company.
[422] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[423] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*

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HVAC – High Efficiency Chiller

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure promotes the installation of efficient water-cooled and air-cooled water chilling packages for comfort cooling applications. Eligible chillers include air-cooled, water cooled rotary screw and scroll, and water cooled centrifugal chillers for single chiller systems or for the lead chiller only in multi-chiller systems.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

Gross energy and demand savings for chiller installations may be custom calculated using the PA's Chillers savings calculation tool. These tools are used to calculated energy and demand savings based on site-specific chiller plant details including specific chiller plan equipment, operational staging, operating load profile and load profile.[424]

Alternatively, the energy and demand savings may be calculated using the following algorithms and inputs. Please note that consistent efficiency types (FL or IPLV) must be used between the baseline and high efficiency cases:

Air-Cooled Chillers:

$$\Delta kWh = (Tons)\left(\frac{12}{EER_{BASE}} - \frac{12}{EER_{EE}}\right)(Hours)$$

$$\Delta kW = (Tons)\left(\frac{12}{EER_{BASE}} - \frac{12}{EER_{EE}}\right)(LF)$$

Water-Cooled Chillers:

$$\Delta kWh = (Tons)(kW/ton_{BASE} - kW/ton_{EE})(Hours)$$

$$\Delta kW = (Tons)(kW/ton_{BASE} - kW/ton_{EE})(LF)$$

Where:

[424] Descriptions of the Chiller savings calculation tools are included in the TRM Library "C&I Spreadsheet Tools" folder.

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Tons = Rated capacity of the cooling equipment
EER_{BASE} = Energy Efficiency Ratio of the baseline equipment. See Table 11 for values.
EER_{EE} = Energy Efficiency Ratio of the efficient equipment. Site-specific.
kW/ton_{BASE} = Energy efficiency rating of the baseline equipment. See Table 11 for values.
kW/ton_{EE} = Energy efficiency rating of the efficient equipment. Site-specific.
Hours = Equivalent full load hours for chiller operation
LF = Load Factor. See table below

Equipment Type	PA	Load Factor[425,426]	
		Full Load	IPLV
Air-cooled chillers	National Grid	0.715	
Water cooled chillers < 300 Tons	National Grid	0.882	0.823
Water cooled chillers > 300 Tons	National Grid	0.762	0.765
All	WMECO	0.80	0.80
All	CLC	Site Specific	Site Specific

Baseline Efficiency

The baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. As described in Chapter 13 of the aforementioned document, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009. Table 11 details the specific efficiency requirements by equipment type and capacity.

Table 11: Water Chilling Packages - Minimum Efficiency Requirements[427]

Equipment Type	Size Category (Tons)	Units	Path A		Path B	
			Full Load	IPLV	Full Load	IPLV
Air-cooled chillers	< 150	EER	9.562	12.5	NA	NA
	≥ 150	EER	9.562	12.75	NA	NA
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 75	kW/ton	0.780	0.63	0.800	0.600
	≥ 75 and < 150	kW/ton	0.775	0.615	0.790	0.586
	≥ 150 and < 300	kW/ton	0.680	0.580	0.718	0.540
	≥ 300	kW/ton	0.620	0.540	0.639	0.490
Water cooled, electrically operated, centrifugal	< 150	kW/ton	0.634	0.596	0.639	0.450
	≥ 150 and < 300	kW/ton	0.634	0.596	0.639	0.450
	≥ 300 and < 600	kW/ton	0.576	0.549	0.600	0.400
	≥ 600	kW/ton	0.570	0.539	0.590	0.400

Note: Compliance with this standard may be obtained by meeting the minimum requirements of Path A or B, however, both the Full Load and IPLV must be met to fulfill the requirements of Path A or B.

High Efficiency

The high efficiency scenario assumes water chilling packages that exceed the efficiency levels required by Massachusetts State Building Code and meet the minimum efficiency requirements as stated in the New Construction HVAC energy efficiency rebate forms. Energy and demand savings calculations are based on actual equipment efficiencies should be determined on a case-by-case basis.

[425] National Grid load factors based on 1994 study.
[426] WMECO load factors based on staff estimates.
[427] DOE (2009). 2009 IECC Based Building Codes; Table 503.2.3(7): Water Chilling Packages, Efficiency Requirements - as of 1/1/2010 minimum efficiency values.

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Hours

The equivalent full load hours of operation for water chilling packages are site-specific and should be determined on a case-by-case basis. If site-specific EFLH is unavailable, refer to the default hours presented in Appendix A: Table 40.

Measure Life

The measure life is 23 years.[428]

Secondary Energy Impacts

There are no secondary energy impacts counted for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Chillers	NC	National Grid	1.00	1.00	1.04	1.00	1.00	1.00	0.00	n/a	n/a
Chillers	NC	NSTAR, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
Chillers	NC	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.00	n/a	n/a
Chillers	NC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	custom	custom

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- National Grid energy RRs based on a 1994 study of hvac and process cooling equipment.[429]
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[430]
- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: RRs are based on end use from 2007/2008 Large C&I Programs impact evaluation[431]

Coincidence Factors

- National Grid: CFs estimated based on 1993-1994 evaluation research and engineering estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- Unitil CFs set to 1.0 for summer and 0.0 for winter since no space cooling savings during winter.
- WMECO: CFs are custom calculated

[428] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[429] The Fleming Group (1994). *Persistence of Commercial/Industrial Non-Lighting Measures, Volume 2, Energy Efficient HVAC and Process Cooling Equipment*. Prepared for New England Power Service Company.
[430] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[431] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*

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HVAC – Hotel Occupancy Sensors

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: The measure is to the installation of hotel occupancy sensors (HOS) to control packaged terminal AC units (PTACs) with electric heat, heat pump units and/or fan coil units in hotels that operate all 12 months of the year.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

Unit savings are deemed based on evaluation results:

$$\Delta kWh = SAVE_{kWh}$$
$$\Delta kW = SAVE_{kW}$$

Where:

Unit	=	Installed hotel room occupancy sensor
$SAVE_{kWh}$	=	Average annual kWh reduction per unit: 438 kWh[432]
$SAVE_{kW}$	=	Average annual kWh reduction per unit: 0.09 kW[433]

Baseline Efficiency

The baseline efficiency case assumes the equipment has no occupancy based controls.

High Efficiency

The high efficiency case is the installation of controls that include (a) occupancy sensors, (b) window/door switches for rooms that have operable window or patio doors, and (c) set back to 65 F in the heating mode and set forward to 78 F in the cooling mode when occupancy detector is in the unoccupied mode. Sensors controlled by a front desk system are not eligible.

Hours

Not applicable.

Measure Life

For retrofit applications, the measure life is 10 years.[434]

[432] MassSave (2010). *Energy Analysis: Hotel Guest Occupancy Sensors*. Prepared for National Grid and NSTAR.
[433] Ibid.
[434] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1; Measure life is assumed to be the same as for EMS retrofit measure.

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Secondary Energy Impacts

There are no secondary energy impacts.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
HOS	Large Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.30	0.70	n/a	n/a
HOS	Large Retrofit	NSTAR, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
HOS	Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.82	0.05	n/a	n/a
HOS	Large Retrofit	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	0.00	0.00
HOS	Small Retrofit	CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

- National Grid: RRs based on engineering estimates.
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[435]
- Unitil: Energy and demand RRs are 100% based on no evaluations.
- WMECO: RRs are based on end use from 2007/2008 Large C&I Programs impact evaluation[436]

Coincidence Factors

- National Grid: CFs based on engineering estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs set to 0.0 since no DEEC savings are not during seasonal peak periods.

[435] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[436] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*

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HVAC – Programmable Thermostats

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure involves the installation of a programmable thermostat for cooling and/or heating systems in spaces with either no or erratic existing control.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (SQFT)(SAVE_{kWh})$$
$$\Delta kW = (SQFT)(SAVE_{kW})$$

Where:
SQFT = Square feet of controlled space
$SAVE_{kWh}$ = Average kW reduction per SQFT of controlled space. See Table 12.
$SAVE_{kW}$ = Average annual kWh reduction per SQFT of controlled. See Table 12.

Table 12: Savings Factors (Save)[437]

Equipment Type	$SAVE_{kWh}$ (kWh/SQFT)	$SAVE_{kW}$ (kW/SQFT)
Cool Only No Existing Control	0.539	0.00
Col Only Erratic Existing Control	0.154	0.00
Heat Only No Existing Control	0.418	0.00
Heat Only Erratic Existing Control	0.119	0.00
Cool and Heat No Existing Control	0.957	0.00
Cool and Heat Erratic Existing Control	0.273	0.00
Heat Pump No Existing Control	0.848	0.00
Heat Pump Erratic Existing Control	0.242	0.00

Baseline Efficiency

The baseline efficiency case includes spaces with either no or erratic heating and/or cooling control as indicated in the equipment type selection.

[437] Massachusetts common assumptions.

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High Efficiency

The high efficiency case includes control of the space cooling and/or heating system as indicated in the equipment type selection.

Hours

Not applicable.

Measure Life

For retrofit applications, the measure life is 8 years.[438]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Thermostat	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Thermostat	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Thermostat	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Thermostat	Small Retrofit	WMECO	1.00	1.00	1.00	1.00	1.00	n/a	n/a	0.00	0.00

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs set to 100% based on no evaluations.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[439]
-

Coincidence Factors

- National Grid, WMECO, Unitil, NSTAR, CLC: CFs set to zero since no savings are expected during peak periods.

[438] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[439] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Door Heater Controls

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of controls to reduce the run time of door and frame heaters for freezers and walk-in or reach-in coolers. The reduced heating results in a reduced cooling load.[440]
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = kW_{DH} * \%OFF * 8760$$
$$\Delta kW = kW_{DH} * \%OFF$$

Where:

kW_{DH}	=	Total demand of the door heater, calculated as Volts * Amps / 1000
8760	=	Door heater annual run hours before controls
%OFF		Door heater Off time[441]: 46% for freezer door heaters or 74% for cooler door heaters)

Baseline Efficiency

The baseline efficiency case is a cooler or freezer door heater that operates 8,760 hours per year without any controls.

High Efficiency

The high efficiency case is a cooler or freezer door heater connected to a heater control system, which controls the door heaters by measuring the ambient humidity and temperature of the store, calculating the dewpoint, and using pulse width modulation (PWM) to control the anti-sweat heater based on specific algorithms for freezer and cooler doors. Door temperature is typically maintained about 5°F above the store air dewpoint temperature.[442]

Hours

Pre-retrofit hours are 8,760 hours per year. After controls are installed, the door heaters in freezers are on for an average 4,730.4 hours/year (46% off time) and the door heaters for coolers are on for an average 2,277.6 hours/year (74% off time).

[440] The assumptions and algorithms used in this section are specific to NRM products.
[441] The value is an estimate by NRM based on hundreds of downloads of hours of use data from Door Heater controllers. These values are also supported by Select Energy Services, Inc. (2004). *Cooler Control Measure Impact Spreadsheet User's Manual*. Prepared for NSTAR.
[442] Select Energy Services, Inc. (2004). *Analysis of Cooler Control Energy Conservation Measures*. Prepared for NSTAR.

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Measure Life

The measure life for cooler and freezer door heater controls is 10 years.[443]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Door Heater Control	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.50	1.00	n/a	n/a
Door Heater Control	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	0.50	1.00	n/a	n/a
Door Heater Control	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.50	1.00	n/a	n/a
Door Heater Control	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	0.10	0.10

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid: energy RR based on staff estimates.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- Unitil: RRs set to 100% based on no evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[444]

Coincidence Factors

- National Grid, Unitil, NSTAR, CLC: CFs from the 1995 HEC study of walk-in cooler anti-sweat door heater controls.[445]
- WMECO: CFs based on staff estimates.

[443] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[444] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.
[445] HEC, Inc. (1995). *Analysis of Door Master Walk-In Cooler Anti-Sweat Door Heater Controls Installed at Ten Sites in Massachusetts*. Prepared for New England Power Service Company; Table 9. Adjusted to account for updated RR.

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Refrigeration – Novelty Cooler Shutoff

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of controls to shut off a facility's novelty coolers for non-perishable goods based on pre-programmed store hours. Energy savings occur as coolers cycle off during facility unoccupied hours.[446]
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = (kW_{NC})(DC_{AVG})(HoursOFF)$$

$$\Delta kW = 0$$

Where:

ΔkW	=	0 since savings are assumed to occur during evening hours and are therefore not coincident with either summer or winter peak periods.
kW_{NC}	=	Power demand of novelty cooler calculated from equipment nameplate data and estimated 0.85 power factor[447]
HoursOFF	=	Potential hours off every night per year, estimated as one less than the number of hours the store is closed per day
DC_{AVG}	=	Weighted average annual duty cycle: 48.75%[448]

Baseline Efficiency

The baseline efficiency case is the novelty coolers operating 8,760 hours per year.

High Efficiency

The high efficiency case is the novelty coolers operating fewer than 8,760 hours per year since they are controlled to cycle each night based on pre-programmed facility unoccupied hours.

Hours

Energy and demand savings are based on the reduced operation hours of the cooler equipment. Hours reduced per day are estimated on a case-by-case basis, and are typically calculated as one less than the number of hours per day that the facility is closed each day.

[446] The assumptions and algorithms used in this section are specific to NRM products.
[447] Conservative value based on 15 years of NRM field observations and experience.
[448] Ibid; the estimated duty cycles for Novelty Coolers are supported by Select Energy Services, Inc. (2004). *Cooler Control Measure Impact Spreadsheet Users' Manual*. Prepared for NSTAR. The study gives a less conservative value than used by NRM.

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Measure Life

The measure life is 10 years.[449]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SP}	CF_{WP}
Novelty Cooler Shutoff	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Novelty Cooler Shutoff	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Novelty Cooler Shutoff	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Novelty Cooler Shutoff	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	0.00	0.00

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid: energy RR based on staff estimates..
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- Unitil: RRs set to 100% based on no evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[450]

Coincidence Factors

Coincidence factors are set to zero since demand savings typically occur during off-peak hours.

[449] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[450] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – ECM Evaporator Fan Motors for Walk–in Coolers and Freezers

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of various sizes of electronically commutated motors (ECMs) in walk-in coolers and freezers to replace existing evaporator fan motors.[451]
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Fan} = kW_{Fan} * LRF * Hours$$

$$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$$

$$\Delta kW = \Delta kWh / 8{,}760$$

Where:

ΔkWh_{Fan}	=	Energy savings due to increased efficiency of evaporator fan motor
ΔkWh_{Heat}	=	Energy savings due to reduced heat from the evaporator fans
kW_{Fan}	=	Power demand of evaporator fan calculated from equipment nameplate data and estimated 0.55 power factor/adjustment[452]: Amps x Voltage x PF x √Phase
LRF	=	Load reduction factor for motor replacement (65%)[453]
Hours	=	Annual fan operating hours.
0.28	=	Conversion factor between kW and tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton
Eff_{RS}	=	Efficiency of typical refrigeration system: 1.6 kW/ton[454]
ΔkW	=	Average demand savings
8,760	=	Hours per year

Baseline Efficiency

The baseline efficiency case is an existing evaporator fan motor.

[451] The assumptions and algorithms used in this section are specific to NRM products.
[452] Conservative value based on 15 years of NRM field observations and experience.
[453] Load factor is an estimate by NRM based on several pre- and post-meter readings of installations; the value is supported by RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation.* Prepared for National Grid.
[454] Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). *Cooler Control Measure Impact Spreadsheet Users' Manual*. Prepared for NSTAR.

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High Efficiency

The high efficiency case is the replacement of existing evaporator fan motors with ECMs.

Hours

The annual operating hours are assumed to be 8,760 * (1-%OFF), where %OFF = 0 if the facility does not have evaporator fan controls or %OFF = 46% if the facility has evaporator fan controls (4,030 hours). See section: Refrigeration – Evaporator Fan Controls for more on %OFF value.

Measure Life

The measure life is 15 years.[455]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings[456]

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Evap Fan ECMs	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Evap Fan ECMs	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	1.00	1.00	n/a	n/a
Evap Fan ECMs	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Evap Fan ECMs	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	1.00	1.00

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid: RRs set to 100% since changes to calculation methodology made based on 2005 Custom SBS program evaluation. [457]
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- Unitil: RRs set to 100% based on no evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[458]

Coincidence Factors

All: CFs set to 1 since demand savings are average

[455] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; 15-year measure life for retrofit motor installations.
[456] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation.* Prepared for National Grid.
[457] RLW Analytics (2007). *Impact Evaluation Analysis of the 2005 Custom SBS Program*. Prepared for National Grid.
[458] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Case Motor Replacement

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of electronically commutated motors (ECMs) in multi-deck and freestanding coolers and freezers, typically on the retail floor of convenience stores, liquor stores, and grocery stores.[459]
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = \Delta kWh_{Motor} + \Delta kWh_{Heat}$$
$$\Delta kWh_{motor} = kW_{Motor} * LRF * Hours$$
$$\Delta kWh_{heat} = \Delta kWh_{Motor} * 0.28 * Eff_{RS}$$
$$\Delta kW = \Delta kWh / 8{,}760$$

Where:

ΔkWh_{Motor}	=	Energy savings due to increased efficiency of case motor
ΔkWh_{Heat}	=	Energy savings due to reduced heat from evaporator fans
kW_{motor}	=	Metered load of case motor
LRF	=	Load reduction factor: 53% when shaded pole motors are replaced, 29% when PSC motors are replaced[460]
Hours	=	Average runtime of case motors (8,500 hours)[461]
0.28	=	Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
Eff_{RS}	=	Efficiency of typical refrigeration system (1.6 kW/ton) [462]
ΔkW	=	Average demand savings
8,760	=	Hours per year

Baseline Efficiency

The baseline efficiency case is the existing case motor.

High Efficiency

The high efficiency case is the replacement of the existing case motor with an ECM.

[459] The assumptions and algorithms used in this section are specific to NRM products.
[460] Load factor is an estimate by NRM based on several pre- and post-meter readings of installations
[461] Conservative value based on 15 years of NRM field observations and experience.
[462] Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). *Cooler Control Measure Impact Spreadsheet Users' Manual*. Prepared for NSTAR.

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Hours

Hours are the annual operating hours of the case motors.

Measure Life

The measure life is 15 years.[463]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Case ECMs	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Case ECMs	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	1.00	1.00	n/a	n/a
Case ECMs	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Case ECMs	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	1.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid: RRs set to 100% since changes to calculation methodology made based on 2005 Custom SBS program evaluation. [464]
- Unitil: RRs set to 100% based on no evaluations.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program[465].

Coincidence Factors

All: CFs set to 1 since demand savings are average

[463] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; 15-year measure life for retrofit motor installations.
[464] RLW Analytics (2007). *Impact Evaluation Analysis of the 2005 Custom SBS Program*. Prepared for National Grid.
[465] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Cooler Night Covers

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of retractable aluminum woven fabric covers for open-type refrigerated display cases, where the covers are deployed during the facility unoccupied hours in order to reduce refrigeration energy consumption.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = (Width)(Save)(Hours)$$

$$\Delta kW = (Width)(Save)$$

Where:
Width = Width of the opening that the night covers protect (ft)
Save = Savings factor based on the temperature of the case (kW/ft). See Table 13.
Hours = Annual hours that the night covers are in use

Table 13: Savings Factors[466]

Cooler Case Temperature	Savings Factor (kW/ft)
Low Temperature (-35 F to -5 F)	0.03
Medium Temperature (0 F to 30 F)	0.02
High Temperature (35 F to 55 F)	0.01

Baseline Efficiency

The baseline efficiency case is the annual operation of open-display cooler cases.

High Efficiency

The high efficiency case is the use of night covers to protect the exposed area of display cooler cases during unoccupied hours.

Hours

Hours represent the number of annual hours that the night covers are in use, and should be determined on a case-by-case basis.

[466] CL&P Program Savings Documentation for 2011 Program Year (2010). Factors based on Southern California Edison (1997). *Effects of the Low Emissive Shields on Performance and Power Use of a Refrigerated Display Case.*

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Measure Life

The measure life is 10 years.[467]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Cooler Night Cover	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Cooler Night Cover	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	1.00	1.00	n/a	n/a
Cooler Night Cover	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Cooler Night Cover	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	1.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs set to 100% based on no evaluations.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[468]

Coincidence Factors

Coincidence factors are set to zero since demand savings typically occur during off-peak hours.

[467] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Page 4-5 to 4-6.
[468] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Electronic Defrost Control

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: A control mechanism to skip defrost cycles when defrost is unnecessary.[469]
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = \Delta kWh_{Defrost} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Defrost} = kW_{Defrost} * Hours * DRF$$

$$\Delta kWh_{Heat} = \Delta kWh_{Defrost} * 0.28 * Eff_{RS}$$

$$\Delta kW = \Delta kWh / 8{,}760$$

Where:

$\Delta kWh_{Defrost}$	=	Energy savings resulting from an increase in operating efficiency due to the addition of electronic defrost controls.
ΔkWh_{Heat}	=	Energy savings due to reduced heat from reduced number of defrosts.
$kW_{Defrost}$	=	Load of electric defrost.
Hours	=	Number of hours defrost occurs over a year without the defrost controls.
DRF	=	Defrost reduction factor- percent reduction in defrosts required per year (35%)[470]
0.28	=	Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
Eff_{RS}	=	Efficiency of typical refrigeration system (1.6 kW/ton)[471]
ΔkW	=	Average demand savings
8,760	=	Hours per year

Baseline Efficiency

The baseline efficiency case is an evaporator fan electric defrost system that uses a time clock mechanism to initiate defrost.

High Efficiency

The high efficiency case is an evaporator fan defrost system with electric defrost controls.

[469] The assumptions and algorithms used in this section are specific to NRM products.
[470] Ibid; supported by 3rd party evaluation: Independent Testing was performed by Intertek Testing Service on a Walk-in Freezer that was retrofitted with Smart Electric Defrost capability.
[471] Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). *Cooler Control Measure Impact Spreadsheet Users' Manual*. Prepared for NSTAR.

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Hours

The number of defrost cycles is estimated to decrease by 35% from an average number of defrost cycles of 1460 defrosts/year at 40 minutes each for a total of 973 hours/year.[472] The number of defrost cycles with the defrost controls is 949 cycles/year, or 633 hours/year.

Measure Life

The measure life is 10 years.[473]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Defrost Control	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Defrost Control	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	1.00	1.00	n/a	n/a
Defrost Control	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Defrost Control	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	1.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs set to 100% based on no evaluations.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[474]

Coincidence Factors

- All: CFs set to 1 since demand savings are average

[472] Conservative value based on 15 years of NRM field observations and experience.
[473] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities.
[474] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Evaporator Fan Controls

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of controls to modulate the evaporator fans based on temperature control. Energy savings include: fan energy savings from reduced fan operating hours, refrigeration energy savings from reduced waste heat, and compressor energy savings resulting from the electronic temperature control. Electronic controls allow less fluctuation in temperature, thereby creating savings.[475]
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat} + \Delta kWh_{Control}$$

$$\Delta kWh_{Fan} = kW_{Fan} * 8760 * \%OFF$$

$$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$$

$$\Delta kWh_{Control} = \left[kW_{CP} * Hours_{CP} + kW_{Fan} * 8760 * (1 - \%Off)\right] * 5\%$$

$$\Delta kW = \Delta kWh / 8760$$

Where:

ΔkWh_{Fan}	=	Energy savings due to evaporator being shut off
ΔkWh_{Heat}	=	Energy savings due to reduced heat from the evaporator fans
$\Delta kWh_{Control}$	=	Energy savings due to the electronic controls on compressor and evaporator
kW_{Fan}	=	Power demand of evaporator fan calculated from equipment nameplate data and estimated 0.55 power factor/ adjustment[476]: Amps x Voltage x PF x √Phase
%OFF	=	Percent of annual hours that the evaporator is turned off: 46%[477]
0.28	=	Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
Eff_{RS}	=	Efficiency of typical refrigeration system: 1.6 kW/ton[478]
kW_{CP}	=	Total power demand of compressor motor and condenser fan calculated from equipment nameplate data and estimated 0.85 power factor[479]: Amps x Voltage x PF x √Phase

[475] The assumptions and algorithms used in this section are specific to NRM products.
[476] Conservative value based on 15 years of NRM field observations and experience.
[477] The value is an estimate by NRM based on hundreds of downloads of hours of use data. These values are also supported by Select Energy Services, Inc. (2004). *Cooler Control Measure Impact Spreadsheet User's Manual*. Prepared for NSTAR.
[478] Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). *Cooler Control Measure Impact Spreadsheet Users' Manual*. Prepared for NSTAR.
[479] This value is an estimate by NRM based on hundreds of downloads of hours of use data from the electronic controller.

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$Hours_{CP}$	=	Equivalent annual full load hours of compressor operation: 4,072 hours[480]
5%	=	Reduced run-time of compressor and evaporator due to electronic temperature controls[481]
ΔkW	=	Average demand savings
8,760	=	Hours per year

Baseline Efficiency

The baseline efficiency case assumes evaporator fans that run 8760 annual hours with no temperature control.

High Efficiency

The high efficiency case is the use of an energy management system to control evaporator fan operation based on temperature.

Hours

The operation of the fans is estimated to be reduced by 46% from the 8,760 hours in the base case scenario.

Measure Life

The measure life is 10 years[482].

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Evap Fan Control	Small Retrofit	National Grid	1	1	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Evap Fan Control	Small Retrofit	NSTAR, CLC	1	1	0.91	0.92	0.92	1.00	1.00	n/a	n/a
Evap Fan Control	Small Retrofit	Unitil	1	1	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Evap Fan Control	Small Retrofit	WMECO	1	1	0.86	0.57	0.57	n/a	n/a	1.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

[480] Conservative value based on 15 years of NRM field observations and experience.
[481] Conservative estimate supported by less conservative values given by several utility-sponsored 3rd Party studies including: Select Energy Services, Inc. (2004). *Analysis of Cooler Control Energy Conservation Measures*. Prepared for NSTAR.
[482] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.

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Realization Rates

- National Grid set to 100% after small retrofit RRs from 1996 savings analysis[483] suggestions for more accurate calculations adopted.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.
- Unitil: RRs set to 100% based on no evaluations.
- WMECO: RRs from impact evaluation of 2008 small retrofit program[484].

Coincidence Factors

- All: CFs set to 1 since demand savings are average

[483] HEC, Inc. (1996). *Analysis of Savings from Walk-In Cooler Air Economizers and Evaporator Fan Controls*. Prepared for New England Power Service Company.
[484] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Vending Misers

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Controls can significantly reduce the energy consumption of vending machine lighting and refrigeration systems. Qualifying controls must power down these systems during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure applies to refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. This measure should not be applied to ENERGY STAR® qualified vending machines, as they already have built-in controls.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: Refrigeration
Program: C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh = (kW_{RATED})(Hours)(SAVE)$$
$$\Delta kW = \Delta kWh / Hours$$

Where:

kW_{rated} = Rated kW of connected equipment. See Table 14 for default rated kW by connected equipment type.
Hours = Operating hours of the connected equipment: default of 8,760 hours
SAVE = Percent savings factor for the connected equipment. See Table 14 for values.

Table 14: Vending Machine and Cooler Controls Savings Factors [485]

Equipment Type	kW_{RATED}	SAVE (%)	ΔkW	ΔkWh
Refrigerated Beverage Vending Machines	0.40	46	0.184	1612
Non- Refrigerated Beverage Vending Machines	0.085	46	0.039	343
Glass Front Refrigerated Coolers	0.46	30	0.138	1208

Baseline Efficiency

The baseline efficiency case is a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

[485] USA Technologies Energy Management Product Sheets (2006). http://www.usatech.com/energy_management/energy_productsheets.php. Accessed 9/1/09.

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High Efficiency

The high efficiency case is a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Hours

It is assumed that the connected equipment operates 24 hours per day, 7 days per week for a total annual operating hours of 8,760.

Measure Life

The measure life is 5 years.[486]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Vending Misers	Large Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Vending Misers	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Vending Misers	Large Retrofit	NSTAR	1.00	1.00	0.85	0.41	0.24	0.00	0.00	n/a	n/a
Vending Misers	Small Retrofit	NSTAR	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Vending Misers	Large Retrofit	CLC	1.00	1.00	0.85	0.41	0.24	0.00	0.00	n/a	n/a
Vending Misers	Small Retrofit	CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Vending Misers	Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Vending Misers	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Vending Misers	Large Retrofit	WMECO	1.00	1.00	0.91	2.08	0.87	n/a	n/a	0.00	0.00
Vending Misers	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	0.00	0.00

In-Service Rates

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs set to 100% since savings estimated are based on study results.
- NSTAR, CLC: large retrofit RRs from impact evaluation of NSTAR 2006 refrigeration installations[487]; small retrofit RRs from impact evaluation of 2002 program year[488]
- WMECO: RRs from impact evaluation of 2008 small retrofit program[489]; large retrofit RRs are based on end use from 2007/2008 Large C&I Programs impact evaluation[490]

[486] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[487] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[488] RLW Analytics (2003). *Small Business Solutions Program Year 2002 Impact Evaluation - Final Report*. Prepared for NSTAR.

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Coincidence Factors

- National Grid, Unitil, NSTAR, CLC, WMECO: CFs based on staff estimates- assumed that savings occur during off peak hours.

[489] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.
[490] KEMA, Inc. (2011). *2007/2008 Large C&I Programs,*

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Food Service – Commercial Electric Ovens

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of a qualified ENERGY STAR® commercial oven. ENERGY STAR® commercial ovens save energy during preheat, cooking and idle times due to improved cooking efficiency, and preheat and idle energy rates.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial
Market: Lost Opportunity
End Use: Food Service
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impacts

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh / Hours$$

Where:
ΔkWh = gross annual kWh savings from the measure: 2,262 kWh[491]
ΔkW = gross average kW savings from the measure: 0.52 kW

Baseline Efficiency

The baseline efficiency case is a convection oven with a cooking energy efficiency of 65%, production capacity of 70 pounds per hour, preheat energy of 1.5 kWh and idle energy rate of 2.0 kW.

High Efficiency

The high efficiency case is a convection oven with a cooking energy efficiency of 70%, production capacity of 80 pounds per hour, preheat energy of 1.0 kWh and idle energy rate of 1.5 kW.

Hours

The average commercial oven is assumed to operate 4,380 hours per year[492].

Measure Life

The measure life for a new commercial electric oven is 12 years[493].

[491] Pacific Gas & Electric Company – Customer Energy Efficiency Department (2007). *Work Paper PGECOFST101, Commercial Convection Oven, Revision #0.*
[492] Ibid.
[493] Pacific Gas & Electric Company – Customer Energy Efficiency Department (2007). *Work Paper PGECOFST101, Commercial Convection Oven, Revision #0.*

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Convection Oven	NC	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

100% realization rates are assumed because savings are based on researched assumptions by FSTC.

Coincidence Factors

Coincidence factors are 1.0 for both summer and winter seasons because the cooking equipment is assumed to operate throughout the on-peak demand periods.

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Food Service – Commercial Electric Steam Cooker

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of a qualified ENERGY STAR® commercial steam cooker. ENERGY STAR® steam cookers save energy during cooling and idle times due to improved cooking efficiency and idle energy rates.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: Water, Wastewater
Sector: Commercial
Market: Lost Opportunity
End Use: Food Service
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impacts

Unit savings are deemed based on study results:

$$\Delta kWh = (SAVE)(Quantity)(Hours)$$
$$\Delta kW = (SAVE)(Quantity)$$

Where:

ΔkWh	=	gross annual kWh savings from the measure
ΔkW	=	average kW savings from the measure: 2.23 kW
SAVE	=	Savings per pan: 3,258 kWh/pan[494]
Quantity	=	Number of pans. Default of 3 pans.
Hours	=	Average annual equipment operating hours

Baseline Efficiency

The Baseline Efficiency case is a conventional electric steam cooker with a cooking energy efficiency of 30%, pan production capacity of 23.3 pounds per hour, and an idle energy rate of 1.2 kW.

High Efficiency

The High Efficiency case is an ENERGY STAR® electric steam cooker with a cooking energy efficiency of 50%, pan production capacity of 16.7 pounds per hour, and an idle energy rate of 0.4 kW.

Hours

The average steam cooker is assumed to operate 4,380 hours per year[495].

Measure Life

The measure life for a new steam cooker is 12 years[496].

[494] ENERGY STAR® Commercial Kitchen Equipment Savings Calculator: Steam Cooker Calcs. < *http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/commercial_kitchen_equipment_calculator.xls* >
[495] Ibid
[496] Ibid.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Water and wastewater is saved due to the improved cooking efficiency of the high efficiency equipment.

Benefit Type	Description	Savings[497]
C&I Water	Annual water savings per unit	162,060 gallons/unit
C&I WasteWater	Annual wastewater savings per unit	162,060 gallons/unit

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Steam Cooker	NC	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

100% realization rates are assumed because savings are based on researched assumptions by ENERGY STAR®.

Coincidence Factors

Coincidence factors are 1.0 for both summer and winter seasons because the cooking equipment is assumed to operate throughout the on-peak demand periods.

[497] Ibid.

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Food Service – Commercial Electric Griddle

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of a qualified ENERGY STAR® griddle. ENERGY STAR® griddles save energy during preheat, cooking and idle times due to improved cooking efficiency, and preheat and idle energy rates.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial
Market: Lost Opportunity
End Use: Food Service
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impacts

Unit savings are deemed based on study results:

$$\Delta kWh = (SAVE)(Width)(Hours)$$
$$\Delta kW = (SAVE)(Width)$$

Where:

ΔkWh	=	gross annual kWh savings from the measure
ΔkW	=	gross average kW savings from the measure: 0.58 (calculated)
SAVE	=	Savings per foot of griddle width: 845.67 kWh/ft[498]
Width	=	Width of griddle in feet. Default of 3 feet.
Hours	=	Average annual equipment operating hours

Baseline Efficiency

The baseline efficiency case is a conventional 3-foot wide electric griddle with a cooking energy efficiency of 60%, production capacity of 35 pounds per hour, preheat energy of 4 kWh and an idle energy rate of 2.4 kW.

High Efficiency

The high efficiency case is an ENERGY STAR® 3-foot wide electric griddle with a cooking energy efficiency of 70%, production capacity of 40 pounds per hour, preheat energy of 2 kWh and an idle energy rate of 2.13 kW.

Hours

The average steam cooker is assumed to operate 4,380 hours per year[499].

[498] Food Service Technology Center, Electric Griddle Life-Cycle Cost Calculator for Griddle Width: http://www.fishnick.com/saveenergy/tools/calculators/egridcalc.php
[499] PG&E calculator: http://www.fishnick.com/saveenergy/tools/calculators/egridcalc.php

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Measure Life

The measure life for a new steam cooker is 12 years[500].

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Griddle	NC	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

100% realization rates are assumed because savings are based on researched assumptions by FSTC.

Coincidence Factors

Coincidence factors are 1.0 for both summer and winter seasons because the cooking equipment is assumed to operate throughout the on-peak demand periods.

[500] PG&E calculator: http://www.fishnick.com/saveenergy/tools/calculators/egridcalc.php

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Food Service – Commercial Fryers

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of a qualified ENERGY STAR® commercial fryer. ENERGY STAR® commercial fryers save energy during preheat, cooking and idle times due to improved cooking efficiency, and preheat and idle energy rates.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial
Market: Lost Opportunity
End Use: Food Service
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impacts

Unit savings are deemed based on the Energy Star Commercial Kitchen Equipment Savings Calculator:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW / Hours$$

Where:

ΔkWh	=	gross annual kWh savings from the measure: 760 kWh[501]
ΔkW	=	gross average kW savings from the measure: 0.202 kW[502]
Hours	=	Annual hours of operation. See Hours section below.

Baseline Efficiency

The baseline efficiency case is a deep-fat fryer with a cooking energy efficiency of 75%, shortening capacity of up to 65 pounds, daily preheat energy of 2.3 kWh and idle energy rate of 1.05 kW.

High Efficiency

The high efficiency case is a deep-fat fryer with a cooking energy efficiency of 80%, shortening capacity of up to 65 pounds, daily preheat energy of 1.7 kWh, and idle energy rate of no more than 1.0 kW. For large-capacity fryers (shortening capacity exceeds 50 pounds), the idle energy rate may be up to 1.1 kW.

Hours

Fryers assumed to operate 313 days per year.[503] Fryers assumed to operate 12 hours a day, or 3,756 hours per year.[504]

[501] ENERGY STAR® Commercial Kitchen Equipment Savings Calculator: Fryer Calculations. < *http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/commercial_kitchen_equipment_calculator.xls* >. Default assumptions used except for operating hours, see Hours section, and food cooked per day. Food cooked is adjusted based on the reduction in operating hours.
[502] Ibid.
[503] The default value of 365 days per year seems excessive. Though many or most restaurants operate 7 days per week, many institutional kitchens do not. 6 day operation is assumed. 365 * 6/7 = 313 days/yr

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Measure Life

The measure life for a new commercial electric fryer is 12 years[505].

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Fryer	NC	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

100% realization rates are assumed because savings are based on researched assumptions by ENERGY STAR®.

Coincidence Factors

Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

[504] Default hours of 16 seem excessive by staff estimates and compared to other commercial equipment operation hours. Twelve hours used as more reasonable estimate.
[505] Pacific Gas & Electric Company – Customer Energy Efficiency Department (2007). *Work Paper PGECOFST101, Commercial Convection Oven, Revision #0.*

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Compressed Air – High Efficiency Air Compressors

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: Covers the installation of oil flooded, rotary screw compressors with Load/No Load, Variable Speed Drive, or Variable Displacement capacity control with properly sized air receiver. Efficient air compressors use various control schemes to improve compression efficiencies at partial loads. When an air compressor fitted with Load/No Load, Variable Speed Drive, or Variable Displacement capacity controls is used in conjunction with a properly-sized air receiver, considerable amounts of energy can be saved.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: Compressed Air
Program: C&I New Construction, C&I Large Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (HP_{COMPRESSOR})(SAVE)(Hours)$$
$$\Delta kW = (HP_{COMPRESSOR})(SAVE)$$

Where:
$HP_{COMPRESSOR}$ = Nominal rated horsepower of high efficiency air compressor.
Save = Air compressor kW reduction per HP. See Table 15 for values.
Hours = Annual operating hours of the air compressor.

Table 15: Air Compressor kW Reduction per Horsepower

Control Type	Nominal Horsepower (HP)	kW Reduction per Horsepower (Save)[506]	
		Lost Opportunity	Retrofit
Load/No Load	≥15 and <25	0.076	0.102
Load/No Load	≥25 and <=75	0.114	0.102
VSD	≥15 and <25	0.159	0.207
VSD	≥25 and <=75	0.228	0.206
Variable Displacement	≥50 and <=75	0.110	0.116

Baseline Efficiency

The baseline efficiency case is a typical modulating compressor with blow down valve.

[506] From NSTAR analysis based on metering data. The location of original data and analysis is unknown; however, these values are supported by multiple 3rd party impact evaluations.

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High Efficiency

The high efficient case is an oil-flooded, rotary screw compressor with Load/No Load, Variable Speed Drive, or Variable Displacement capacity control with a properly sized air receiver. Air receivers are designed to provide a supply buffer to meet short-term demand spikes which can exceed the compressor capacity. Installing a larger receiver tank to meet occasional peak demands can allow for the use of a smaller compressor.

Hours

The annual hours of operation for air compressors are site-specific and should be determined on a case-by-case basis.

Measure Life

For lost-opportunity installations, the lifetime for this measure is 15 years. For retrofit projects, the lifetime is 13 years.[507]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Air Compressor	NC, Large Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.80	0.54	n/a	n/a
Air Compressor	NC, Large Retrofit	NSTAR, CLC	1.00	1.00	1.25	0.95	0.80	0.88	0.69	n/a	n/a
Air Compressor	NC, Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
Air Compressor	NC, Large Retrofit	WMECO	1.00	1.00	0.90	1.71	1.22	n/a	n/a	0.77	0.54

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs based on impact evaluation of PY 2004 compressed air installations.[508]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[509]
- WMECO: energy RRs are from 2007/2008 Large C&I Programs impact evaluation[510]

Coincidence Factors

- National Grid, Unitil, WMECO: CFs based on impact evaluation of PY 2004 compressed air installations.[511]

[507] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[508] Ibid.
[509] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[510] KEMA, Inc. (2010). *2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures*. Prepared for Western Massachusetts Electric Company.
[511] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.

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- NSTAR, CLC: CFs based on standard assumptions.

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Compressed Air – Refrigerated Air Dryers

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: The installation of cycling or variable frequency drive (VFD)-equipped refrigerated compressed air dryers. Refrigerated air dryers remove the moisture from a compressed air system to enhance overall system performance. An efficient refrigerated dryer cycles on and off or uses a variable speed drive as required by the demand for compressed air instead of running continuously. Only properly sized refrigerated air dryers used in a single-compressor system are eligible.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Compressed Air
Program: C&I New Construction and Major Renovation

Algorithms for Calculating Primary Energy Impact

$$\Delta kWh = (CFM_{DRYER})(SAVE)(Hours)$$
$$\Delta kW = (CFM_{DRYER})(SAVE)$$

Where:

CFM_{DRYER} = Full flow rated capacity of the refrigerated air dryer in cubic feet per minute (CFM). Obtain from equipment's Compressed Air Gas Institute Datasheet.
Save = Refrigerated air dryer kW reduction per dryer full flow rated CFM. See Table 16.
Hours = Annual operating hours of the refrigerated air dryer.

Table 16: Default kW Reduction per CFM by Dryer Capacity (*SAVE*)

Dryer Capacity (CFM_{DRYER})	kW Reduction per CFM (Save)[512]
<100	0.00474
≥100 and <200	0.00359
≥200 and <300	0.00316
≥300 and <400	0.00290
≥400	0.00272

Baseline Efficiency

The baseline efficiency case is a non-cycling refrigerated air dryer.

High Efficiency

The high efficiency case is a cycling refrigerated dryer or a refrigerated dryer equipped with a VFD.

[512] From NSTAR analysis based on metering data. The location of original data and analysis is unknown; however, these values are supported by multiple 3rd party impact evaluations. Single set of savings numbers used since VFD and cycling savings similar down to 40-50% load and prescriptive compressor loading is in the 50-60% range.

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Hours

The annual hours of operation for compressed air dryers are site-specific.

Measure Life

The measure life is 15 years.[513]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Refrigerated Air Dryer	NC	National Grid	1.00	1.00	1.00	1.00	1.00	0.54	0.77	n/a	n/a
Refrigerated Air Dryer	NC	NSTAR, CLC	1.00	1.00	1.25	0.95	0.80	0.88	0.69	n/a	n/a
Refrigerated Air Dryer	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
Refrigerated Air Dryer	NC	WMECO	1.00	1.00	0.90	1.71	1.22	n/a	n/a	0.77	0.54

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs based on impact evaluation of PY 2004 compressed air installations.[514]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[515]
- WMECO: energy RRs are from 2007/2008 Large C&I Programs impact evaluation[516]

Coincidence Factors

- National Grid, Unitil, WMECO: CFs based on impact evaluation of PY 2004 compressed air installations.[517]
- NSTAR, CLC: CFs based on standard assumptions.

[513] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[514] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.
[515] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[516] KEMA, Inc. (2010). *2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures*. Prepared for Western Massachusetts Electric Company.
[517] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.

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Compressed Air – Low Pressure Drop Filters

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Filters remove solids and aerosols from compressed air systems. Low pressure drop filters have longer lives and lower pressure drops than traditional coalescing filters resulting in higher efficiencies.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity & Retrofit
End Use: Compressed Air
Program: C&I New Construction, C&I Large Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (Quantity)(HP_{COMP})(0.7457)(\%Savings)(Hours)$$
$$\Delta kW = (Quantity)(HP_{COMP})(0.7457)(\%Savings)$$

Where:

ΔkWh	=	Energy savings
ΔkW	=	Demand savings
Quantity	=	Number of filters installed
HP_{COMP}	=	Average compressor load
0.7457	=	Conversion from HP to kW
% Savings	=	Percent change in pressure drop. Site specific.
Hours	=	Annual operating hours of the lower pressure drop filter.

Baseline Efficiency

The baseline efficiency case is a standard coalescing filter with initial drop of between 1 and 2 pounds per sq inch (psi) with an end of life drop of 10 psi.

High Efficiency

The high efficiency case is a low pressure drop filter with initial drop not exceeding 1 psi over life and 3 psi at element change. Filters must be deep-bed, "mist eliminator" style and installed on a single operating compressor rated 15 – 75 HP.

Hours

The annual hours of operation are site specific and will be determined on a case by case basis.

Measure Life

For lost-opportunity installations, the lifetime for this measure is 5 years. For retrofit projects, the lifetime is 3 years.[518]

[518] Based on typical replacement schedules for low pressure filters (NSTAR staff estimates).

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
LP Drop Filter	NC, Large Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
LP Drop Filter	NC, Large Retrofit	NSTAR, CLC	1.00	1.00	1.25	0.95	0.80	0.88	0.69	n/a	n/a
LP Drop Filter	NC, Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
LP Drop Filter	NC, Large Retrofit	WMECO	1.00	1.00	0.90	1.71	1.22	n/a	n/a	custom	custom

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs based on impact evaluation of PY 2004 compressed air installations.[519]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[520]
- WMECO: RRs from 2011 WMECO C&I impact evaluation.[521]

Coincidence Factors

- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.522
- NSTAR, CLC: CFs based on standard assumptions.
- WMECO: CFs are custom calculated.

[519] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.
[520] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[521] KEMA (2011). 2007/2008 Large C&I Programs. Prepared for Western Massachusetts Electric Company.
[522] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.

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Compressed Air – Zero Loss Condensate Drains

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Drains remove water from a compressed air system. Zero loss condensate drains remove water from a compressed air system without venting any air, resulting in less air demand and consequently greater efficiency.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity & Retrofit
End Use: Compressed Air
Program: C&I New Construction, C&I Large Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (CFM_{pipe})(CFM_{saved})(SAVE)(Hours)$$
$$\Delta kW = (CFM_{pipe})(CFM_{save})(SAVE)$$

Where:

ΔkWh	=	Energy Savings
ΔkW	=	Demand savings
CFM_{pipe}	=	CFM capacity of piping. Site specific.
CFM_{saved}	=	Average CFM saved per CFM of piping capacity: 0.049
Save	=	Average savings per CFM: 0.24386 kW/CFM[523]
Hours	=	Annual operating hours of the zero loss condensate drain.

Baseline Efficiency

The baseline efficiency case is installation of a standard condensate drain on a compressor system.

High Efficiency

The high efficiency case is installation of a zero loss condensate drain on a single operating compressor rated ≤ 75 HP.

Hours

The annual hours of operation are site specific and will be determined on a case by case basis.

Measure Life

For lost-opportunity installations, the lifetime for this measure is 15 years. For retrofit projects, the lifetime is 13 years.[524]

[523] Based on NSTAR analysis assuming a typical timed drain settings discharge scenario.
[524] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1. Drains not expected to change during life of compressor.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Zero Loss Drain	NC, Large Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
Zero Loss Drain	NC, Large Retrofit	NSTAR, CLC	1.00	1.00	1.25	0.95	0.80	0.88	0.69	n/a	n/a
Zero Loss Drain	NC, Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
Zero Loss Drain	NC, Large Retrofit	WMECO	1.00	1.00	0.90	1.71	1.22	n/a	n/a	custom	custom

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid, Unitil: RRs based on impact evaluation of PY 2004 compressed air installations.[525]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[526]
- WMECO: RRs from 2011 WMECO C&I impact evaluation.[527]

Coincidence Factors

- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.[528]
- NSTAR, CLC: CFs based on standard assumptions.
- WMECO: CFs are custom calculated.

[525] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.
[526] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[527] KEMA (2011). 2007/2008 Large C&I Programs. Prepared for Western Massachusetts Electric Company.
[528] DMI (2006). *Impact Evaluation of 2004 Compressed Air Prescriptive Rebates*. Prepared for National Grid; results analyzed in RLW Analytics (2006). *Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs*. Prepared for National Grid.

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Motors/Drives – Variable Frequency Drives

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: This measure covers the installation of variable speed drives according to the terms and conditions stated on the statewide worksheet. The measure covers multiple end use types and building types. The installation of this measure saves energy since the power required to rotate a pump or fan at lower speeds requires less power than when rotated at full speed.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: Motors/Drives
Program: C&I New Construction & Major Renovation, C&I Large Retrofit, C&I Small Retrofit

Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (HP)\left(\frac{1}{\eta_{motor}}\right)(kWh/HP)$$

$$\Delta kW = (HP)\left(\frac{1}{\eta_{motor}}\right)(kW/HP)_{SP}$$

Where:

HP	=	Rated horsepower for the impacted motor.
η_{motor}	=	Motor efficiency
kWh/HP	=	Annual electric energy reduction based on building and equipment type. See Table 17.
kW/HP_{SP}	=	Summer demand reduction based on building and equipment type. See Table 17.
kW/HP_{WP}	=	Winter demand reduction based on building and equipment type. See Table 17.

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Table 17: Savings Factors for C&I VFDs (kWh/HP and kW/HP)[529]

	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating. Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
Annual Energy Savings Factors (kWh/HP)									
University/College	3,641	449	745	2,316	2,344	3,220	1,067	1,023	3,061
Elm/H School	3,563	365	628	1,933	1,957	3,402	879	840	2,561
Multi-Family	3,202	889	1,374	2,340	2,400	3,082	1,374	1,319	3,713
Hotel/Motel	3,151	809	1,239	2,195	2,239	3,368	1,334	1,290	3,433
Health	3,375	1,705	2,427	2,349	2,406	3,002	1,577	1,487	3,670
Warehouse	3,310	455	816	2,002	2,087	3,229	1,253	1,205	2,818
Restaurant	3,440	993	1,566	1,977	2,047	2,628	1,425	1,363	3,542
Retail	3,092	633	1,049	1,949	2,000	2,392	1,206	1,146	2,998
Grocery	3,126	918	1,632	1,653	1,681	2,230	1,408	1,297	3,285
Offices	3,332	950	1,370	1,866	1,896	3,346	1,135	1,076	3,235
Summer Demand Savings Factors (kW/HP_{SP})									
University/College	0.109	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.056
Elm/H School	0.377	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.275
Multi-Family	0.109	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.056
Hotel/Motel	0.109	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.056
Health	0.109	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.056
Warehouse	0.109	-0.023	0.056	0.457	0.457	0.261	0.102	0.064	0.056
Restaurant	0.261	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.178
Retail	0.109	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.056
Grocery	0.261	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.178
Offices	0.109	-0.023	0.056	0.457	0.457	0.109	0.102	0.064	0.056
Winter Demand Savings Factors (kW/HP_{WP})									
University/College	0.377	-0.006	0.457	0.457	0.457	0.109	0.113	0.113	0.457
Elementary/High School	0.457	-0.006	0.457	0.457	0.457	0.109	0.113	0.113	0.457
Multi-Family	0.109	-0.006	0.457	0.355	0.384	0.109	0.113	0.113	0.355
Hotel/Motel	0.109	-0.006	0.457	0.418	0.444	0.109	0.113	0.113	0.418
Health	0.377	-0.006	0.457	0.275	0.298	0.109	0.113	0.113	0.275
Warehouse	0.377	-0.006	0.457	0.178	0.193	0.261	0.113	0.113	0.178
Restaurant	0.109	-0.006	0.457	0.355	0.384	0.109	0.113	0.113	0.355
Retail	0.109	-0.006	0.457	0.275	0.298	0.109	0.113	0.113	0.275
Grocery	0.457	-0.006	0.457	0.418	0.444	0.109	0.113	0.113	0.418
Offices	0.457	-0.006	0.457	0.418	0.444	0.109	0.113	0.113	0.418

Baseline Efficiency

The baseline efficiency case for this measure varies with the equipment type. All baselines assume either a constant speed motor or 2-speed motor. In the baselines, air or water volume/temperature is controlled using valves, dampers, and/or reheats.

High Efficiency

In the high efficiency case, pump flow or fan air volume is directly controlled using downstream information. The pump or fan will automatically adjust its speed based on inputted set points and the downstream feedback it receives.

[529] Chan, Tumin (2010). *Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR.* Prepared for NSTAR.

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Hours

Hours vary by end use and building type.

Measure Life

For lost-opportunity installations, the lifetime for this measure is 15 years. For retrofit projects, the lifetime is 13 years.[530]

Secondary Energy Impacts

There are no secondary energy impacts.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
VFD	NC	All	1.00	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00
VFD	Large Retrofit	All	1.00	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00
VFD	Small Retrofit	CLC	1.00	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Energy RRs for all PAs based on impact evaluation of 2011-2012 prescriptive VSD projects.[531] Demand RRs from study not used due to low precision of demand results.

Coincidence Factors

CFs for all PAs set to 1.0 based summer and winter factors in gross calculation and pending impact evaluation.

[530] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[531] KEMA, Inc. and DMI, Inc. (2013). *2011-2012 Massachusetts Prescriptive VSD Impact Evaluation.* Prepared for the Massachusetts Program Administrators and the Massachusetts Energy Efficiency Advisory Council.

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Custom Measures (Large C&I)

Version Date and Revision History

Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: The Custom project track is offered for energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.
Primary Energy Impact: Electric
Secondary Energy Impact: Project Specific
Non-Energy Impact: Project Specific
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: All
Program: C&I New Construction & Major Renovation, C&I Large Retrofit

Notes

In 2011 the PAs agreed on the following set of categories for Large C&I custom projects. All Large C&I Custom projects will be assigned to one of the following categories for future statewide impact evaluation.

Custom Category	Description
Comprehensive Design	New construction projects which address multiple end-uses, reach 20%+ total energy savings, and use whole-building simulations for ex-ante savings estimates and Retrofit projects which address multiple end-uses, reach 15%+ electric energy savings, and do not require whole-building simulations.
Compressed Air	New construction and/or retrofit projects for compressed air systems.
CHP	Combined Heat and Power projects.
HVAC	New construction and/or retrofit projects for HVAC system equipment and controls.
Lighting	New construction and/or retrofit projects for lighting system equipment and controls.
Motor	New construction and/or retrofit projects for motor installations or controls.
Other	New construction and/or retrofit projects that do not fit in with other categories.
Process	New construction and/or retrofit projects for process system equipment and controls.
Refrigeration	New construction and/or retrofit projects for refrigeration system equipment and controls.
Verified Savings	Retrofit "Pay-for-Performance" projects for which savings are estimated based on post-installation measurement and verification.

Algorithms for Calculating Primary Energy Impact

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis with project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, end-use metering or other engineering analysis and include estimates of savings, costs, and an evaluation of the projects' cost-effectiveness.

Baseline Efficiency

For Lost Opportunity projects, the baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code or industry accepted standard practice.

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For retrofit projects, the baseline efficiency case is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency

The high efficiency scenario is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective in order to qualify for energy efficiency incentives.

Hours

All hours for custom savings analyses should be determined on a case-by-case basis.

Measure Life

For both lost-opportunity and retrofit custom applications, the measure life is determined based on specific project using the common custom measure life recommendations.[532]

Secondary Energy Impacts

All secondary energy impacts should be determined on a case-by-case basis.

Non-Energy Impacts

All non-energy impacts should be determined on a case-by-case basis.

[532] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-2.

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Impact Factors for Calculating Adjusted Gross Savings

Measure	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Comprehensive Design	NSTAR, CLC, Unitil, WMECO	1.00	1.00	0.91	0.64	0.60	custom	custom	custom	custom
	NGRID	1.00	1.00	0.97	0.64	0.55	custom	custom	n/a	n/a
Compressed Air	All (except WMECO)	1.00	1.00	0.85	0.76	0.74	custom	custom	n/a	n/a
	WMECO	1.00	1.00	0.85	0.75	0.75	n/a	n/a	custom	custom
CHP	NSTAR	1.00	1.00	1.15	1.00	1.00	custom	custom	custom	custom
	NGRID	1.00	1.00	0.86	1.00	1.00	custom	custom	custom	custom
	WMECo	1.00	1.00	1.00	1.00	1.00	n/a	n/a	custom	custom
HVAC	Unitil, WMECO	1.00	1.00	1.10	0.88	0.86	custom	custom	custom	custom
	NGRID	1.00	1.00	1.01	0.84	0.82	custom	custom	n/a	n/a
	NSTAR	1.00	1.00	1.24	0.94	0.75	custom	custom	n/a	n/a
	CLC	1.00	1.00	1.10	0.94	0.75	custom	custom	n/a	n/a
Lighting	NGRID	1.00	1.00	0.98	1.16	0.85	custom	custom	n/a	n/a
	NSTAR	1.00	1.00	1.02	0.85	0.84	custom	custom	n/a	n/a
	Unitil, CLC	1.00	1.00	0.98	0.94	0.92	custom	custom	n/a	n/a
	WMECO	1.00	1.00	0.98	0.92	0.88	n/a	n/a	custom	custom
Motor	NGRID	1.00	1.00	0.89	0.89	0.74	custom	custom	n/a	n/a
	NSTAR, CLC	1.00	1.00	0.91	0.90	0.76	custom	custom	n/a	n/a
	Unitil	1.00	1.00	0.91	0.90	0.76	custom	custom	n/a	n/a
	WMECO	1.00	1.00	0.91	0.76	0.75	n/a	n/a	custom	custom
Process	NGRID	1.00	1.00	0.68	0.96	0.82	custom	custom	n/a	n/a
	NSTAR	1.00	1.00	1.04	0.80	1.11	custom	custom	n/a	n/a
	Unitil, CLC	1.00	1.00	0.76	0.82	0.88	custom	custom	n/a	n/a
	WMECO	1.00	1.00	0.76	0.84	0.89	n/a	n/a	custom	custom
Refrigeration	NGRID	1.00	1.00	1.19	1.21	1.20	custom	custom	n/a	n/a
	NSTAR, CLC	1.00	1.00	1.13	1.38	1.10	custom	custom	n/a	n/a
	Unitil	1.00	1.00	1.11	1.21	1.14	custom	custom	n/a	n/a
	WMECO	1.00	1.00	1.11	1.33	1.17	n/a	n/a	custom	custom
Other	NGRID	1.00	1.00	0.31	0.34	0.33	custom	custom	n/a	n/a
	WMECO	1.00	1.00	0.61	0.64	0.63	n/a	n/a	custom	custom
Verified Savings[533]	Statewide	1.00	1.00	1.00	1.00	1.00	custom	custom	custom	custom

Note: Unless otherwise stated, PA's use Statewide results.

[533] The PAs assume 100% realization rates for verified savings projects because gross savings assumptions are based on post-installation verification and analysis. This custom category is new in 2011 and has not been evaluated.

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In-Service Rates
All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
- Comprehensive: Realization rates from statewide impact evaluation completed in 2011. National Grid uses PA specific values, all other PA's use statewide values due to small sample size.[534]
- HVAC: Realization rates from statewide impact evaluation completed in 2011. National Grid and NSTAR use PA specific values, all other PA's use statewide values due to small sample size.[535]
- CHP: NSTAR and National Grid CHP RRs from National Grid / NSTAR impact evaluation of CHP 2010 projects.[536]
- Lighting: Realization rates from statewide impact evaluation completed in 2012. National Grid and NSTAR use PA specific values, all other PAs use statewide values due to small sample size.[537]
- Compressed Air and Process: Realization rates from statewide impact evaluation completed in 2012. All PAs use statewide values due to poor precision on a PA level for compressed air. National Grid and NSTAR use PA specific results for the process measure while other PAs use statewide results. .[538]
- Refrigeration, Motors, and Other: Realization rates from statewide impact evaluation completed in 2012. National Grid uses PA specific values for each end use, all other PAs use statewide values due to small sample size. In the case of NSTAR, the statewide rate for Custom Motors was used due to small sample size, and the PA specific number for Refrigeration.[539]

Coincidence Factors
For all PAs, gross summer and winter peak coincidence factors are custom-calculated for each custom project based on project-specific information. The actual or measured coincidence factors are included in the summer and winter demand realization rates.

[534] KEMA, Inc. and SBW (2011). *Impact Evaluation of 2008 and 2009 Custom CDA Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[535] KEMA, Inc. and DMI (2011). *Impact Evaluation of 2009 Custom HVAC Installations*. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[536] KEMA (2012). *2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo.* Prepared for National Grid and NSTAR; Table 1-1
[537] KEMA (2012). *Impact Evaluation of the 2010 Custom Lighting Installations*. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[538] KEMA, Inc. and SBW (2012). *Impact Evaluation of 2010 Custom Process and Compressed Air Installations*. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[539] KEMA, Inc. and SBW (2013). *Impact Evaluation of 2011 Custom Refrigeration, Motor, and Other Installations*. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.

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Custom Measures (Small C&I)

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Effective Date: 1/1/2011 (Revised 1/1/2012)
End Date: TBD

Measure Overview

Description: The Custom project track is offered for energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.
Primary Energy Impact: Electric
Secondary Energy Impact: Project Specific
Non-Energy Impact: Project Specific
Sector: Commercial & Industrial
Market: Retrofit
End Use: All
Program: C&I Small Retrofit

Algorithms for Calculating Primary Energy Impact

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis with project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, end-use metering or other engineering analysis and include estimates of savings, costs, and an evaluation of the projects' cost-effectiveness.

Baseline Efficiency

For Lost Opportunity projects, the baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code or industry accepted standard practice. For retrofit projects, the baseline efficiency case is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency

The high efficiency scenario is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective in order to qualify for energy efficiency incentives.

Hours

All hours for custom savings analyses should be determined on a case-by-case basis.

Measure Life

For both lost-opportunity and retrofit custom applications, the measure life is determined based on specific project using the common custom measure life recommendations.[540]

[540] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-2.

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Secondary Energy Impacts

All secondary energy impacts should be determined on a case-by-case basis.

Non-Energy Impacts

All non-energy impacts should be determined on a case-by-case basis.

Impact Factors for Calculating Adjusted Gross Savings

Measure	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Lighting	National Grid	1.00	1.00	1.04	1.02	1.13	custom	custom	n/a	n/a
Refrigeration	National Grid	1.00	1.00	1.60	1.49	0.69	custom	custom	n/a	n/a
Other	National Grid	1.00	1.00	0.81	0.77	0.53	custom	custom	n/a	n/a
Lighting Systems	NSTAR	1.00	1.00	1.02	0.99	0.99	custom	custom	n/a	n/a
Lighting Controls	NSTAR, CLC	1.00	1.00	0.42	0.92	0.92	custom	custom	n/a	n/a
Non-Lighting	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	custom	custom	n/a	n/a
Lighting	Unitil	1.00	1.00	1.08	0.99	0.99	custom	custom	n/a	n/a
Non-Lighting	Unitil	1.00	1.00	1.08	1.00	1.00	custom	custom	n/a	n/a
Lighting	WMECO	1.00	1.00	0.83	0.54	0.25	n/a	n/a	custom	custom
Refrigeration	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	custom	custom
Other	WMECO	1.00	1.00	1.00	1.00	1.00	n/a	n/a	custom	custom

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

- National Grid RRs derived from impact evaluation of 2005 SBS program[541]
- NSTAR and CLC RRs from the 2011 Small C&I Non-Controlled Lighting impact evaluation [542]; non-lighting energy and all demand RRs based on NSTAR 2002–2004 small retrofit impact evaluations, lighting controls from Small Business Direct Install Program: Pre/Post Lighting Controls Study, June 2012 study previously referenced in Large C&I Lighting Controls section above.
- Unitil RRs from Small Business program impact evaluation.[543]
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[544]

Coincidence Factors

For all PAs, gross summer and winter peak coincidence factors are custom-calculated for each custom project based on project-specific information. The actual or measured coincidence factors are included in the summer and winter demand realization rates.

[541] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation*. Prepared for National Grid; Table 4.
[542] Cadmus Group (2011). *Non-Controls Lighting Evaluation for the Massachusetts Small Commercial Direct Install Program*. Prepared for Massachusetts Utilities.
[543] Summit Blue Consulting, LLC (2008). *Multiple Small Business Services Programs Impact Evaluation 2007 – Final Report Update*. Prepared for Cape Light Compact, National Grid, NSTAR, Unitil and Western Massachusetts Electric Company.
[544] The Cadmus Group, Inc. (2010). *Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.

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Residential Natural Gas Efficiency Measures

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Behavior – OPOWER Gas

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: The Behavior/Feedback programs send monthly energy use reports to participating gas customers in order to change customers' energy-use behavior.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Products and Services
End Use: Behavior
Program: Behavior/Feedback Program

Algorithms for Calculating Primary Energy Impact

Unit saving are deemed based on study results:

$$\Delta MMBtu = (MMBtu_{BASE})(\%SAVE)$$

Where:

Unit = One participant household
ΔMMBtu = Average annual gas heating MMBtu savings per unit. See Table 18.
$MMBtu_{BASE}$ = Average baseline consumption MMBtu per unit. See Table 18.
%SAVE = Annual percent of MMBtu savings per unit. See Table 18.

Table 18: Savings Factors for Behavior/Feedback Program[545]

Measure	PA	$MMBtu_{BASE}$	%SAVE	ΔMMBtu
OPOWER Group 2009	National Grid	115	1.43%	1.64
OPOWER Group 2010	National Grid	116.9	1.80%	2.10
OPOWER Group 2011	National Grid	85.8	1.18%	1.01
OPOWER Group 2011 Add	National Grid	54.3	1.18%	0.74
OPOWER Group 2012	National Grid	70	1.13%	0.79
OPOWER Group 2012 Dual	National Grid	69.6	0.50%	0.35

Baseline Efficiency

The baseline efficiency case is a customer who does not receive Behavior/Feedback program reports.

High Efficiency

The high efficiency case is a customer who does receive Behavior/Feedback program reports.

Hours

Not applicable.

[545] Opinion Dynamics Corporation and Navigant Consulting (2013) *Massachusetts Cross-cutting Behavioral Program Evaluation Integrated Report.*

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Measure Life

The measure life is 1 year[546].

Secondary Energy Impacts

There are no secondary energy impacts for this measure

Non-Energy Impacts

There are no-non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
OPOWER Group	Behavior/Feedback	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
OPOWER Group	Behavior/Feedback	NSTAR	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

RRs are 100% because deemed savings are based on assumptions from year-to-date vendor findings. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[546] Vendor estimate.

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Hot Water – Water Heaters

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of high efficiency gas water heaters: *Indirect water heaters* use a storage tank that is heated by the main boiler. The energy stored by the water tank allows the boiler to turn off and on less often, saving considerable energy. *Condensing water heaters* recover energy by using either a larger heat exchanger or a second heat exchanger to reduce the flue-gas temperature to the point that water vapor condenses, thus releasing even more energy. *Stand-alone storage water heaters* are high efficiency water heaters that are not combined with space heating devices. *Tankless water heaters* circulate water through a heat exchanger to be heated for immediate use, eliminating the standby heat loss associated with a storage tank.
Primary Energy Impact: Natural Gas (Residential DHW)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Lost Opportunity
End Use: Hot Water
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

ΔMMBtu = Annual MMBtu savings per unit. See Table 19.

Table 19: Savings for Residential Water Heaters

Equipment Type	Efficiency Requirement	ΔMMBtu
Condensing Water Heater	EF >=0.80	7.4 [547]
	TE >=95%	25.0 [548]
Indirect Water Heater	ENERGY STAR® Boiler	8.0 [549]
Stand-Alone Storage Water Heater	EF >= 0.67	4.2 [550]
On-Demand Tankless Water Heater	EF >= 0.82	10.2 [551]
	EF >= 0.95	10.7 [552]

[547] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.
[548] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[549] Nexus Market Research and The Cadmus Group (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks.
[550] Based on DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10. Savings have been adjusted to reflect the mix of replace on failure and early replacement. Percentage of early retirement is from The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.
[551] Nexus Market Research and The Cadmus Group (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks. Savings have been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.
[552] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10, energy consumption estimated using the DOE test procedure. Based on the following formula: (41,045 BTU/EF x 365)/1,000,000.

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Baseline Efficiency

The baseline efficiency case is a stand alone tank water heater with an energy factor of 0.575 for replace on failure and 0.55 for early retirement.

High Efficiency

The high efficiency case is a stand-alone storage water heater with an energy factor >= 0.62, a condensing water heater with an energy factor >= 0.8, a tankless water heater with an energy factor >= 0.82, or an indirect water heater attached to an ENERGY STAR® rated forced hot water gas boiler.

Hours

Not applicable.

Measure Life

The measure lives vary by water heater type and are described in the table below.

Measure Lives for Residential Water Heaters

Measure	Measure Life (years)
Condensing Water Heater	15 [553]
Indirect Water Heater	20 [554]
Stand-Alone Storage Water Heater	12 [555]
On-Demand Tankless Water Heater	19 [556]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Savings have been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

[553] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.

[554] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.

[555] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10. Lifetime has been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

[556] Ibid.

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Water Heater	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Indirect Water Heater	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Stand Alone Storage Water Heater	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
On-Demand Tankless Water Heater	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. Summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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Hot Water – Showerheads

Version Date and Revision History

Effective Date: 7/1/2012
End Date: TBD

Measure Overview

Description: An existing showerhead with a high flow rate is replaced with a new low flow showerhead.
Primary Energy Impact: Natural Gas (Residential DHW)
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts, Residential Water
Sector: Residential
Market: Retrofit
End Use: Hot Water
Program: Home Energy Services (Gas Weatherization)

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

ΔMMBtu = Average annual savings per showerhead: 1.2 MMBtu[557]

Baseline Efficiency

The baseline efficiency case is the existing showerhead with a high flow.

High Efficiency

The high efficiency case is a low flow showerhead.

Hours

Not applicable.

Measure Life

The measure life is 7 years[558]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[557] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[558] Massachusetts common assumption based on various sources: Connecticut Program Savings Documentation for 2012 Program Year" (United Illuminating Co. and CT Light and Power Co., 2011) has 5 years for existing home retrofit. "Measure Life Report, Residential and Commercial/Industrial lighting and HVAC Measures" (GDS, 2007), reports 10 yr for retrofit per CA DEER, and 9 yr for retrofit or NC for VT.

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Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Gallons water saved per year per unit that received DHW measures[559]	3,696 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Showerhead	HES	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. Summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[559] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators

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Hot Water – Faucet Aerator

Version Date and Revision History

Effective Date: 7/1/2012
End Date: TBD

Measure Overview

Description: An existing faucet aerator with a high flow rate is replaced with a new low flow showerhead.
Primary Energy Impact: Natural Gas (Residential DHW)
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts, Residential Water
Sector: Residential
Market: Retrofit
End Use: Hot Water
Program: Home Energy Services (Gas Weatherization)

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

ΔMMBtu = Average annual savings per faucet aerator: 0.2 MMBtu[560]

Baseline Efficiency

The baseline efficiency case is the existing faucet aerator with a high flow.

High Efficiency

The high efficiency case is a low flow faucet aerator.

Hours

Not applicable.

Measure Life

The measure life is 7 years[561]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[560] The Cadmus Group, Inc. (2012). *Home Energy Services Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[561] Massachusetts common assumption based on various sources: Connecticut Program Savings Documentation for 2012 Program Year" (United Illuminating Co. and CT Light and Power Co., 2011) has 5 years for existing home retrofit. "Measure Life Report, Residential and Commercial/Industrial lighting and HVAC Measures" (GDS, 2007), reports 10 yr for retrofit per CA DEER, and 9 yr for retrofit or NC for VT.

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Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Gallons water saved per year per unit that received DHW measures[562]	332 Gallons/Participant
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Faucet Aerator	HES	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. Summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[562] NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation,* Prepared for Massachusetts Program Administrators

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HVAC – Boilers

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a new high efficiency gas-fired boiler for space heating.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Unit = Installation of high efficiency boiler

ΔMMBtu = Annual MMBtu savings per unit. See Table 20 for values.

Table 20: Savings for Residential Boilers

Measure	ΔMMBtu
Boiler (AFUE >= 90%)	15.4 [563]
Boiler (AFUE >= 96%)	23.0[564]

Baseline Efficiency

The baseline efficiency case is an 80% AFUE boiler for replace on failure and 72.5% AFUE for early retirement.

High Efficiency

The high efficiency case is a boiler with an AFUE of 90% or greater.

Hours

Not applicable.

[563] Nexus Market Research and The Cadmus Group (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks. Savings have been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

[564] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks. Savings have been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

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Measure Life

The measure life is 19 years.[565]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Boiler (AFUE >=85%)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Boiler (AFUE >=90%)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Boiler (AFUE >=95%)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[565] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers.* Lifetime has been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing.* Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

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HVAC – Boiler Reset Controls

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Boiler Reset Controls are devices that automatically control boiler water temperature based on outdoor temperature using a software program.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed boiler reset control
ΔMMBtu = Annual MMBtu savings per unit: 7.9 MMBtu[566]

Baseline Efficiency

The baseline efficiency case is a boiler without reset controls.

High Efficiency

The high efficiency case is a boiler with reset controls.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[567]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[566] ACEEE (2006). *Emerging Technologies Report: Advanced Boiler Controls*. Prepared for ACEEE; Page 2.
[567] Ibid.

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Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Boiler Reset Controls	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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HVAC – Combo Boiler/Water Heater

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: This measure promotes the installation of a combined high-efficiency boiler and water heating unit. Combined boiler and water heating systems are more efficient than separate systems because they eliminate the standby heat losses of an additional tank.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Lost Opportunity
End Use: Residential Heat
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Units = Installation of integrated water heater/boiler unit
ΔMMBtu = Annual MMBtu savings per unit: See Table 21.

Table 21: Savings for Residential Combo Boilers/Water Heater

Measure	ΔMMBtu
Combo Condensing Boiler/DHW 90%	26.1[568]

Baseline Efficiency

The baseline efficiency case is an 80% AFUE boiler with a 0.594 EF water heater for replace on failure and 72% AFUE boiler with a 0.55 EF water heater for early retirement.

High Efficiency

The high efficiency case is an integrated water heater/boiler unit with a 90% AFUE condensing boiler and a 0.9 EF water heater.

Hours

Not applicable.

[568] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks. Savings have been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

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Measure Life

The measure life is 17 years.[569]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Boiler/DHW 90%	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[569] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers*; measure life assumed to be the same as a boiler. Lifetime has been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

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HVAC – Early Replacement Boiler

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 5/1/2012)
End Date: TBD

Measure Overview

Description: Early retirement of inefficient gas-fired boiler and installation of new high efficiency gas-fired boiler.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings for the early replacement of an existing boiler with a high efficiency boiler are counted in two parts: (1) early retirement savings for a code-compliant boiler compared to the existing boiler over the remaining lifetime of the existing boiler, and (2) efficiency savings for the high efficiency boiler compared to a code-compliant boiler for the full life of the new high efficiency boiler:

$$\Delta MMBtu = \Delta MMBtu_{RETIRE} + \Delta MMBtu_{EE}$$

Where:

Unit	=	Removal of existing inefficient boiler and installation of new high efficiency boiler
$\Delta MMBtu_{RETIRE}$	=	Annual MMBtu savings of code-compliant boiler compared to existing boiler: 26.3 MMBtu and 35.1 MMBTU for steam[570]
$\Delta MMBtu_{EE}$	=	Annual MMBtu savings of high efficiency boiler compared to code-compliant boiler: 13.7 MMBtu and 12.3 MMBTU for steam[571]

Baseline Efficiency

For the retirement savings over the remaining life of existing boiler, the baseline is the existing inefficient boiler estimated to be 65% for a forced hot water boiler and 55% for a steam boiler. For the high efficiency unit savings over lifetime of the new boiler, the baseline is a code-compliant boiler (AFUE = 80% for forced hot air and 75% for steam boiler).

High Efficiency

For the retirement savings over the remaining life of existing boiler, the efficient case is a code-compliant boiler (AFUE = 80% for a forced hot water boiler and 75% for a steam boiler). For the high efficiency savings over lifetime of the new boiler, the efficient case is a new high efficiency (AFUE >= 90% for a forced hot water boiler and 82% for steam).

[570] Calculated using information from GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[571] Calculated using information from GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.

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Hours

Not applicable.

Measure Life

The remaining life for the existing unit is 10 years[572], and the measure life of new equipment is 20 years.[573]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Early Replacement Boiler (Retire)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Early Replacement Boiler (EE)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[572] Agreed upon value with EEAC consultants as a reasonable approximation for the number of years an existing boiler would continue to operate if it had not been replaced early due to the program.
[573] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers.*

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HVAC – Furnaces

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of a new high efficiency space heating gas-fired furnace with an electronically commutated motor (ECM) for the fan.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: Electric
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Units = Installation of furnace with ECM
ΔMMBtu = Annual MMBtu savings per unit. See Table 22.

Table 22: Savings for Residential Furnaces

Equipment Type	Efficiency	ΔMMBtu
Furnace (Forced Hot Air) w/ECM	AFUE = 95%	18.9 [574]
	AFUE = 96%	21.7 [575]

Baseline Efficiency

The baseline efficiency case is a 78% AFUE furnace for replace on failure and 72.5% for early retirement.

High Efficiency

The high efficiency case is a new furnace with AFUE >= 95% with an electronically commutated motor installed.

Hours

Not applicable.

[574] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks; value adjusted based on results of: Nexus Market Research and The Cadmus Group (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks. Savings have been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.
[575] Ibid.

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Measure Life

The measure life is 17 years.[576]

Secondary Energy Impacts

High efficiency furnaces equipped with ECM fan motors also save electricity from reduced fan energy requirements. See HVAC - Furnace Fan Motors in the Residential Electric section.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Furnace w/ECM	Residential HEHE	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[576] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace*. Lifetime has been adjusted to reflect the mix of replace on failure and early replacement based on: The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing*. Prepared for the Electric and Gas Program Administrators of Massachusetts. The calculation of the adjustment can be found in the 2012 HEHE Application of Results Excel Workbook.

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HVAC – Heat Recovery Ventilator

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 2012)
End Date: TBD

Measure Overview

Description: Heat Recovery Ventilators (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: Electric
Non-Energy Impact: None
Sector: Residential
Market: Lost Opportunity
End Use: HVAC
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMbtu = \Delta MMbtu$$

Where:
Units = Number of heat recovery ventilation systems installed
ΔMMBtu = Annual MMBtu savings per unit: 7.7 MMBtu[577]

Baseline Efficiency

The baseline efficiency case is an ASHRAE 62.2-compliant exhaust fan system with no heat recovery.

High Efficiency

The high efficiency case is an exhaust fan system with heat recovery.

Hours

Not applicable.

Measure Life

The measure life is 20 years.[578]

Secondary Energy Impacts

An electric penalty results due to the electricity consumed by the system fans.

[577] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[578] Ibid.

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Measure	Energy Type	ΔkWh/Unit[579]	ΔkW/Unit[580]
Heat Recovery Ventilator	Electric	-133	-0.04

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heat Recovery Ventilator	Residential HEHE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate.

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model.[581]

[579] Ibid
[580] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[581] Ibid.

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HVAC – Heating System Replacement

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Replacement of an existing gas heating system with a new high efficiency system. Electric savings are achieved from reduced fan run time.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: Electric
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Low-Income
Market: Retrofit
End Use: HVAC
Program: Low-Income Single Family Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Unit	=	Installation of new high efficiency gas heating system.
ΔMMBtu	=	Annual MMBtu savings per unit: 19.9 (Furnace 20.7, Boiler 19.4)[582]

Baseline Efficiency

The baseline efficiency case is the existing inefficient heating equipment.

High Efficiency

The high efficiency case is the new efficient heating equipment.

Hours

Not applicable.

Measure Life

The measure life is 18 years[583] for new furnaces and 20 years[584] for new boilers.

[582] The Cadmus Group (2012). *Massachusetts Low Income Single Family Program Impact Evaluation*. Prepared for The Electric and Gas Program Administrators of Massachusetts.
[583] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace*.
[584] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers*.

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Secondary Energy Impacts

Unit electric savings are deemed based on study results.

Electric Savings for Heating System Replacement (Gas)

PA	ΔkWh	ΔkW
All	172[585]	0.05[586]

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System Replacement (Gas)	LI SF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates are set to 100% because savings estimates are based on evaluation and analysis results.

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Cadmus Demand Impact Model[587]

[585] The Cadmus Group (2012). *Massachusetts Low Income Single Family Program Impact Evaluation*. Prepared for The Electric and Gas Program Administrators of Massachusetts.
[586] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[587] Ibid

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HVAC – Thermostats

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a 7-day programmable thermostat, which gives the ability to adjust heating or air-conditioning operating times according to a pre-set schedule.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Residential Heating and Water Heating, Home Energy Services, Multifamily Retrofit (not National Grid), Low-Income Multifamily Retrofit (not National Grid)

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Units = Number of Programmable T-stats installed
ΔMMBtu = Annual MMBtu savings per unit: See Table 23.

Table 23: Savings for Thermostats

Program	ΔMMBTU
Residential HEHE	7.7[588]
MF Retrofit and LI MF Retrofit	7.7[589]
HES	3.2[590]

Baseline Efficiency

The baseline efficiency case is an HVAC system using natural gas to provide space heating without a programmable thermostat.

High Efficiency

The high efficiency case is an HVAC system that has a 7-day programmable thermostat installed.

Hours

Not applicable.

[588] RLW Analytics (2007). *Validating the Impact of Programmable Thermostats*. Prepared for GasNetworks; Page 2, conversion factor CCF to Therms is 1.024.
[589] RLW Analytics (2007). *Validating the Impact of Programmable Thermostats*. Prepared for GasNetworks; Page 2, conversion factor CCF to Therms is 1.024.
[590] The Cadmus Group, Inc. (2012). Home Energy Services Impact Evaluation. Prepared for Massachusetts Program Administrators

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Measure Life

The measure life is 15 years.[591] For Multifamily Retrofit the measure persistence was estimated to be 69%[592] so the effective measure life is 10 years (15 years * 69%).

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Programmable Thermostats	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Programmable Thermostats	HES	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Programmable Thermostats	MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Programmable Thermostats	LI MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[591] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat*.
[592] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators

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HVAC – Wi-Fi Thermostats

Version Date and Revision History

Effective Date: 1/1/2013
End Date: TBD

Measure Overview

Description: A communicating thermostat which allows remote set point adjustment and control via remote application. System requires an outdoor air temperature algorithm in the control logic to operate heating and cooling systems
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: Electric
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Residential Heating and Water Heating

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Units	=	Number of Wi-Fi T-stats installed
ΔMMBtu	=	Annual MMBtu savings per unit: 6.6 MMBtu[593]

Baseline Efficiency

The baseline efficiency case is an HVAC system using natural gas to provide space heating without a programmable thermostat.

High Efficiency

The high efficiency case is an HVAC system that has an Wi-Fi thermostat installed.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[594]

Secondary Energy Impacts

When the thermostat also controls the cooling system the electric savings are 104 kWh[595] and 0.231 kW[596].

[593] Cadmus Group (2011). Memo: Wi-fi Programmable Thermostat Billing Analysis. Prepared for Keith Miller and Whitney Domigan, National Grid
[594] Assumed to have the same lifetime as a regular programmable thermostat. Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat.*

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Wi-Fi Thermostats (heating only)	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Wi-Fi Thermostats (heating and cooling)	Residential HEHE	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors
Summer and winter coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model[597]

[595] The Cadmus Group, Inc. (2011). Memo Wi-Fi Programmable Thermostat Billing Analysis. Prepared for Keith Miller and Whitney Domigan, National Grid.
[596] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[597] Ibid.

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HVAC – Weatherization

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of weatherization measures such as air sealing and insulation in gas heated homes. Electric savings are achieved from reduced fan run time.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: Electric
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Low Income
Market: Retrofit
End Use: HVAC
Program: Low-Income Single Family Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Unit	=	Household with weatherization measures installed
ΔMMBtu	=	Average annual MMBtu savings per unit: 26.3[598]

Baseline Efficiency

The baseline efficiency case is the existing home shell.

High Efficiency

The high efficiency case can be a combination of increased insulation, air sealing, duct sealing, and other improvements to the home shell.

Hours

Not applicable.

Measure Life

The measure lives for weatherization projects may differ depending on the measures implemented. The final measure life of each application is weighted based on the mix of weatherization measures installed. The measure life for each type of weatherization measure is based on statewide measure lives for residential energy efficiency measures[599]. If installation details are not tracked, the measure life is assumed to be 20 years[600].

[598] The Cadmus Group, Inc (2012). *Low Income Single Family Impact Evaluation*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[599] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[600] Ibid.

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Secondary Energy Impact

Electric savings are from reduced furnace fan runtime (206 kWh) and reduced cooling due to weatherization (138 kWh). The kWh savings values are deemed based on study results.

Electric Savings for Weatherization (Gas)

PA	ΔkWh	ΔkW
All	344[601]	0.31[602]

Non-Energy Benefits

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Weatherization (Gas)	LI SF Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	0.36

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates are set to 100% because savings estimates are based on evaluation and analysis results.

Coincidence Factors

Summer and winter coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model[603]

[601] The Cadmus Group, Inc (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[602] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[603] Ibid.

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Multifamily – Vendor Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Retrofit measures installed in multi-family facilities including: building envelope insulation, air sealing, and DHW measures.
Primary Energy Impact: Natural Gas (Residential Heat), Natural Gas (Residential DHW)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Multifamily Retrofit, Low-Income Multifamily Retrofit

Notes

The PAs, except National Grid, currently use vendor-calculated savings for their Multifamily gas programs. The vendor methodology and other measure characterization for these programs are described in this section. The savings methodology used for National Grid's program is described in the Multifamily measure characterizations following this section.

Algorithms for Calculating Primary Energy Impact

The Program Administrators use vendor calculated savings for measures in the Multifamily gas programs. The vendors who perform the measure implementations calculate estimated savings for each project based on project-specific detail.

Baseline Efficiency

The baseline efficiency case is the existing conditions of the participating facility.

High Efficiency

The high efficiency case includes installed energy efficiency measures that reduce heating energy use.

Hours

Hours are project-specific.

Measure Life

Measure	Measure Life (years)
Air Sealing	15
Insulation	25

Secondary Energy Impacts

There are no secondary energy impacts counted for these measures.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing	MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Insulation	MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Air Sealing	LI MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Insulation	LI MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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Multifamily – Air Sealing

Version Date and Revision History

Draft Date: 06/30/2011
Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Thermal shell air leaks are sealed through strategic use and location of air-tight materials.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: *National Grid only:* Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta MMBtu = BldgVolume \times (ACH_{PRE} - ACH_{POST}) \times HDD \times 24 \times 0.018 \times \frac{CorrectionFactor}{SeasonalEff} \times \frac{1}{1{,}000{,}000}$$

Where:

$CFM50_{PRE}$	=	CFM50 measurement before air sealing (ft^3/min)
$CFM50_{POST}$	=	CFM50 measurement after air sealing (ft^3/min)
LBL	=	LBL Factor[604]
BldgVolume	=	Total volume of the project building (ft^3)
ACH_{PRE}	=	Air changes per hour measured before air sealing (1/hr)
ACH_{POST}	=	Air changes per hour measured after air sealing (1/hr)
0.018	=	Heat capacity of 1 cubic foot of air at 70 °F (Btu/ft^3-°F)
HDD	=	Heating degree days (°F-day)
24	=	Hours per day (hr/day)
60	=	Minutes per hour (min/hr)
CorrectionFactor	=	Correction factor determined by auditor (e.g. for seasonal homes): Default = 1.
SeasonalEff	=	Heating system efficiency factor determined by auditor: Default = 0.7 for homes heated with natural gas.
1/1,000,000	=	Conversion from Btu to MMBtu

Baseline Efficiency

The baseline efficiency case is the existing building before the air sealing measure is implemented. The baseline building is characterized by the existing CFM50 measurement ($CFM50_{PRE}$) for single family homes, or the existing air changes per hour (ACH_{PRE}) for multi-family facilities, which is measured prior to the implementation of the air sealing measure.

[604] The LBL Factor is determined as the product of the N-factor and a Height Correction Factor according to BPI Protocol. The N-factor is assumed to be 18.5 for all installations in New England; the Height Correction Factor is determined based on the number of stories in the facility.

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High Efficiency

The baseline efficiency case is the existing building after the air sealing measure is implemented. The high efficiency building is characterized by the new CFM50 measurement for single family homes ($CFM50_{POST}$), or the new air changes per hour (ACH_{POST}) for multi-family facilities, which is measured after the air sealing measure is implemented.

Hours

Heating hours are characterized by the heating degree days for the facility. The heating degree days are looked up based on the nearest weather station to the customer, as selected by the program vendor.

Measure Life

The measure life is 15 years.[605]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF SPACE Air Sealing	MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF SPACE Air Sealing	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rates are 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

[605] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Multifamily – DHW System

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of high efficiency water heating equipment to replace the existing inefficient water heater.
Primary Energy Impact: Natural Gas (Residential DHW)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Low Income
Market: Retrofit
End Use: DHW
Program: National Grid only: Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta MMBtu = Units \times \frac{18\ MMBtu}{Unit} \times \left(\frac{1}{EF_{BASE}} - \frac{1}{EF_{EE}} \right)$$

Where:

Unit	=	Total number of apartment units utilizing the water heater
18 MMBtu/Unit	=	Average annual water heating energy demand per apartment unit[606]
EF_{BASE}	=	Energy Factor for the baseline water heater
EF_{EE}	=	Energy Factor for the new efficient water heater

Baseline Efficiency

The baseline water heating equipment is assumed to have an Energy Factor = 0.575.

High Efficiency

The high efficiency case includes the new efficient water heater with an Energy Factor > 0.575.

Hours

Not applicable.

Measure Life

Measure	Measure Life (years)
Indirect Water Heater	20 [607]
Stand-Alone Storage Water Heater	13 [608]
On-Demand Tankless Water Heater	20 [609]

[606] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[607] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[608] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.
[609] Ibid.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF DHW System	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rate is 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

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Multifamily – DHW Measures

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: DHW measures include equipment installed to reduce consumption of hot water, insulation installed to reduce losses, or other retrofits which save on hot water heating energy.
Primary Energy Impact: Natural Gas (Residential DHW)
Secondary Energy Impact: None
Non-Energy Impact: Residential Water, Annual Non-Resource, One-Time Non-Resource
Sector: Residential, Low Income
Market: Retrofit
End Use: Hot Water
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on program vendor assumptions:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Units = Total quantity of installed units. Units are defined in Table 24.
ΔMMBtu/Unit = Annual MMBtu savings per unit. See Table 24.

Table 24: Savings for MF DHW Measures

Measure	Unit	ΔMMBtu[610]
Faucet Aerator	Each	0.944
Low-Flow Showerhead	Each	2.020
DHW pipe sleeve or pipewrap	Linear Feet	0.016
Water Heater Tank Wrap (Small < 50 gallons)	Each	2.187
Water Heater Tank Wrap (Large >= 50 gallons)	Each	2.137
DHW TurnDown to 125°F	Each	0.398

Baseline Efficiency

The baseline is the existing multi-family facility without the efficiency measure(s) installed.

High Efficiency

The high efficiency case is the existing multi-family facility with new efficiency measure(s) installed.

Hours

Not applicable.

Measure Life

The measure life for all DHW measures is 7 years.[611]

[610] Savings assumptions from National Grid program vendor.
[611] Massachusetts Common Assumption.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Resource	Residential water savings for low-flow showerheads [612]	3,696 gallons/unit
Annual Resource	Residential water savings for faucet aerators [613]	332 gallons/unit
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF DHW Measures	MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF DHW Measures	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rates are 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

[612] NMR Group and Tetra Tech (2011). *Residential and Low-Income Non-Energy Impacts (NEI) Evaluation* Prepared for MA Program Administrators
[613] Ibid

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Multifamily – Duct Systems

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Ducts are sealed by reconnecting disconnected duct joints and sealing gaps or seams with mastic and fiber-mesh tape as appropriate
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource
Sector: Residential, Low Income
Market: Retrofit
End Use: HVAC
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta MMBtu = AnnualHeatingConsumption \times \%SAVE \times \frac{1}{1{,}000{,}000}$$

Where:
AnnualHeatingConsumption = The total annual heating consumption for the facility (Btu)
%SAVE = Average reduction in energy consumption. See Table 25.
1/1,000,000 = Conversion from Btu to MMBtu

Table 25: Savings Factors for MF Duct Systems

Measure Type	%SAVE[614]
Surface Area < 50 SQFT	7%
Surface Area > 50 SQFT and < 200 SQFT	3%
Surface Area > 200 SQFT	1%

Baseline Efficiency

The baseline efficiency case is the existing facility or equipment prior to the implementation of duct sealing.

High Efficiency

The baseline efficiency case is the existing facility or equipment after the implementation of duct sealing.

Hours

Not applicable.

Measure Life

The measure life is 20 years.[615]

[614] Savings assumptions from National Grid program vendor.
[615] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF SPACE Duct Sealing	MF Retrofit	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF SPACE Duct Sealing	LI MF Retrofit	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rate is 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

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Multifamily – Heating System

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of high efficiency heating equipment to replace the existing inefficient gas-fired furnace, hydronic boiler, steam boiler or condensing boiler.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Low Income
Market: Retrofit
End Use: HVAC
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta MMBtu = \frac{Btu}{hr} \times \left(\frac{1}{AFUE_{BASE}} - \frac{1}{AFUE_{EE}} \right) \times EFLH_{Heat} \times \frac{1}{1{,}000{,}000}$$

Where:

Btu/hr	=	Nominal heating capacity of the installed equipment (Btu/hr)
$AFUE_{BASE}$	=	Average fuel utilization efficiency of the existing equipment (%)
$AFUE_{EE}$	=	Average fuel utilization efficiency of the efficient equipment (%)
$EFLH_{Heat}$	=	Equivalent full load heating hours for the facility (Hr)
1/1,000,000	=	Conversion from Btu to MMBtu

Baseline Efficiency

The baseline efficiency is determined based on the type of heating equipment installed and the table of baseline efficiencies ($AFUE_{BASE}$) below.

Baseline Efficiencies for MF Heat System Equipment

Equipment Type	$AFUE_{BASE}$ [616]
Boiler	75%
Furnace	78%

High Efficiency

The high efficiency case is characterized by the rated efficiency ($AFUE_{EE}$) of the new high efficiency furnace or boiler.

Hours

The equivalent full load hours are assumed to be 1,418 for all multi-family residential facilities in Massachusetts (see Appendix A Table 21 in 2011 Plan TRM).

[616] Federal Register / Vol. 73, No. 145 / Monday, July 28, 2008 / Rules and Regulations Pg. 43613

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Measure Life

Equipment Type	Lifetime (years)
Boiler	20 [617]
Furnace	18 [618]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF Heat System	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rate is 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

[617] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers.*
[618] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace.*

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Multifamily – Other Insulation

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Insulation upgrades applied in existing facilities.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on program vendor assumptions:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Units = Total quantity of installed units.
ΔMMBtu/Unit = Deemed savings per unit installed.

Savings for MF Other Insulation

Measure	Unit	ΔMMBtu[619]
Existing hatches: weatherstrip, insulate, dam perimeter	Each	1.382
Attic staircase cover (Therma-dome)	Each	2.763

Baseline Efficiency

The baseline efficiency case is the existing facility or equipment prior to the implementation of additional insulation.

High Efficiency

The baseline efficiency case is the existing facility or equipment after the implementation of additional insulation.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[620]

[619] Savings assumptions from National Grid program vendor.
[620] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Secondary Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Non-Energy Impacts

There are no non-energy impacts for this measure

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF SPACE Other Insulation	MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF SPACE Other Insulation	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rates are 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

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Multifamily – Pipe Insulation

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Insulation upgrades to existing heating system pipes.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential, Low Income
Market: Retrofit
End Use: HVAC
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta MMBtu = LF \times MMBtu / LF$$

Where:
LF = Linear feet of installed pipe insulation
MMBtu/LF = Deemed MMBtu savings per linear foot of installed insulation

Savings for MF Pipe Insulation

Measure	Unit	MMBtu/LF[621]
Heating System Pipe Insulation	Linear Feet	0.160

Baseline Efficiency

The baseline efficiency case is the existing facility or equipment prior to the implementation of additional insulation.

High Efficiency

The baseline efficiency case is the existing facility or equipment after the implementation of additional insulation.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[622]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[621] Savings assumptions from National Grid program vendor.
[622] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF Pipe Insulation	MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF Pipe Insulation	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
The energy realization rate is 100% based on no evaluations.

Coincidence Factors
There are no electric savings for this measure.

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Multifamily – Shell Insulation

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Shell insulation upgrades are applied in existing facilities including improved insulation in attics, basements and sidewalls.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

$$\Delta MMBtu = SQFT \times \left(\frac{1}{R_{BASE}} - \frac{1}{R_{BASE} + R_{ADD}} \right) \times HDD \times 24 \times \frac{CorrectionFactor}{SeasonalEff} \times \frac{1}{1{,}000{,}000}$$

Where:

SQFT	=	Square feet of insulation installed (ft^2)
R_{BASE}	=	Total R-value of the existing attic, basement or sidewall (ft^2-hr-°F/Btu)
R_{ADD}	=	R-value of the added insulation (ft^2-hr-°F/Btu)
HDD	=	Heating degree days (°F-day)
24	=	Hours per day (hr/day)
CorrectionFactor	=	Correction factor determined by auditor (e.g. for seasonal homes): Default = 1.
SeasonalEff	=	Heating system seasonal efficiency factor determined by auditor: Default = 0.7
1/1,000,000	=	Conversion from Btu to MMBtu

Baseline Efficiency

The baseline efficiency case is characterized by the total R-value of the existing attic, basement or sidewall (R_{BASE}). This is calculated as the R-value of the existing insulation, estimated by the program contractor, plus the R-value of the ceiling, floor, or wall (for all projects: $R_{CEILING} = 3.36$; $R_{FLOOR} = 6.16$; $R_{WALL} = 6.65$)[623].

High Efficiency

The high efficiency case is characterized by the total R-value of the attic after the installation of additional attic, basement or sidewall insulation. This is calculated as the sum of the existing R-value (R_{BASE}) plus the R-value of the added insulation (R_{ADD}).

Hours

Heating hours are characterized by the heating degree days for the facility. The heating degree days are looked up based on the nearest weather station to the customer, as selected by the program vendor.

[623] Savings assumptions from National Grid program vendor.

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Measure Life

The measure life is 25 years.[624]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF SPACE Shell Insulation	MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF SPACE Shell Insulation	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rates are 100% based on no evaluations.

Coincidence Factors

There are no electric savings for this measure.

[624] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Multifamily – Thermostats

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Installation of programmable thermostats in multi-family facilities.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential, Low-Income
Market: Retrofit
End Use: HVAC
Program: National Grid only: Multifamily Retrofit, Low-Income Multifamily Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on program vendor assumptions:

$$\Delta MMBtu = AnnualHeatingConsumption \times \%SAVE \times \frac{1}{1{,}000{,}000}$$

Where:

AnnualHeatingConsumption	=	The total annual heating consumption for the facility (Btu)
%SAVE	=	Average reduction in energy consumption. See Table 26.
1/1,000,000	=	Conversion from Btu to MMBtu

Table 26: Savings for MF Thermostats

Equipment Type	%SAVE[625]
Thermostats	3%
Thermostat – Outdoor Reset Control	11%

Baseline Efficiency

The baseline efficiency case is the existing facility without a set back programmable thermostat. The existing facility is characterized by its average annual heating consumption as determined from the customers' billing data.

High Efficiency

The high efficiency case is the existing facility with a programmable thermostat installed.

Hours

Not applicable.

Measure Life

The measure life is 10 years.[626] For Multifamily Retrofit the measure persistence was estimated to be 69%[627] so the effective measure life is 10 years (15 years * 69%).

[625] Savings assumptions from National Grid program vendor.
[626] Environmental Protection Agency (2010). *Life-Cycle Assessment for Thermostats*.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MF SPACE Thermostat	MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
MF SPACE Thermostat	LI MF Retrofit	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

The energy realization rates are 100% based on no evaluations.

Coincidence Factors

Coincidence factors are not used since there are no electric savings counted for this measure.

[627] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators

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Home Energy Services (Gas Weatherization) – Vendor Measures

Version Date and Revision History

Effective Date: 1/1/2012
End Date: TBD

Measure Overview

Description: Retrofit measures installed through the Home Energy Services program including: building envelope insulation, air sealing, and exterior doors.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Annual Non-Resource, One-Time Non-Resource
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Home Energy Services (Gas Weatherization)

Algorithms for Calculating Primary Energy Impact

The Program Administrators use vendor calculated savings for measures in the Residential Home Energy Services gas program. These savings values are calculated using vendor proprietary software where the user inputs a minimum set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The proprietary building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms. Infiltration savings use site-specific seasonal N-factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to incorrectly "adding" individual measure results.

Baseline Efficiency

The baseline efficiency case is the existing conditions of the participating household.

High Efficiency

The high efficiency case includes installed energy efficiency measures that reduce heating energy use.

Hours

Hours are project-specific.

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Measure Life

Measure	Measure Life (years)
Air Sealing	15[628]
Exterior Doors	25[629]
Shell Insulation	25[630]
Duct and Pipe Insulation	15 [631]

Secondary Energy Impacts

There are no secondary energy impacts counted for these measures.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing	HES	Berkshire	1.00	1.00	0.85	n/a	n/a	n/a	n/a
Air Sealing	HES	Columbia	1.00	1.00	0.63	n/a	n/a	n/a	n/a
Air Sealing	HES	NGRID	1.00	1.00	0.74	n/a	n/a	n/a	n/a
Air Sealing	HES	NSTAR	1.00	1.00	0.84	n/a	n/a	n/a	n/a
Air Sealing	HES	NEG	1.00	1.00	1.11	n/a	n/a	n/a	n/a
Air Sealing	HES	Unitil	1.00	1.00	0.68	n/a	n/a	n/a	n/a
Insulation	HES	Berkshire	1.00	1.00	0.85	n/a	n/a	n/a	n/a
Insulation	HES	Columbia	1.00	1.00	0.63	n/a	n/a	n/a	n/a
Insulation	HES	NGRID	1.00	1.00	0.74	n/a	n/a	n/a	n/a
Insulation	HES	NSTAR	1.00	1.00	0.84	n/a	n/a	n/a	n/a
Insulation	HES	NEG	1.00	1.00	1.11	n/a	n/a	n/a	n/a
Insulation	HES	Unitil	1.00	1.00	0.68	n/a	n/a	n/a	n/a
Exterior Doors	HES	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are based on evaluation results[632].

[628] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[629] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[630] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[631] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.

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Coincidence Factor

Coincidence factors are not used since there are no electric savings counted for this measure.

[632] The Cadmus Group (2013). *HES Realization Rate Results Memo.* June 2013

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Residential New Construction– Heating, Cooling, and DHW Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: To capture lost opportunities, encourage the construction of energy-efficient homes, and drive the market to one in which new homes are moving towards net-zero energy.
Primary Energy Impact: Natural Gas (Residential Heat)
Secondary Energy Impact: Electric, Oil, Propane
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low-Income
Market: Lost Opportunity
End Use: HVAC, Hot Water
Program: Residential New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

As part of the ENERGY STAR® certification process, projected energy use is calculated for each home completed through the program and a geometrically matching baseline home (User Defined Reference Home) using Beacon, an ICF International proprietary DOE-2 based building energy simulation tool. The difference between the projected energy consumption of these two homes represents the energy savings produced by the certified home. This process is used to calculate electric demand as well as electric and fossil fuel energy savings due to heating, cooling, and water heating for all homes, both single family and multifamily. This process is documented in "Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR® Homes Program."[633]

Baseline Efficiency

The User Defined Reference Home was revised for 2012 as a result of the baseline study completed in 2012.[634] [635]

High Efficiency

The high efficiency case is represented by the specific energy characteristics of each "as-built" home completed through the program.

Hours

Not applicable.

[633] ICF International (2008). *Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR ® Homes Program*. Prepared for Joint Management Committee.
[634] NMR Group Inc., KEMA, Inc.,& Dorothy Conant (2012). *Massachusetts 2011 Baseline Study of Single Family Residential New Construction, Final Report*. Prepared for the Massachusetts Joint Management Committee.
[635] NMR Group Inc., KEMA, Inc.,& Dorothy Conant (2012). *Final UDRH Inputs: Addendum to Massachusetts 2011 Baseline Study of Single-Family Residential New Construction, Final Report*. Prepared for the Massachusetts Joint Management Committee.

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Measure Life

Measure Type	Measure Life (years)[636]
Cooling	25
Heating	25
Water Heating	15

Secondary Energy Impacts

Electric, Oil and Propane savings for heating and water heating measures are custom calculating using the same methodology described for the electric energy and demand savings.

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts
One-Time Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
ES Homes – Cooling	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
ES Homes – Heating	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
ES Homes – Water Heating	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	1.0	1.00

In-Service Rates

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factors.

Realization Rates

Realization rates are 100% because energy and demand savings are custom calculated based on project specific detail.

Coincidence Factors

Coincidence factors are custom calculated based on project-specific detail.

[636] Massachusetts Common Assumption.

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Commercial and Industrial Gas Efficiency Measures

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HVAC – Boilers

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: The installation of a high efficiency natural gas fired condensing hot water boiler. High-efficiency condensing boilers can take advantage of improved design, sealed combustion and condensing flue gases in a second heat exchanger to achieve improved efficiency.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Notes

The PAs decided to screen steam and hydronic boilers as custom measures beginning in PY 2012 so they were removed from the TRM.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency boiler
ΔMMBtu = Average annual MMBtu savings per unit. See Table 27 for values.

Table 27: Savings for C&I Boilers

Equipment Type	Size	Efficiency Requirement	ΔMMBtu [637]
Condensing Boilers	<= 300 MBH	>= 90% AFUE	30.6
	301-499 MBH	>= 90% Thermal Efficiency	58.4
	500-999 MBH	>= 90% Thermal Efficiency	107.3
	1000-1700 MBH	>= 90% Thermal Efficiency	197.2
	1701+ MBH	>= 90% Thermal Efficiency	345.1
	<= 300 MBH	>= 96% AFUE	27.8

Baseline Efficiency

The baseline efficiency assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. The deemed savings methodology for this measure does not require specific baseline data, but the baseline information is provided here for use in the future when this is converted to a deemed calculated measure.

[637] KEMA (2013). *Project 25 Prescriptive Gas Program Final Evaluation Report.* Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-2.

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As described in Chapter 13 of the Massachusetts State Building Code, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009. Table 28 details the specific efficiency requirements by equipment type and capacity.

Table 28: Baseline Efficiency Requirements for C&I Gas-Fired Boilers[638]

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency[a]
Boiler, Gas-Fired	<300,000 Btu/h	Hot Water	80% AFUE
	>=300,000 Btu/h and <=2,500,000 Btu/h	Minimum Capacity[a]	75% E_t and 80% E_c
	>2,500,000 Btu/h	Hot Water	80% E_c

a. Minimum ratings as provided for and allowed by the unit's controls

High Efficiency

The high efficiency scenario assumes a gas-fired boiler that exceeds the efficiency levels required by Massachusetts State Building Code. Actual site efficiencies should be determined on a case-by-case basis.

Hours

Not applicable.

Measure Life

The measure life is 25 years.[639]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Boilers	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[638] Adapted from 2009 International Energy Conservation Code; Table 503.2.3(5).
[639] ASHRAE Applications Handbook (2003); Page 36.3.

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HVAC – Boiler Reset Controls

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Boiler Reset Controls are devices that automatically control boiler water temperature based on outdoor or return water temperature using a software program.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I Retrofit, C&I Direct Install

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed boiler reset control
ΔMMBtu = Average annual MMBtu savings per unit: 35.5 MMBtu[640]

Baseline Efficiency

The baseline efficiency case is a boiler without reset controls.

High Efficiency

The high efficiency case is a boiler with reset controls.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[641]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[640] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks; the GDS Study assumes 710.46 MMBTU base use with 5% savings factor.
[641] ACEEE (2006). *Emerging Technologies Report: Advanced Boiler Controls*. Prepared for ACEEE; Page 2

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Boiler Reset Controls	C&I Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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HVAC – Combo Water Heater/Boiler

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: This measure promotes the installation of a combined high-efficiency boiler and water heating unit. Combined boiler and water heating systems are more efficient than separate systems because they eliminate the standby heat losses of an additional tank.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC, Hot Water
Program: New Construction & Major Renovation Commercial

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Unit	=	Installed high efficiency boiler/water heater combo units
ΔMMBtu	=	Average annual savings per unit = 24.6 MMBtu

Baseline Efficiency

The baseline efficiency case is a standard efficiency gas-fired storage tank hot water heater with a separate standard efficiency boiler for space heating purposes.

High Efficiency

The high efficiency case is a condensing, integrated water heater/boiler with an AFUE of >=90% and ER of 0.9.

Hours

Not applicable.

Measure Life

The measure life is 20 years.[642]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[642] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks.

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Combo Water Heater/Condensing Boiler (AFUE 90% and EF 0.90)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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HVAC – Condensing Unit Heaters

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a condensing gas-fired unit heater for space heating with capacity up to 300 MBH and minimum combustion efficiency of 90%.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed condensing unit heater
ΔMMBtu = Average annual MMBtu savings per unit: 40.9 MMBtu[643]

Baseline Efficiency

The baseline efficiency case is a standard efficiency gas fired unit heater with minimum combustion efficiency of 80%, interrupted or intermittent ignition device (IID), and either power venting or an automatic flue damper.[644]

High Efficiency

The high efficiency case is a condensing gas unit heater with 90% AFUE or greater.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[645]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[643] NYSERDA Deemed Savings Database (Rev 11); Measure Name: A.UNIT-HEATER-COND.<300000.CI._._.N. The database provides savings of 204.6 MMBtu per million BTU/hr of heater input capacity. Assume average unit size of 200,000 BTU capacity.
[644] 2009 International Energy Conservation Code
[645] Ecotrope, Inc. (2003). *Natural Gas Efficiency and Conservation Measure Resource Assessment for the Residential and Commercial Sectors*. Prepared for the Energy Trust of Oregon.

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Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Unit Heaters	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

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HVAC – Furnaces

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: The installation of a high efficiency natural gas warm air furnace with an electronically commutated motor (ECM) for the fan. High efficiency furnaces are better at converting fuel into direct heat and better insulated to reduce heat loss. ECM fan motors significantly reduce fan motor electric consumption as compared to both shaped-pole and permanent split capacitor motors.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: Electric
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency furnace.
ΔMMBtu = Average annual MMBtu savings per unit. See **Table 29** for values.

Table 29: Savings for C&I Gas-Fired Furnaces

Equipment Type	Efficiency	ΔMMBtu[646]
Furnace (Forced Hot Air) w/ECM	AFUE = 95%	9.0
	AFUE = 96%	9.5

Baseline Efficiency

The baseline efficiency assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. The deemed savings methodology for this measure does not require specific baseline data, but the baseline information is provided here for use in the future if this is converted to a deemed calculated measure.

As described in Chapter 13 of the Massachusetts State Building Code, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009. Table 30 details the specific efficiency requirements by equipment type and capacity.

[646] KEMA (2013). *Project 25 Prescriptive Gas Program Final Evaluation.* Prepared for the Massachusetts Energy Efficiency Program Administrators

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Table 30: Baseline Efficiency Requirements for C&I Gas-Fired Furnaces[647]

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency
Warm air furnaces, gas fired	< 225,000 Btu/h	-	78% AFUE or 80% Et[b]
	>= 225,000 Btu/h	Maximum capacity[a]	80% E_t[c]
Warm air duct furnaces, gas fired	All capacities	Maximum capacity[a]	80% E_c

a. Minimum and maximum ratings as provided for and allowed by the unit's controls.
b. Combination units not covered by the National Appliance Energy Conservation Act of 1987 (NAECA) (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]) shall comply with either rating.
c. Units must also include an Intermittent Ignition Device (IID), have jackets not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

High Efficiency

The high efficiency scenario assumes a gas-fired furnace that exceeds the efficiency levels required by Massachusetts State Building Code. Actual site efficiencies should be determined on a case-by-case basis.

Hours

Not applicable.

Measure Life

The measure life is 18 years.[648]

Secondary Energy Impacts

High efficiency furnaces equipped with ECM fan motors also save electricity from reduced fan energy requirements. The reduction of electric use is 168 kWh and 0.124 kW[649].

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Furnace (<150 MBH) AFUE 95% w/ECM	C&I NC	All	1.00	1.00	1.00	1.00	1.00	0.00	0.16
Furnace (<150 MBH) AFUE 96% w/ECM	C&I NC	All	1.00	1.00	1.00	1.00	1.00	0.00	0.16

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

[647] Adapted from 2009 International Energy Conservation Code; Table 503.2.3(4).
[648] ASHRAE Applications Handbook (2003); Page 36.3.
[649] ERS (2011) Pilot Evaluation of BFM DRAFT. Results as of 9/29/2011. The savings values for the BFM come from Page 1, Table 1 of the BFM impact evaluation filed with the Annual Report. While this report was only to provide savings for the BFM - -the original savings used by the PA's 600 kWh and .116 kW were used for both the BFM and ECM. When the BFM study was almost complete we asked the evaluation team if it were possible to come up with savings for the ECM motor; they calculated the 168 kWh using data from the BFM onsites, after several discussions the evaluation team determined the ECM motor was a different measure than the BFM so the calculations were not 100% accurate. They note that while the 600 kWh was too high, the 168 may be on the low side but could not confirm without an evaluation of the ECM. PA's determined while we did not have an evaluation for the 168 it was probably a more realistic number than the 600.

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Realization Rates
All PAs use 100% energy realization rate.

Coincidence Factors
Coincident factors are based on evaluation results.[650]

[650] Ibid.

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HVAC – Infrared Heaters

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a gas-fired low intensity infrared heating system in place of unit heater, furnace, or other standard efficiency equipment. Infrared heating uses radiant heat as opposed to warm air to heat buildings. In commercial environments with high air exchange rates, heat loss is minimal because the space's heat comes from surfaces rather than air.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: HVAC
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed infrared heating unit
ΔMMBtu = Average annual MMBtu savings per unit: 12.0 MMBtu[651]

Baseline Efficiency

The baseline efficiency case is a standard efficiency gas-fired unit heater with combustion efficiency of 80%.

High Efficiency

The high efficiency case is a gas-fired low-intensity infrared heating unit.

Hours

Not applicable.

Measure Life

The measure life is 17 years.[652]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[651] KEMA (2013*). Project 25 Prescriptive Gas Program Final Evaluation Report.* Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-5.
[652] Nexant (2006). *DSM Market Characterization Report*. Prepared for Questar Gas.

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Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Intensity Infrared Heater	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

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HVAC – Thermostats

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a 7-day programmable thermostat with the ability to adjust heating or air-conditioning operating times according to a pre-set schedule to meet occupancy needs and minimize redundant HVAC operation.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I Retrofit, C&I Direct Install

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Unit	=	Installed programmable thermostat
ΔMMBtu	=	Average annual MMBtu reduction per unit: 7.7 MMBtu[653]

Baseline Efficiency

The baseline efficiency case is an HVAC system using natural gas to provide space heating without a programmable thermostat.

High Efficiency

The high efficiency case is an HVAC system using natural gas to provide space heating with a 7-day programmable thermostat installed.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[654]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[653] RLW Analytics (2007). *Validating the Impact of Programmable Thermostats*. Prepared for GasNetworks; Page 2, conversion factor CCF to Therms is 1.024.
[654] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat*.

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Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Thermostats	C&I Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostats	C&I Direct Install	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

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Hot Water – Water Heaters

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of a high-efficiency gas-fired water heater. *Indirect water heaters* use a storage tank that is heated by the main boiler. The energy stored by the water tank allows the boiler to turn off and on less often, saving considerable energy. *Tankless water heaters* circulate water through a heat exchanger to be heated for immediate use, eliminating the standby heat loss associated with a storage tank.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Hot water
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Unit = Installed condensing stand-alone water heater
ΔMMBtu = Average annual MMBtu savings per unit. See Table 31.

Table 31: Savings for C&I Water Heaters

Measure	ΔMMBtu
Condensing Stand-Alone Water Heater (75-300 MBH)	25.0 [655]
Free-Standing Water Heater (EF 0.67)	3.0 [656]
Indirect Water Heater (EF 0.82 and CAE 85%)	19.0 [657]
On-Demand Tankless Water Heater (EF 0.82)	7.1 [658]
On-Demand Tankless Water Heater (EF 0.95)	9.59 [659]

[655] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Page 2 of Appendix B-2, measure GDS C-WH-3. The GDS study references "ESource (2007). *Gas Fired Water Heater Screening Tool*. http://www.esource.com/BEA/demo/PDF/P_PA_41.pdf. Accessed on 10/22/10; used 0.96 Thermal Efficiency and 250 gallons per day."
[656] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Appendix B-2.
[657] KEMA (2013). *Project 25 Prescriptive Gas Program Final Evaluation Report.* Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-5
[658] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Page 2 of Appendix B-2, measure GDS C-WH-5. The GDS study references "FEMP Calculator for Electric & Gas Water Heaters (assumes 64 gal/day) Base use =27.1 MMBTU."
[659] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Page 2 of Appendix B-2, measure GDS C-WH-7. The GDS study references "FEMP Calculator for Electric & Gas Water Heaters (assumes 64 gal/day) Base use =25.3 MMBTU."

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Baseline Efficiency

The baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. As described in Chapter 13 of the State Building Code, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2009. The two documents present nearly identical requirements for gas-fired storage water heaters. The assumed efficiency slightly exceeds the minimum required by code to reflect the typical baseline unit available in the marketplace.

For indirect, on-demand tankless and free-standing water heaters the baseline is a code-compliant gas-fired storage water heater with EF = 0.59. For condensing stand-alone water heaters, the assumed baseline is a stand-alone tank water heater with a thermal efficiency of 80%.[660]

High Efficiency

Condensing Stand-Alone: The high efficiency case is a condensing stand alone commercial water heater with a thermal efficiency of 95% or greater and a capacity between 75,000 Btu and 300,000 Btu.
Free-Standing: The high efficiency case is an ENERGY STAR® gas-fired freestanding hot water heater with an Energy Factor of at least 0.67 and a nominal input of 75,000 BTU/hour.
Indirect: The high efficiency scenario is an indirect water heater with a Combined Appliance Efficiency (CAE) of 85% or greater.
On-Demand Tankless: The high efficiency equipment is a gas-fired instantaneous hot water heater with an Energy Factor of at least 0.82.

Hours

Not applicable.

Measure Life

The measure lives for water heater vary by type as listed in the table below.

Measure Lives for C&I Water Heaters

Equipment Type	Measure Life (years)
Condensing Stand-Alone Water Heater (75-300 MBH)	15 [661]
Free-Standing Water Heater	13 [662]
Indirect Water Heater	15 [663]
On-Demand Tankless Water Heater	20 [664]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[660] Adapted from 2009 International Energy Conservation Code; Table 504.2.
[661] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Page 2 of Appendix B-2, measure GDS C-WH-4. The GDS study references "ACEEE (2004). *Emerging technologies and practices*; W1 - pg 46."
[662] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Appendix A-2.
[663] Ibid.
[664] Hewitt, D. Pratt, J. & Smith, G. (2005). *Tankless Gas Water Heaters: Oregon Market Status*. Prepared for the Energy Trust of Oregon.

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Stand-Alone Water Heater (75-300 MBH)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Free-Standing Water Heater (EF 0.67)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Indirect Water Heater (EF 0.82 and CAE 85%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
On-Demand Tankless Water Heater (EF 0.82)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
On-Demand Tankless Water Heater (EF 0.95)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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Hot Water – Pre-Rinse Spray Valve

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Retrofitting existing standard spray nozzles in locations where service water is supplied by natural gas fired hot water heater with new low flow pre-rinse spray nozzles with an average flow rate of 1.6 GPM.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: C&I Water, C&I Sewer
Sector: Commercial, Industrial
Market: Retrofit
End Use: Hot Water
Program: C&I Retrofit, C&I Direct Install

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed pre-rinse spray valve
ΔMMBtu = Average annual MMBtu savings per unit: 33.6 MMBtu[665]

Baseline Efficiency

The baseline efficiency case is a standard efficiency spray valve.

High Efficiency

The high efficiency case is a low flow pre-rinse spray valve with an average flow rate of 1.6 GPM.

Hours

Not applicable.

Measure Life

The measure life is 5 years.[666]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[665] SBW Consulting, Inc. (2004). *Evaluation, Measurement & Verification Report for the CUWCC Pre-Rinse Spray Head Distribution Program.* Prepared for the California Urban Water Conservation Council; Page 20, savings of 0.92 therms per day * 365 days per year = 335.8 therms.8.
[666] Veritec Consulting (2005). *Region of Waterloo Pre-Rinse Spray Valve Pilot Study, Final Report*; Page 8.

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Non-Energy Impacts

Benefit Type	Description	Savings[667]
C&I Water	C&I water savings	62,305 gallons/unit
C&I Sewer	C&I sewer water savings	62,305 gallons/unit

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pre-Rinse Spray Valve	C&I Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pre-Rinse Spray Valve	C&I Direct Install	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[667] SBW Consulting, Inc. (2004). *Evaluation, Measurement & Verification Report for the CUWCC Pre-Rinse Spray Head Distribution Program.* Prepared for the California Urban Water Conservation Council; Page 18, savings based on assumptions of 2.24 gallons per minute flow rate, 1.27 hours per day, 365 days per year.

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Hot Water – Steam Traps

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Repair or replace malfunctioning steam traps.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Retrofit
End Use: HVAC
Program: C&I Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Repaired/replaced steam trap
ΔMMBtu = Average annual MMBtu savings per unit: 25.7 MMBtu[668]

Baseline Efficiency

The baseline efficiency case is a failed steam trap.

High Efficiency

The high efficiency case is a repaired or replaced steam trap.

Hours

Not applicable.

Measure Life

The measure life is 3 year.[669]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[668] National Grid 2008 based on historical steam trap surveys. Steam losses in lbs/hr are found using "Boiler Efficiency Institute (1987). *Steam Efficiency Improvement*.; Page 34, Table 4.1 under Steam Leak Rate Through Holes. Average loss rate for all trap sizes 1/32" to 1/4" for low steam pressures (5 psig and 10 psig) and high pressures (50 psig and 100 psig). Assume trap failure effective for 540 EFLH per year. Determine to equivalent therms per year and factor for frequency encountered = [80% * (78.50 + 111.46)/2] + [20% * (1,108.04 + 1,982.18)/2] = 385.01 BTU/trap-year. Assume that 50% of traps fail in the open position and savings is grossed up by the efficiency of the boiler supplying the steam of (inverse of 75%). Net savings is 257 therms per trap.
[669] Massachusetts Common Assumption. Most sources suggest a measure life or equipment life of five years. Massachusetts PAs have traditionally taken equipment life and applied a factor to account for measure persistence when determining measure life.

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Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Steam Traps	C&I Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

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Hot Water – Low-Flow Shower Heads

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a low flow showerhead with a flow rate of 1.5 GPM or less in a commercial setting with service water heated by natural gas.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: C&I Water, C&I Sewer
Sector: Commercial
Market: Retrofit
End Use: Hot water
Program: C&I Direct Install, C&I Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed low-flow shower head.
ΔMMBtu = Average annual MMBtu savings per unit: 5.2 MMBtu[670]

Baseline Efficiency

The baseline efficiency case is a 2.5 GPM showerhead.

High Efficiency

The high efficiency case is a 1.5 GPM showerhead.

Hours

The savings estimates for this measure are determined empirically in terms of units installed and so the equivalent heating full load hours are not directly used, however, the calculator used to determine the deemed savings uses a default operation of 20 minutes a day, 365 days a year.

Measure Life

The measure life is 10 years.[671]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[670] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Table B-2a, measure C-WH-15.
[671] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Table B-2a, measure C-WH-15.

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Non-Energy Impacts

Benefit Type	Description	Savings[672]
C&I Water	C&I water savings	7,300 gallons/unit
C&I Sewer	C&I sewer water savings	7,300 gallons/unit

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Flow Shower Heads	C&I Direct Install	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[672] US DOE-Federal Energy Management Program (FEMP): Energy Cost Calculator for Faucets and Showerheads. Accessed 9/13/2011.

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Hot Water – Faucet Aerator

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a faucet aerator with a flow rate of 1.5 GPM or less on an existing faucet with high flow in a commercial setting with service water heated by natural gas.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: C&I Water, C&I Sewer
Sector: Commercial
Market: Retrofit
End Use: Hot water
Program: C&I Direct Install, C&I Retrofit

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed faucet aerator
ΔMMBtu = Average annual MMBtu savings per unit: 1.7 MMBtu[673]

Baseline Efficiency

The baseline efficiency case is a 2.2 GPM faucet.

High Efficiency

The high efficiency case is a faucet with 1.5 GPM or less aerator installed.

Hours

The savings estimates for this measure are determined empirically in terms of units installed and so the equivalent heating full load hours are not directly used, however, the calculator used to determine the deemed savings uses a default operation of 30 minutes a day, 260 days a year.

Measure Life

The measure life is 10 years.[674]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[673] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Table B-2a, measure C-WH-16.
[674] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Table B-2a, measure C-WH-16.

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Non-Energy Impacts

Benefit Type	Description	Savings[675]
C&I Water	C&I water savings	5,460 gallons/unit
C&I Sewer	C&I sewer water savings	5,460 gallons/unit

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Faucet Aerator	C&I Direct Install	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[675] US DOE-Federal Energy Management Program (FEMP): Energy Cost Calculator for Faucets and Showerheads. Accessed 9/13/2011.

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Hot Water - Heating Pipe Insulation

Version Date and Revision History

Effective date: 1/1/2011
End date: TBD

Measure Overview

Description: Install insulation on hot water or steam piping located in non-conditioned spaces.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial
Market: Retrofit
End Use: HVAC
Program: C&I Direct Install

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed:

ΔMMBtu = ΔMMBtu * Unit

Where:

Unit	=	Linear feet of insulation (for specific type) installed
ΔMMBtu	=	Average annual MMBtu savings per unit. See Table 32.

Table 32: Savings for Hot Water and Steam Pipe Insulation

Pipe size / type	ΔMMBTU per foot[676]
Hot Water Pipe <=1.5", install 1.5" of mineral fiber insulation	0.21
Hot Water Pipe 2", install 2" of mineral fiber insulation	0.36
Steam Pipe <=1.5", install 1.5" of mineral fiber insulation	0.21
Steam Pipe 2", install 3" of mineral fiber insulation	0.37

Baseline Efficiency

The baseline efficiency case is un-insulated steam or hot water piping in unconditioned space.

High Efficiency

The high efficiency condition is steam or hot water piping in unconditioned space with insulation installed.

Hours

The savings estimates for this measure have been determined empirically in terms of units installed. Therefore, estimated hours of operation are unnecessary for the savings algorithms.

Measure Life

The measure life is 15 years.[677]

[676] National Grid Staff Calculation (2010). Pipe insulation for SBS DI measures 2010 Excel Workbook

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Hot Water and Steam Pipe Insulation	C&I Direct Install	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[677] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Table B-2a, measure.

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HVAC - Duct Sealing and Insulation

Version Date and Revision History

Effective date: 1/1/2011
End date: TBD

Measure Overview

Description: For existing ductwork in non-conditioned spaces, seal and insulate ductwork. This could include replacing un-insulated flexible duct with rigid insulated ductwork or sealing leaky fixed ductwork with mastic or aerosol and installing 1"-2" of duct-wrap insulation.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: No secondary energy impact has been determined for this new measure, but cooling savings (electricity) should be evaluated when enough systems are addressed.
Non-Energy Impact: None
Sector: Commercial
Market: Retrofit
End Use: Envelope
Program: C&I Direct Install

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed:

$\Delta MMBtu = \Delta MMBtu * units$

Where:
Units = Number of square feet of ductwork treated
ΔMMBtu = Average annual MMBtu savings per unit: 0.13[678]

Baseline Efficiency

The baseline efficiency condition is existing, non-sealed (leaky) and un-insulated ductwork in unconditioned spaces (e.g. attic or basement)

High Efficiency

The high efficiency condition is air sealed and insulated ductwork in unconditioned spaces.

Hours

The savings estimates for this measure have been determined empirically in terms of units installed. Therefore, estimated hours of operation are unnecessary for the savings algorithms.

Measure Life

The measure life is 20 years.[679]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[678] National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings.
[679] National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings.

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Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Sealing and Insulation	C&I Direct Install	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

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Food Service – Commercial Ovens

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: Installation of High Efficiency Gas Ovens
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: Water
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Process
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency gas oven
ΔMMBtu = Average annual MMBtu savings per unit. See Table 33 for values.

Table 33: Baseline and High Efficiency Ratings and Savings for C&I Ovens

Equipment Type	Baseline Efficiency	Efficiency Requirement	ΔMMBtu
Gas-Fired Convection Oven	30%	>= 44%	24.8[680]
Gas-Fired Combination Oven	35%	>= 44%	110.3 [681]
Gas-Fired Conveyer Oven	20% Heavy Load	>= 44%	84.5[682]
Gas-Fired Rack Oven	30%	>= 50%	211.3[683]

Baseline Efficiency

The baseline efficiency case is a standard efficiency oven. See Table 33 for values by oven type.

High Efficiency

High efficiency case is an oven that meets or exceeds the high efficiency ratings per oven type shown in Table 33.

Hours

Not applicable.

[680] Consortium for Energy Efficiency (2008). *Technology Opportunity Assessment: Convection Ovens*; Page 5.
[681] Food Service Technology Center (2010). *Gas Combination Oven Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/gcombicalc.php. Accessed 9/6/11.
[682] Food Service Technology Center (2010). *Gas Conveyor Oven Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/gconvovencalc.php. Accessed 6/10/10.
[683] Food Service Technology Center (2010). *Gas Conveyor Oven Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/grackovencalc.php. Accessed 6/10/10.

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Measure Life

The measure life is 12 years for all commercial ovens. [684]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

43,800 Gallons of water[685] for the combination oven

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Gas-Fired Convection Oven (>=40%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Gas-Fired Combination Oven (>=40%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Gas-Fired Conveyer Oven (>=40%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Gas-Fired Rack Oven (>=50%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[684] Food Service Technology Center (2010). *Gas Combination Oven Life-Cycle Cost Calculator*. http://www.fishnick.com/saveenergy/tools/calculators/gcombicalc.php. Accessed 6/10/10. AND Food Service Technology Center (2009). *Gas Rack Oven Life-Cycle Cost Calculator*. http://www.fishnick.com/saveenergy/tools/calculators/grackovencalc.php. Accessed on 6/10/10.
[685] Food Service Technology Center (2010). *Gas Combination Oven Life-Cycle Cost Calculator*. http://www.fishnick.com/saveenergy/tools/calculators/gcombicalc.php. Accessed 9/6/11.

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Food Service – Commercial Griddle

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a gas griddle with an efficiency of 38%.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Process
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency gas griddle.
ΔMMBtu = Average annual MMBtu savings per unit: 18.5 MMBtu[686]

Baseline Efficiency

The baseline efficiency case is a standard efficiency (30% efficient) gas griddle.

High Efficiency

The high efficiency case is a gas griddle with an efficiency of 38%.

Hours

Not applicable.

Measure Life

The measure life is 12 years.[687]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[686] Food Service Technology Center (2010). *Gas Griddle Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/ggridcalc.php. Accessed on 10/22/10.
[687] Ibid.

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Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Gas-Fired Griddle	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

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Food Service – Commercial Fryer

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a natural-gas fired fryer that is either ENERGY STAR® rated or has a heavy-load cooking efficiency of at least 50%. Qualified fryers use advanced burner and heat exchanger designs to use fuel more efficiently, as well as increased insulation to reduce standby heat loss.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Process
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithm and assumptions:

$$\Delta MMBtu = \left[\left(\frac{A_{BASE}}{\eta_{BASE}} + \left(B_{BASE} \times IDLE_{BASE}\right) + C_{BASE}\right) - \left(\frac{A_{EE}}{\eta_{EE}} + B_{EE}\left(IDLE_{EE}\right) + C_{EE}\right)\right]\left(\frac{365}{1{,}000{,}000}\right)$$

Where:

Unit	=	Installed high efficiency gas commercial fryer
ΔMMBtu	=	gross annual average MMBtu savings per unit: 58.6[688]
A_{BASE}	=	Baseline equipment daily cooking energy (Btu/day). Default = 85,500 Btu.
η_{BASE}	=	Baseline equipment heavy-load cooking efficiency. Default = 35%.
B_{BASE}	=	Baseline equipment daily fryer idle time (hours). Default = 13.25 hrs.
$IDLE_{BASE}$	=	Baseline equipment idle energy rate (Btu/h). Default = 14,000 Btu/h.
C_{BASE}	=	Baseline equipment total daily preheat energy (Btu). Default = 16,000 Btu.
A_{EE}	=	Efficient equipment daily cooking energy (Btu/day). Default = 85,500 Btu.
η_{EE}	=	Efficient equipment heavy-load cooking efficiency. Default = 55%
B_{EE}	=	Efficiency equipment daily fryer idle time (hours). Default 13.44 hrs.
$IDLE_{EE}$	=	Efficient equipment idle energy rate (Btu/h). Default = 8,500 Btu/hr.
C_{EE}	=	Efficient equipment daily total preheat energy (Btu). Default = 15,500 Btu.
365	=	Days per year.
1,000,000	=	Btu per MMBtu.

Baseline Efficiency

The baseline efficiency case is a typical low-efficiency gas-fired fryer with 35% cooking efficiency, 16,000 Btu preheat energy, 14,000 Btu/h Idle Energy Rate, 60 lbs/h production capacity[689].

[688] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Gas Fryer*.
[689] Food Service Technology Center (2010). *Gas Fryer Life-Cycle Cost Calculator*. http://www.fishnick.com/saveenergy/tools/calculators/gfryercalc.php. Accessed on 10/19/2010.

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High Efficiency

The high efficiency case cooking efficiency and Idle Energy Rate are site specific and can be determined on a case-by-case basis. To simplify the savings algorithm, typical values for food load (150 lbs/day) and preheat energy (15,500 Btu) are assumed.

Hours

Not applicable.

Measure Life

The measure life is 12 years.[690]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Gas-Fired Commercial Fryer	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[690] Ibid.

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Food Service – Commercial Steamer

Version Date and Revision History

Effective Date: 1/1/2011 (Revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: The installation of an ENERGY STAR® rated natural-gas fired steamer, either connectionless or steam-generator design, with heavy-load cooking efficiency of at least 38%. Qualified steamers reduce heat loss due to better insulation, improved heat exchange, and more efficient steam delivery systems.
Primary Energy Impact: Natural Gas
Secondary Energy Impact: None
Non-Energy Impact: Water, Wastewater
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Process
Program: C&I New Construction & Major Renovation

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithm and assumptions:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency gas-fired steamer
ΔMMBtu = Average annual MMbtu savings per unit: 106.6 MMBtu

Baseline Efficiency

The baseline efficiency case is a typical boiler-based steamer with the following operating parameters: Preheat Energy rate = 72,000 Btu/hour, Idle Energy Rate = 18,000 Btu/hour, Heavy Load Efficiency = 18.0%, Production Capacity = 23.3 lbs/h/pan, Average Water Consumption Rate = 40 gal/h, and Percentage of Time in Constant Steam Mode = 40%.[691]

High Efficiency

The high efficiency case is an ENERGY STAR® qualified gas-fired steamer with the following operating parameters for a 6 pan steamer: Preheat Energy rate= 36,000 Btu/hour, Idle Energy Rate = 12,500 Btu/hour, Heavy Load Efficiency = 38.0%, Production Capacity = 20.0 lbs/h/pan, Average Water Consumption Rate = 3.0 gal/h, and Percentage of Time in Constant Steam Mode = 40%.[692]

Hours

The deemed savings assumes 4,380 annual operating hours (12 hours a day * 365 days/year).[693]

[691] Environmental Protection Agency (2011). *Life Cycle Cost Estimate for ENERGY STAR Gas Steamer.* Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COF Accessed on 09/21/2011.
[692] Ibid.
[693] Ibid

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Measure Life

The measure life is 12 years.[694]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings[695]
C&I Water	C&I Water Savings	162,060 gallons/unit
C&I Wastewater	C&I Wastewater Savings	162,060 gallons/unit

Impact Factors for Calculating Adjusted Gross Savings

Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Gas-Fired Steamer	C&I NC	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[694] Ibid.
[695] Ibid.

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Custom Measures

Version Date and Revision History

Effective Date: 1/1/2011 (revised for 1/1/2012)
End Date: TBD

Measure Overview

Description: The Custom project track is offered for energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.
Primary Energy Impact: Natural Gas (Heating, Water Heating, or All)
Secondary Energy Impact: Project Specific
Non-Energy Impact: Project Specific
Sector: Commercial & Industrial
Market: Lost Opportunity, Retrofit
End Use: All
Program: All

Algorithms for Calculating Primary Energy Impact

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis and project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, or other engineering analysis and include estimates of savings, costs, and an evaluation of the project's cost-effectiveness.

Baseline Efficiency

For Lost Opportunity projects, the baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code or industry accepted standard practice.

For retrofit projects, the baseline efficiency case is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency

The high efficiency scenario is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective in order to qualify for energy efficiency incentives.

Hours

All hours for custom savings analyses should be determined on a case-by-case basis.

Measure Life

For both lost-opportunity and retrofit custom applications, the measure life is determined on a case-by-case basis.

Secondary Energy Impacts

All secondary energy impacts should be determined on a case-by-case basis.

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Non-Energy Impacts

All non-energy impacts should be determined on a case-by-case basis.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Custom NC	NC	Statewide	1.00	1.00	0.821	n/a	n/a	n/a	n/a
Custom NC	NC	NSTAR	1.00	1.00	0.844	n/a	n/a	n/a	n/a
Custom NC	NC	National Grid	1.00	1.00	0.685	n/a	n/a	n/a	n/a
Custom NC	NC	Columbia Gas	1.00	1.00	0.832	n/a	n/a	n/a	n/a
Custom Retrofit	Retrofit	Statewide	1.00	1.00	0.821	n/a	n/a	n/a	n/a
Custom Retrofit	Retrofit	NSTAR	1.00	1.00	0.844	n/a	n/a	n/a	n/a
Custom Retrofit	Retrofit	National Grid	1.00	1.00	0.685	n/a	n/a	n/a	n/a
Custom Retrofit	Retrofit	Columbia Gas	1.00	1.00	0.832	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in service rate since programs include verification of equipment installations.

Savings Persistence Factor

All PAs use 100% savings persistence factor.

Realization Rates

Realization rates for National Grid and Columbia Gas are from 2011 impact evaluation of Custom Gas installations[696]. Realization rates for NSTAR are from the 2012 impact evaluation of Custom Gas installations[697]. NSTAR, Columbia, and National Grid use PA specific values while all other PAs use the statewide average, which was calculated based on the combined 2011 and 2012 impact evaluation results.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

[696] KEMA ERS (2012). *Impact Evaluation of 2010 Custom Gas Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council; Page 8.
[697] KEMA ERS (2013). *Impact Evaluation of 2011 Custom Gas Installations.* Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council; Pages 1-3 and 1-4.

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Appendices

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Appendix A: Common Lookup Tables

Table 34: Lighting Power Densities Using the Building Area Method ($WATTS_{b,i}$)[698]

Building Area Type	Lighting Power Density (W/ft^2)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare-Clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theatre	1.2
Multi-Family	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theatre	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

[698] IECC 2009 Lighting Provisions, Section 505 Electrical Power and Lighting Systems, Table 505.5.2 Interior Lighting Power Allowances, Lighting provisions pgs.5-6.

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Table 35: Lighting Power Densities Using the Space-by-Space Method ($WATTS_{b,i}$)[699]

Common Space Types	Lighting Power Density (W/ft^2)
Office – Enclosed	1.1
Office - Open Plan	1.1
Conference/Meeting/Multipurpose	1.3
Classroom/Lecture/Training	1.4
For Penitentiary	1.3
Lobby	1.3
For Hotel	1.1
For Performing Arts Theater	3.3
For Motion Picture Theater	1.1
Audience/Seating Area	0.9
For Gymnasium	0.4
For Exercise Center	0.3
For Convention Center	0.7
For Penitentiary	0.7
For Religious Buildings	1.7
For Sports Arena	0.4
For Performing Arts Theater	2.6
For Motion Picture Theater	1.2
For Transportation	0.5
Atrium - First Three Floors	0.6
Atrium - Each Additional Floor	0.2
Lounge/Recreation	1.2
For Hospital	0.8
Dining Area	0.9
For Penitentiary	1.3
For Hotel	1.3
For Motel	1.2
For Bar Lounge/Leisure Dining	1.4
For Family Dining	2.1
Food Preparation	1.2
Laboratory	1.4
Restrooms	0.9
Dressing/Locker/Fitting Room	0.6
Corridor/Transition	0.5
For Hospitals	1.0
For Manufacturing Facilities	0.5
Stairs – Active	0.6
Active Storage	0.8
For Hospital	0.9
Inactive Storage	0.3
For Museum	0.8
Electrical/Mechanical	1.5
Gymnasium/Exercise Center	

[699] ASHRAE 90.1-2007 Energy Standard for Building Except Low-Rise Residential Buildings, Table 9.6.1, pp.63-64.

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Common Space Types	Lighting Power Density (W/ft^2)
Exercise Area	0.9
Playing Area	1.4
Court House/Police Station/Penitentiary	
Courtroom	1.9
Confinement Cells	0.9
Judges Chambers	1.3
Fire Stations	
Engine Room	0.8
Sleeping Quarters	0.3
Post Office – Sorting Area	1.2
Convention Center - Exhibit Space	1.3
Library	
Card File and Cataloging	1.1
Stacks	1.7
Reading Area	1.2
Hospital	
Emergency	2.7
Recovery	0.8
Nurses' Station	1.0
Exam/Treatment	1.5
Pharmacy	1.2
Patient Room	0.7
Operating Room	2.2
Nursery	0.6
Medical Supply	1.4
Physical Therapy	0.9
Radiology	0.4
Laundry-Washing	0.6
Automobile - Service/Repair	0.7
Manufacturing	
Low Bay (< 25 ft. Floor to Ceiling Height)	1.2
High Bay (≥ 25 ft. Floor to Ceiling Height)	1.7
Detailed Manufacturing	2.1
Equipment Room	1.2
Control Room	0.5
Hotel/Motel Guest Rooms	1.1
Dormitory - Living Quarters	1.1
Museum	
General Exhibition	1.0
Restoration	1.7
Bank/Office - Banking Activity Areas	1.5
Workshop	1.9
Sales Area [for accent lighting, see Section 9.6.2(b)]	1.7
Religious Buildings	
Worship Pulpit, Choir	2.4
Fellowship Hall	0.9

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Common Space Types	**Lighting Power Density (W/ft^2)**
Retail	
Sales Area [for accent lighting, see Section 9.6.3(c)]	1.7
Mall Concourse	1.7
Sports Arena	
Ring Sports Arena	2.7
Court Sports Arena	2.3
Indoor Playing Field Area	1.4
Warehouse	
Fine Material Storage	1.4
Medium/Bulky Material Storage	0.9
Parking Garage - Garage Area	0.2
Transportation	
Airport – Concourse	0.6
Airport/Train/Bus - Baggage Area	1.0
Terminal - Ticket Counter	1.5

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Table 36: MassSAVE New Construction Proposed Lighting Wattage Tables

2012 MassSAVE C&I Lighting Rated Wattage Tables developed by Lighting Worksheet Team

Device Code	Device Description	Rated Watts
LED Exit Signs		
1E0002	2.0 WATT LED	2
1E0003	3.0 WATT LED	3
1E0005	5.0 WLED	5
1E0005C	0.5 WATT LEC	0.5
1E0008	8.0 WLED	8
1E0015	1.5 WATT LED	1.5
1E0105	10.5 WATT LED	10.5
Compact Fluorescents (CFL's)		
2C0007S	2/7W COMPACT HW	18
1C0005S	5W COMPACT HW	7
1C0007S	7W COMPACT HW	9
1C0009S	9W COMPACT HW	11
1C0011S	11W COMPACT HW	13
1C0013S	13W COMPACT HW	15
1C0018E	18W COMPACT HW ELIG	20
1C0018S	18W COMPACT HW	20
1C0022S	22W COMPACT HW	24
1C0023E	1/23W COMPACT HW ELIG	25
1C0026E	26W COMPACT HW ELIG	28
1C0026S	26W COMPACT HW	28
1C0028S	28W COMPACT HW	30
1C0032E	32W COMPACT HW ELIG	34
1C0032S	32W CIRCLINE HW	34
1C0042E	1/42W COMPACT HW ELIG	48
1C0044S	44W CIRCLINE HW	46
1C0057E	1/57W COMPACT HW ELIG	65
1C2232S	22/32W CIRCLINE HW	58
1C2D10E	10W 2D COMPACT HW ELIG	12
1C2D16E	16W 2D COMPACT HW ELIG	18
1C2D21E	21W 2D COMPACT HW ELIG	22
1C2D28E	28W 2D COMPACT HW ELIG	28
1C2D38E	38W 2D COMP.HW ELIG	36
1C3240S	32/40W CIRCLINE HW	80
2C0005S	2/5W COMPACT HW	14
2C0009S	2/9W COMPACT HW	22
2C0011S	2/11W COMPACT HW	26
2C0013E	2/13W COMPACT HW ELIG	28
2C0013S	2/13W COMPACT HW	30
2C0018E	2/18W COMP. HW ELIG	40
2C0026E	2/26W COMP. HW ELIG	54
2C0032E	2/32W COMPACT HW ELIG	68
Device	**Device Description**	**Rated**

Code		Watts
Compact Fluorescents (CFL's) (cont)		
2C0042E	2/42W COMPACT HW ELIG	100
3C0009S	3/9W COMPACT HW	33
3C0013S	3/13W COMPACT HW	45
3C0018E	3/18W COMPACT HW ELIG	60
3C0026E	3/26W COMPACT HW ELIG	82
3C0032E	3/32W COMPACT HW ELIG	114
3C0042E	3/42W COMPACT HW ELIG	141
4C0018E	4/18W COMPACT HW ELIG	80
4C0026E	4/26W COMPACT HW ELIG	108
4C0032E	4/32W COMPACT HW ELIG	152
4C0042E	4/42W COMPACT HW ELIG	188
6C0026E	6/26W COMPACT HW ELIG	162
6C0032E	6/32W COMPACT HW ELIG	228
6C0042E	6/42W COMPACT HW ELIG	282
8C0026E	8/26W COMPACT HW ELIG	216
8C0032E	8/32W COMPACT HW ELIG	304
8C0042E	8/42W COMPACT HW ELIG	376
T5 Systems		
1F14SSE	1L2' 14W T5/ELIG	16
2F14SSE	2L2' 14W T5/ELIG	32
3F14SSE	3L2' 14W T5/ELIG	50
4F14SSE	4L2' 14W T5/ELIG	68
1F24HSE	1L2' 24W T5HO/ELIG	29
2F24HSE	2L2' 24W T5HO/ELIG	52
3F24HSE	3L2' 24W T5HO/ELIG	80
1F21SSE	1L3' 21W T5/ELIG	24
2F21SSE	2L3' 21W T5/ELIG	47
1F39HSE	1L3' 39W T5HO/ELIG	42
2F39HSE	2L3' 39W T5HO/ELIG	85
1F28SSE	1L4' 28W T5/ELIG	32
2F28SSE	2L4' 28W T5/ELIG	63
3F28SSE	3L4' 28W T5/ELIG	95
4F28SSE	4L4' 28W T5/ELIG	126
6F28SSE	6L4' 28W T5/ELIG	189
1F47HSE	1L4' 47W T5HO/ELIG	53
2F47HSE	2L4' 47W T5HO/ELIG	103
3F47HSE	3L4' 47W T5HO/ELIG	157
4F47HSE	4L4' 47W T5HO/ELIG	200
5F47HSE	5L4' 47W T5HO/ELIG	260
6F47HSE	6L4' 47W T5HO/ELIG	303
1F50HSE	1L4' 50W T5HO/ELIG	58
2F50HSE	2L4' 50W T5HO/ELIG	110

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Device Code	Device Description	Rated Watts
	T5 Systems (cont.)	
3F50HSE	3L4' 50W T5HO/ELIG	168
4F50HSE	4L4' 50W T5HO/ELIG	215
5F50HSE	5L4' 50W T5HO/ELIG	278
6F50HSE	6L4' 50W T5HO/ELIG	325
1F54HSE	1L4' 54W T5HO/ELIG	59
2F54HSE	2L4' 54W T5HO/ELIG	117
3F54HSE	3L4' 54W T5HO/ELIG	177
4F54HSE	4L4' 54W T5HO/ELIG	234
5F54HSE	5L4' 54W T5HO/ELIG	294
6F54HSE	6L4' 54W T5HO/ELIG	351
8F54HSE	8L4' 54W T5HO/ELIG	468
10F54HSE	10L4' 54W T5HO/ELIG	585
Two Foot High Efficient T8 Systems		
1F17ESL	1L2' 17W T8EE/ELEE LOW PWR	14
1F17ESN	1L2' 17W T8EE/ELEE	17
1F17ESH	1L2' 17W T8EE/ELEE HIGH PWR	20
1F28BXE	1L2' F28BX/ELIG	32
2F17ESL	2L2' 17W T8EE/ELEE LOW PWR	27
2F17ESN	2L2' 17W T8EE/ELEE	32
2F17ESH	2L2' 17W T8EE/ELEE HIGH PWR	40
2F28BXE	2L2' F28BX/ELIG	63
3F17ESL	3L2' 17W T8EE/ELEE LOW PWR	39
3F17ESN	3L2' 17W T8EE/ELEE	46
3F17ESH	3L2' 17W T8EE/ELEE HIGH PWR	61
3F28BXE	3L2' F28BX/ELIG	94
Three Foot High Efficient T8 Systems		
1F25ESL	1L3' 25W T8EE/ELEE LOW PWR	21
1F25ESN	1L3' 25W T8EE/ELEE	24
1F25ESH	1L3' 25W T8EE/ELEE HIGH PWR	30
2F25ESL	2L3' 25W T8EE/ELEE LOW PWR	40
2F25ESN	2L3' 25W T8EE/ELEE	45
2F25ESH	2L3' 25W T8EE/ELEE HIGH PWR	60
3F25ESL	3L3' 25W T8EE/ELEE LOW PWR	58
3F25ESN	3L3' 25W T8EE/ELEE	67
3F25ESH	3L3' 25W T8EE/ELEE HIGH PWR	90

Device Code	Device Description	Rated Watts
Four Foot T8 High Efficient / Reduce Wattage Systems		
1F25EEH	1L4' 25W T8EE/ELEE HIGH PWR	30
1F25EEE	1L4' 25W T8EE/ELEE	22
1F25EEL	1L4' 25W T8EE/ELEE LOW PWR	19
2F25EEH	2L4' 25W T8EE/ELEE HIGH PWR	57
2F25EEE	2L4' 25W T8EE/ELEE	43
2F25EEL	2L4' 25W T8EE/ELEE LOW PWR	37
3F25EEH	3L4' 25W T8EE/ELEE HIGH PWR	86
3F25EEE	3L4' 25W T8EE/ELEE	64
3F25EEL	3L4' 25W T8EE/ELEE LOW PWR	57
4F25EEH	4L4' 25W T8EE/ELEE HIGH PWR	111
4F25EEE	4L4' 25W T8EE/ELEE	86
4F25EEL	4L4' 25W T8EE/ELEE LOW PWR	75
1F28EEH	1L4' 28W T8EE/ELEE HIGH PWR	33
1F28EEE	1L4' 28W T8EE/ELEE	24
1F28EEL	1L4' 28W T8EE/ELEE LOW PWR	22
2F28EEH	2L4' 28WT8EE/ELEE HIGH PWR	64
2F28EEE	2L4' 28W T8EE/ELEE	48
2F28EEL	2L4' 28W T8EE/ELEE LOW PWR	42
3F28EEH	3L4' 28W T8EE/ELEE HIGH PWR	96
3F28EEE	3L4' 28W T8EE/ELEE	72
3F28EEL	3L4' 28W T8EE/ELEE LOW PWR	63
4F28EEH	4L4' 28W T8EE/ELEE HIGH PWR	126
4F28EEE	4L4' 28W T8EE/ELEE	94
4F28EEL	4L4' 28W T8EE/ELEE LOW PWR	83
1F30EEH	1L4' 30W T8EE/ELEE HIGH PWR	36
1F30EEE	1L4' 30W T8EE/ELEE	26
1F30EEL	1L4' 30W T8EE/ELEE LOW PWR	24
2F30EEH	2L4' 30WT8EE/ELEE HIGH PWR	69
2F30EEE	2L4' 30W T8EE/ELEE	52
2F30EEL	2L4' 30W T8EE/ELEE LOW PWR	45
3F30EEH	3L4' 30W T8EE/ELEE HIGH PWR	103
3F30EEE	3L4' 30W T8EE/ELEE	77
3F30EEL	3L4' 30W T8EE/ELEE LOW PWR	68

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Device Code	Device Description	Rated Watts
Four Foot T8 High Efficient / Reduce Wattage Systems (cont.)		
4F30EEH	4L4' 30W T8EE/ELEE HIGH PWR	133
4F30EEE	4L4' 30W T8EE/ELEE	101
4F30EEL	4L4' 30W T8EE/ELEE LOW PWR	89
1F32EEH	1L4' 32W T8EE/ELEE HIGH PWR	38
1F32EEE	1L4' 32W T8EE/ELEE	28
1F32EEL	1L4' 32W T8EE/ELEE LOW PWR	25
2F32EEH	2L4' 32W T8EE/ELEE HIGH PWR	73
2F32EEE	2L4' 32W T8EE/ELEE	53
2F32EEL	2L4' 32W T8EE/ELEE LOW PWR	47
3F32EEH	3L4' 32W T8EE/ELEE HIGH PWR	109
3F32EEE	3L4' 32W T8EE/ELEE	82
3F32EEL	3L4' 32W T8EE/ELEE LOW PWR	72
4F32EEH	4L4' 32W T8EE/ELEE HIGH PWR	141
4F32EEE	4L4' 32W T8EE/ELEE	107
4F32EEL	4L4' 32W T8EE/ELEE LOW PWR	95
6F32EEH	6L4' 32W T8EE/ELEE HIGH PWR	218
6F32EEE	6L4' 32W T8EE/ELEE	168
6F32EEL	6L4' 32W T8EE/ELEE LOW PWR	146
Eight Foot T8 Systems		
1F59SSE	1L8' T8/ELIG	60
1F80SSE	1L8' T8 HO/ELIG	85
2F59SSE	2L8' T8/ELIG	109
2F59SSL	2L8' T8/ELIG LOW PWR	100
2F80SSE	2L8' T8 HO/ELIG	160
LED Lighting Fixtures		
1L002	2 WATT LED	2
1L003	3 WATT LED	3
1L004	4 WATT LED	04
1L005	5 WATT LED	05
1L006	6 WATT LED	06
1L007	7 WATT LED	07
1L008	8 WATT LED	08
1L009	9 WATT LED	09
1L010	10 WATT LED	10
1L011	11 WATT LED	11
1L012	12 WATT LED	12

Device Code	Device Description	Rated Watts
LED Lighting Fixtures (cont.)		
1L013	13 WATT LED	13
1L014	14 WATT LED	14
1L015	15 WATT LED	15
1L016	16 WATT LED	16
1L017	17 WATT LED	17
1L018	18 WATT LED	18
1L019	19 WATT LED	19
1L020	20 WATT LED	20
1L021	21 WATT LED	21
1L022	22 WATT LED	22
1L023	23 WATT LED	23
1L024	24 WATT LED	24
1L025	25 WATT LED	25
1L026	26 WATT LED	26
1L027	27 WATT LED	27
1L028	28 WATT LED	28
1L029	29 WATT LED	29
1L030	30 WATT LED	30
1L031	31 WATT LED	31
1L032	32 WATT LED	32
1L033	33 WATT LED	33
1L034	34 WATT LED	34
1L035	35 WATT LED	35
1L036	36 WATT LED	36
1L037	37 WATT LED	37
1L038	38 WATT LED	38
1L039	39 WATT LED	39
1L040	40 WATT LED	40
1L041	41 WATT LED	41
1L042	42 WATT LED	42
1L043	43 WATT LED	43
1L044	44 WATT LED	44
1L045	45 WATT LED	45
1L046	46 WATT LED	46
1L047	47 WATT LED	47
1L048	48 WATT LED	48
1L049	49 WATT LED	49
1L050	50 WATT LED	50
1L055	55 WATT LED	55
1L060	60 WATT LED	60
1L070	70 WATT LED	70
1L073	73 WATT LED	73
1L075	75 WATT LED	75
1L080	90 WATT LED	90
1L085	85 WATT LED	85
1L090	90 WATT LED	90

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Device Code	Device Description	Device Code
LED Lighting Fixtures (cont.)		
1L095	95 WATT LED	95
1L100	100 WATT LED	100
1L106	106 WATT LED	106
1L107	107 WATT LED	107
1L116	116 WATT LED	116
1L120	120 WATT LED	120
1L125	125 WATT LED	125
1L130	130 WATT LED	130
1L135	135 WATT LED	135
1L140	140 WATT LED	140
1L145	145 WATT LED	145
1L150	150 WATT LED	150
1L155	155 WATT LED	155
1L160	160 WATT LED	160
1L165	165 WATT LED	165
1L170	170 WATT LED	170
1L175	175 WATT LED	175
1L180	180 WATT LED	180
1L185	185 WATT LED	185
1L190	190 WATT LED	190
1L200	200 WATT LED	200

Device Code	Device Description	Device Code
LED Lighting Fixtures (cont.)		
1L210	210 WATT LED	210
1L220	220 WATT LED	220
1L240	240 WATT LED	240
Electronic Metal Halide Lamps		
1M0150E	150W METAL HALIDE EB	160
1M0200E	200W METAL HALIDE EB	215
1M0250E	250W METAL HALIDE EB	270
1M0320E	320W METAL HALIDE EB	345
1M0350E	350W METAL HALIDE EB	375
1M0400E	400W METAL HALIDE EB	430
1M0450E	400W METAL HALIDE EB	480
MH Track Lighting		
1M0020E	20W MH SPOT	25
1M0025E	25W MH SPOT	25
1M0035E	35W MH SPOT	44
1M0039E	39W MH SPOT	47
1M0050E	50W MH SPOT	60
1M0070E	70W MH SPOT	80
1M0100E	100W MH SPOT	111
1M0150E	150W MH SPOT	162

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Table 37: MassSAVE Retrofit Existing Lighting Wattage Tables

2012 MassSAVE C&I Lighting Rated Wattage Tables developed by Lighting Worksheet Team

Device Code	Device Description	Rated Watts
Incandescent Lamps		
1I0015	15W INC	15
1I0020	20W INC	20
1I0025	25W INC	25
1I0034	34W INC	34
1I0036	36W INC	36
1I0040	40W INC	40
1I0042	42W INC	42
1I0045	45W INC	45
1I0050	50W INC	50
1I0052	52W INC	52
1I0054	54W INC	54
1I0055	55W INC	55
1I0060	60W INC	60
1I0065	65W INC	65
1I0067	67W INC	67
1I0069	69W INC	69
1I0072	72W INC	72
1I0075	75W INC	75
1I0080	80W INC	80
1I0085	85W INC	85
1I0090	90W INC	90
1I0093	93W INC	93
1I0100	100W INC	100
1I0120	120W INC	120
1I0125	125W INC	125
1I0135	135W INC	135
1I0150	150W INC	150
1I0200	200W INC	200
1I0300	300W INC	300
1I0448	448W INC	448
1I0500	500W INC	500
1I0750	750W INC	750
1I1000	1000W INC	1000
1I1500	1500W INC	1500
Low Voltage Halogen Fixture (includes Transformer)		
1R0020	20W LV HALOGEN FIXT	30
1R0025	25W LV HALOGEN FIXT	35
1R0035	35W LV HALOGEN FIXT	45
1R0042	42W LV HALOGEN FIXT	52
1R0050	50W LV HALOGEN FIXT	60
1R0065	65W LV HALOGEN FIXT	75

Device Code	Device Description	Rated Watts
Low Voltage Halogen Fixture (includes Transformer) (cont.)		
1R0075	75W LV HALOGEN FIXT	85
Halogen/Quartz Lamps		
1T0035	35W HALOGEN LAMP	35
1T0040	40W HALOGEN LAMP	40
1T0042	42W HALOGEN LAMP	42
1T0045	45W HALOGEN LAMP	45
1T0047	47W HALOGEN LAMP	47
1T0050	50W HALOGEN LAMP	50
1T0052	52W HALOGEN LAMP	52
1T0055	55W HALOGEN LAMP	55
1T0060	60W HALOGEN LAMP	60
1T0072	72W HALOGEN LAMP	72
1T0075	75W HALOGEN LAMP	75
1T0090	90W HALOGEN LAMP	90
1T0100	100W HALOGEN LAMP	100
1T0150	150W HALOGEN LAMP	150
1T0200	200W HALOGEN LAMP	200
1T0250	250W HALOGEN LAMP	250
1T0300	300W HALOGEN LAMP	300
1T0350	350W HALOGEN LAMP	350
1T0400	400W HALOGEN LAMP	400
1T0425	425W HALOGEN LAMP	425
1T0500	500W HALOGEN LAMP	500
1T0750	750W HALOGEN LAMP	750
1T0900	900W HALOGEN LAMP	900
1T1000	1000W HALOGEN LAMP	1000
1T1200	1200W HALOGEN LAMP	1200
1T1500	1500W HALOGEN LAMP	1500
Mercury Vapor (MV)		
1V0040S	40W MERCURY	50
1V0050S	50W MERCURY	75
1V0075S	75W MERCURY	95
1V0100S	100W MERCURY	120
1V0175S	175W MERCURY	205
1V0250S	250W MERCURY	290
1V0400S	400W MERCURY	455
1V0700S	700W MERCURY	775
1V1000S	1000W MERCURY	1075
2V0400S	2/400W MERCURY	880

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Device Code	Device Description	Rated Watts
Low Pressure Sodium (LPS)		
1L0035S	35W LPS	60
1L0055S	55W LPS	85
1L0090S	90W LPS	130
1L0135S	135W LPS	180
1L0180S	180W LPS	230
High Pressure Sodium (HPS)		
1H0035S	35W HPS	45
1H0050S	50W HPS	65
1H0070S	70W HPS	90
1H0100S	100W HPS	130
1H0150S	150W HPS	190
1H0200S	200W HPS	240
1H0225S	225W HPS	275
1H0250S	250W HPS	295
1H0310S	310W HPS	350
1H0360S	360W HPS	435
1H0400S	400W HPS	460
1H0600S	600W HPS	675
1H0750S	750W HPS	835
1H1000S	1000W HPS	1085
Metal Halide (MH)		
1M0032S	32W METAL HALIDE	40
1M0050S	50W METAL HALIDE	65
1M0070S	70W METAL HALIDE	95
1M0100S	100W METAL HALIDE	120
1M0150S	150W METAL HALIDE	190
1M0175S	175W METAL HALIDE	205
1M0250S	250W METAL HALIDE	295
1M0360S	360W METAL HALIDE	430
1M0400S	400W METAL HALIDE	455
1M0750S	750W METAL HALIDE	825
1M1000S	1000W METAL HALIDE	1075
1M1500S	1500W METAL HALIDE	1615
1M1800S	1800W METAL HALIDE	1875
Pulse Start Metal Halide Lamp/Ballast		
1M0100P	100W MH CWA	128
1M0100R	100W MH LINEAR	118
1M0150P	150W MH CWA	190
1M0150R	150W MH LINEAR	172
1M0175P	175W MH CWA	208
1M0175R	175W MH LINEAR	190
1M0200P	200W MH CWA	232

Device Code	Device Description	Rated Watts
Pulse Start Metal Halide Lamp/Ballast (cont.)		
1M0200R	200W MH LINEAR	218
1M0250P	250W MH CWA	288
1M0250R	250W MH LINEAR	265
1M0300P	300W MH CWA	342
1M0300R	300W MH LINEAR	324
1M0320P	320W MH CWA	365
1M0320R	320W MH LINEAR	345
1M0350P	350W MH CWA	400
1M0350R	350W MH LINEAR	375
1M0400P	400W MH CWA	455
1M0400R	400W MH LINEAR	430
1M0450P	450W MH CWA	508
1M0450R	450W MH LINEAR	480
1M0750P	750W MH CWA	815
1M0750R	750W MH LINEAR	805
1M0875P	875W MH CWA	950
1M0875R	875W MH LINEAR	927
1M1000P	1000W MH CWA	1080
Two Foot T8 / T12 Systems		
1F20SSS	F20T12/HPF(1)	32
1F80BXE	1L2' F80BXE/ELIG	90
1F55BXE	1L2' F55BX/ELIG	56
2F17SSE	2L2' 17W T8/ELIG	37
2F17SSL	2L2' 17W T8/ELIG LOW POWER	27
2F17SSM	2L2' 17W T8/EEMAG	45
2F20SSS	F20T12/HPF(2)	56
2F24HSS	2L2' 24 T12HO/STD/STD	85
2F40BXE	2L2' F40BX/ELIG	72
2F50BXE	2L2' F50BX/ELIG	108
2F55BXE	2L2'55BXE/ELIG	112
3F17SSE	3L2' 17W T8/ELIG	53
3F17SSL	3L2' 17W T8/ELIG LOW POWER	39
3F20SSS	F20T12/HPF(3)	78
3F40BXE	3L2' F40BX/ELIG	102
3F50BXE	3L2' F50BX/ELIG	162
3F55BXE	3L2' F55BX/ELIG	168
4F17SSE	4L2' 17W T8/ELIG	62
4F36BXE	4L2' F36BX/ELIG	148
4F40BXE	4L2' F40BX/ELIG	144
4F40BXH	4L 40W T5 (Std.) HIGH LMN	170
4F50BXE	4L2' F50BX/ELIG	216
4F55BXE	4L2' F55BX/ELIG	224
5F40BXE	5L2' F40BX/ELIG	190

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Device Code	Device Description	Rated Watts
Two Foot T8 / T12 Systems (cont.)		
5F50BXE	5L2' F50BX/ELIG	270
5F55BXE	5L2' F55BX/ELIG	280
6F36BXE	6L2' F36BX/ELIG	212
6F40BXE	6L2' F40BX/ELIG	204
6F50BXE	6L2' F50BX/ELIG	324
6F55BXE	6L2' F55BX/ELIG	336
8F36BXE	8L2' F36BX/ELIG	296
8F40BXE	8L2' F40BX/ELIG	288
8F50BXE	8L2' F50BX/ELIG	432
8F55BXE	8L2' F55BX/ELIG	448
9F36BXE	9L2' F36BX/ELIG	318
9F40BXE	9L2' F40BX/ELIG	306
9F50BXE	9L2' F50BX/ELIG	486
9F55BXE	9L2' F55BX/ELIG	504
12F40BE	12L2' F40BX/ELIG	408
12F50BE	12L2' F50BX/ELIG	648
12F55BE	12L2' F55BX/ELIG	672
Three Foot T8 / T12 Systems		
1F30SEM	1L3' 30W T12 EE/EEMAG	38
1F30SES	1L3' 30W T12 EE/STD	42
1F30SSS	1L3' 30W T12 STD/STD	46
1F25SSE	1L3' 25W T8/ELIG	24
1F25SSH	1L3' 25W T8/ELIG HIGH LMN	28
2F30SEE	2L3' 30W T12 EE/ELIG	49
2F30SEM	2L3' 30W T12 EE/EEMAG	66
2F30SES	2L3' 30W T12 EE/STD	73
2F30SSS	2L3' 30W T12 STD/STD	80
2F25SSE	2L3' 25W T8/ELIG	47
2F25SSM	2L3' 25W T8/EEMAG	65
3F30SSS	3L3' 30W T12 STD/STD	140
3F30SES	3L3' 30W T12 EE/STD	127
3F25SSE	3L3' 25W T8/ELIG	68
4F25SSE	4L3' 25W T8/ELIG	88
Four Foot F48 T8 Systems		
1F48SES	1L4' F48T12EE/STD	50
1F48SSS	1L4' F48T12/STD	60
2F48SES	2L4' F48T12EE/STD	82
2F48SSS	2L4' F48T12/STD	102
3F48SES	3L4' F48T12EE/STD	132
3F48SSS	3L4' F48T12/STD	162
4F48SES	4L4' F48T12EE/STD	164
4F48SSS	4L4' F48T12/STD	204

Device Code	Device Description	Rated Watts
Four Foot F48HO T8 Systems		
1F48HES	1L4' F48HO/EE/STD	80
1F48HSS	1L4' F48H0/STD/STD	85
2F48HES	2L4' F48HO/EE/STD	135
2F48HSS	2L4' F48H0/STD/STD	145
3F48HES	3L4' F48HO/EE/STD	215
3F48HSS	3L4' F48H0/STD/STD	230
4F48HES	4L4' F48HO/EE/STD	270
4F48HSS	4L4' F48H0/STD/STD	290
Four Foot F48VHO T12 Systems		
1F48VES	1L4' F48VHO/EE/STD	123
1F48VSS	1L4' F48VHO/STD/STD	138
2F48VES	2L4' F48VHO/EE/STD	210
2F48VSS	2L4' F48VHO/STD/STD	240
3F48VES	3L4' F48VHO/EE/STD	333
3F48VSS	3L4' F48VHO/STD/STD	378
4F48VES	4L4' F48VHO/EE/STD	420
4F48VSS	4L4' F48VHO/STD/STD	480
Four Foot T12 Systems		
1F40SEE	1L4' EE/ELIG	38
1F40SEM	1L4' EE/EEMAG	40
1F40SES	1L4' EE/STD	50
1F40SSE	1L4' STD/ELIG	46
1F40SSM	1L4' STD/EEMAG	50
1F40SSS	1L4' STD/STD	57
1F40HSE	1L4' HO/STD/ELIG	59
2F40SEE	2L4' EE/ELIG	60
2F40SEM	2L4' EE/EEMAG	70
2F40SES	2L4' EE/STD	80
2F40SSE	2L4' STD/ELIG	72
2F40SSM	2L4' STD/EEMAG	86
2F40SSS	2L4' STD/STD	94
3F40SEE	3L4' EE/ELIG	90
3F40SEM	3L4' EE/EEMAG	110
3F40SES	3L4' EE/STD	130
3F40SSE	3L4' STD/ELIG	110
3F40SSM	3L4' STD/EEMAG	136
3F40SSS	3L4' STD/STD	151
4F40SEE	4L4' EE/ELIG	120
4F40SEM	4L4' EE/EEMAG	140
4F40SES	4L4' EE/STD	160
4F40SSE	4L4' STD/ELIG	144
4F40SSM	4L4' STD/EEMAG	172
4F40SSS	4L4' STD/STD	188

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Device Code	Device Description	Rated Watts
Four Foot T12 Systems (cont.)		
6F40SSS	6L4' STD/STD	282
Four Foot T8 Systems		
1F32SSE	1L4' T8/ELIG	30
1F32SSL	1L4' T8/ELIG LOW POWER	26
1F32SSM	1L4' T8/EEMAG	37
1F32SSH	1L4' T8/ELIG HIGH LMN	36
2F32SSE	2L4' T8/ELIG	60
2F32SSH	2L4' T8/ELIG HIGH LMN	78
2F32SSL	2L4' T8/ELIG LOW PWR	52
2F32SSM	2L4' T8/EEMAG	70
3F32SSE	3L4' T8/ELIG	88
3F32SSH	3L4' T8/ELIG HIGH LMN	112
3F32SSL	3L4' T8/ELIG LOW POWER	76
3F32SSM	3L4' T8/EEMAG	107
4F32SSE	4L4' T8/ELIG	112
4F32SSH	4L4' T8/ELIG HIGH LMN	156
4F32SSL	4L4' T8/ELIG LOW PWR	98
4F32SSM	4L4' T8/EEMAG	140
5F32SSE	5L4' T8/ELIG	148
5F32SSH	5L4' T8/ELIG HIGH LMN	190
6F32SSE	6L4' T8/ELIG	174
8F32SSH	8L4' T8/ELIG HIGH LMN	312
Five Foot T8 / T12 Systems		
1F60HSM	1L5' HO/STD/EEMAG	90
1F60HSE	1L5' HO/STD/ELIG	70
1F60SSM	1L5'/STD/EEMAG	73
1F60TSM	1L5' T10HO/STD/EEMAG	135
2F40HSE	2L5' HO/STD/ELIG	123
2F40TSE	2L5'T8/ELIG	68
2F60HSM	2L5' HO/STD/EEMAG	178
2F60SSM	2L5'/STD/EEMAG	122
3F40TSE	3L5'T8/ELIG	106
Six Foot T12 & T12HO Systems		
1F72HSE	1L6' T8HO/ELIG	80
1F72HSS	1L6' F72HO/STD/STD	113
1F72SSM	1L6' STD/EEMAG	80
1F72SSS	1L6' STD/STD	95
2F72HSE	2L6'T8 HO/ELIG	160
2F72HSM	2L6' F72HO/STD/EEMAG	193
2F72HSS	2L6' F72HO/STD	195
2F72SSM	2L6' STD/EEMAG	135
2F72SSS	2L6' STD/STD	173

Device Code	Device Description	Rated Watts
Eight Foot T12HO Systems		
1F96HES	1L8' HO/EE/STD	125
1F96HSS	1L8' HO/STD/STD	135
2F96HEE	2L8' HO/EE/ELIG	170
2F96HEM	2L8' HO/EE/EEMAG	207
2F96HES	2L8' HO/EE/STD	227
2F96HSE	2L8' HO/STD/ELIG	195
2F96HSM	2L8' HO/STD/EEMAG	237
2F96HSS	2L8' HO/STD/STD	257
3F96HES	3L8' HO/EE/STD	352
3F96HSS	3L8' HO/STD/STD	392
4F96HEE	4L8' HO/EE/ELIG	340
4F96HEM	4L8' HO/EE/EEMAG	414
4F96HES	4L8' HO/EE/STD	454
4F96HSE	4L8' HO/STD/ELIG	390
4F96HSM	4L8' HO/STD/EEMAG	474
4F96HSS	4L8' HO/STD/STD	514
Eight Foot T12VHO Systems		
1F96VES	1L8' VHO/EE/STD	200
1F96VSS	1L8' VHO/STD/STD	230
2F96VES	2L8' VHO/EE/STD	390
2F96VSS	2L8' VHO/STD/STD	450
3F96VES	3L8' VHO/EE/STD	590
3F96VSS	3L8' VHO/STD/STD	680
4F96VES	4L8' VHO/EE/STD	780
4F96VSS	4L8' VHO/STD/STD	900
Eight Foot T8 Systems		
1F59SSE	1L8' T8/ELIG	60
1F80SSE	1L8' T8 HO/ELIG	85
2F59SSE	2L8' T8/ELIG	109
2F59SSL	2L8' T8/ELIG LOW PWR	100
2F80SSE	2L8' T8 HO/ELIG	160
Eight Foot T12 Systems		
1F96SEE	1L8' EE/ELIG	60
1F96SES	1L8' EE/STD	83
1F96SSE	1L8' STD/ELIG	70
1F96SSS	1L8' STD/STD	100
2F96SEE	2L8' EE/ELIG	109
2F96SEM	2L8' EE/EEMAG	123
2F96SES	2L8' EE/STD	138
2F96SSE	2L8' STD/ELIG	134
2F96SSM	2L8' STD/EEMAG	158
2F96SSS	2L8' STD/STD	173
3F96SES	3L8' EE/STD	221

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Device Code	Device Description	Rated Watts
Eight Foot T12 Systems (cont.)		
3F96SSS	3L8' STD/STD	273
4F96SEE	4L8' EE/ELIG	218
4F96SEM	4L8' EE/EEMAG	246

Device Code	Device Description	Rated Watts
Eight Foot T12 Systems (cont.)		
4F96SES	4L8' EE/STD	276
4F96SSE	4L8' STD/ELIG	268
4F96SSM	4L8' STD/EEMAG	316
4F96SSS	4L8' STD/STD	346

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Table 38: MassSAVE Retrofit Proposed Lighting Wattage Tables

2012 MassSAVE C&I Lighting Rated Wattage Tables developed by Lighting Worksheet Team

Device Code	Device Description	Rated Watts
LED Exit Signs		
1E0002	2.0 WATT LED	2
1E0003	3.0 WATT LED	3
1E0005	5.0 WLED	5
1E0005C	0.5 WATT LEC	0.5
1E0008	8.0 WLED	8
1E0015	1.5 WATT LED	1.5
1E0105	10.5 WATT LED	10.5
Compact Fluorescents (CFL's)		
2C0007S	2/7W COMPACT HW	18
1C0005S	5W COMPACT HW	7
1C0007S	7W COMPACT HW	9
1C0009S	9W COMPACT HW	11
1C0011S	11W COMPACT HW	13
1C0013S	13W COMPACT HW	15
1C0018E	18W COMPACT HW ELIG	20
1C0018S	18W COMPACT HW	20
1C0022S	22W COMPACT HW	24
1C0023E	1/23W COMPACT HW ELIG	25
1C0026E	26W COMPACT HW ELIG	28
1C0026S	26W COMPACT HW	28
1C0028S	28W COMPACT HW	30
1C0032E	32W COMPACT HW ELIG	34
1C0032S	32W CIRCLINE HW	34
1C0042E	1/42W COMPACT HW ELIG	48
1C0044S	44W CIRCLINE HW	46
1C0057E	1/57W COMPACT HW ELIG	65
1C2232S	22/32W CIRCLINE HW	58
1C2D10E	10W 2D COMPACT HW ELIG	12
1C2D16E	16W 2D COMPACT HW ELIG	18
1C2D21E	21W 2D COMPACT HW ELIG	22
1C2D28E	28W 2D COMPACT HW ELIG	28
1C2D38E	38W 2D COMP.HW ELIG	36
1C3240S	32/40W CIRCLINE HW	80
2C0005S	2/5W COMPACT HW	14
2C0009S	2/9W COMPACT HW	22
2C0011S	2/11W COMPACT HW	26
2C0013E	2/13W COMPACT HW ELIG	28
2C0013S	2/13W COMPACT HW	30
2C0018E	2/18W COMP. HW ELIG	40
2C0026E	2/26W COMP. HW ELIG	54
2C0032E	2/32W COMPACT HW ELIG	68

Device Code	Device Description	Rated Watts
Compact Fluorescents (CFL's) (cont.)		
2C0042E	2/42W COMPACT HW ELIG	100
3C0009S	3/9W COMPACT HW	33
3C0013S	3/13W COMPACT HW	45
3C0018E	3/18W COMPACT HW ELIG	60
3C0026E	3/26W COMPACT HW ELIG	82
3C0032E	3/32W COMPACT HW ELIG	114
3C0042E	3/42W COMPACT HW ELIG	141
4C0018E	4/18W COMPACT HW ELIG	80
4C0026E	4/26W COMPACT HW ELIG	108
4C0032E	4/32W COMPACT HW ELIG	152
4C0042E	4/42W COMPACT HW ELIG	188
6C0026E	6/26W COMPACT HW ELIG	162
6C0032E	6/32W COMPACT HW ELIG	228
6C0042E	6/42W COMPACT HW ELIG	282
8C0026E	8/26W COMPACT HW ELIG	216
8C0032E	8/32W COMPACT HW ELIG	304
8C0042E	8/42W COMPACT HW ELIG	376
T5 Systems		
1F14SSE	1L2' 14W T5/ELIG	16
2F14SSE	2L2' 14W T5/ELIG	32
3F14SSE	3L2' 14W T5/ELIG	50
4F14SSE	4L2' 14W T5/ELIG	68
1F24HSE	1L2' 24W T5HO/ELIG	29
2F24HSE	2L2' 24W T5HO/ELIG	52
3F24HSE	3L2' 24W T5HO/ELIG	80
1F21SSE	1L3' 21W T5/ELIG	24
2F21SSE	2L3' 21W T5/ELIG	47
1F39HSE	1L3' 39W T5HO/ELIG	42
2F39HSE	2L3' 39W T5HO/ELIG	85
1F28SSE	1L4' 28W T5/ELIG	32
2F28SSE	2L4' 28W T5/ELIG	63
3F28SSE	3L4' 28W T5/ELIG	95
4F28SSE	4L4' 28W T5/ELIG	126
6F28SSE	6L4' 28W T5/ELIG	189
1F47HSE	1L4' 47W T5HO/ELIG	53
2F47HSE	2L4' 47W T5HO/ELIG	103
3F47HSE	3L4' 47W T5HO/ELIG	157
4F47HSE	4L4' 47W T5HO/ELIG	200
5F47HSE	5L4' 47W T5HO/ELIG	260
6F47HSE	6L4' 47W T5HO/ELIG	303
1F50HSE	1L4' 50W T5HO/ELIG	58

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Device Code	Device Description	Rated Watts
T5 Systems (cont.)		
2F50HSE	2L4' 50W T5HO/ELIG	110
3F50HSE	3L4' 50W T5HO/ELIG	168
4F50HSE	4L4' 50W T5HO/ELIG	215
5F50HSE	5L4' 50W T5HO/ELIG	278
6F50HSE	6L4' 50W T5HO/ELIG	325
1F54HSE	1L4' 54W T5HO/ELIG	59
2F54HSE	2L4' 54W T5HO/ELIG	117
3F54HSE	3L4' 54W T5HO/ELIG	177
4F54HSE	4L4' 54W T5HO/ELIG	234
5F54HSE	5L4' 54W T5HO/ELIG	294
6F54HSE	6L4' 54W T5HO/ELIG	351
8F54HSE	8L4' 54W T5HO/ELIG	468
10F54HSE	10L4' 54W T5HO/ELIG	585
Two Foot High Efficient T8 Systems		
1F17ESL	1L2' 17W T8EE/ELEE LOW PWR	14
1F17ESN	1L2' 17W T8EE/ELEE	17
1F17ESH	1L2' 17W T8EE/ELEE HIGH PWR	20
1F28BXE	1L2' F28BX/ELIG	32
2F17ESL	2L2' 17W T8EE/ELEE LOW PWR	27
2F17ESN	2L2' 17W T8EE/ELEE	32
2F17ESH	2L2' 17W T8EE/ELEE HIGH PWR	40
2F28BXE	2L2' F28BX/ELIG	63
3F17ESL	3L2' 17W T8EE/ELEE LOW PWR	39
3F17ESN	3L2' 17W T8EE/ELEE	46
3F17ESH	3L2' 17W T8EE/ELEE HIGH PWR	61
3F28BXE	3L2' F28BX/ELIG	94
Three Foot High Efficient T8 Systems		
1F25ESL	1L3' 25W T8EE/ELEE LOW PWR	21
1F25ESN	1L3' 25W T8EE/ELEE	24
1F25ESH	1L3' 25W T8EE/ELEE HIGH PWR	30
2F25ESL	2L3' 25W T8EE/ELEE LOW PWR	40
2F25ESN	2L3' 25W T8EE/ELEE	45
2F25ESH	2L3' 25W T8EE/ELEE HIGH PWR	60
3F25ESL	3L3' 25W T8EE/ELEE LOW PWR	58
3F25ESN	3L3' 25W T8EE/ELEE	67
3F25ESH	3L3' 25W T8EE/ELEE HIGH PWR	90

Device Code	Device Description	Rated Watts
Four Foot T8 High Efficient / Reduce Wattage Systems		
1F25EEH	1L4' 25W T8EE/ELEE HIGH PWR	30
1F25EEE	1L4' 25W T8EE/ELEE	22
1F25EEL	1L4' 25W T8EE/ELEE LOW PWR	19
2F25EEH	2L4' 25W T8EE/ELEE HIGH PWR	57
2F25EEE	2L4' 25W T8EE/ELEE	43
2F25EEL	2L4' 25W T8EE/ELEE LOW PWR	37
3F25EEH	3L4' 25W T8EE/ELEE HIGH PWR	86
3F25EEE	3L4' 25W T8EE/ELEE	64
3F25EEL	3L4' 25W T8EE/ELEE LOW PWR	57
4F25EEH	4L4' 25W T8EE/ELEE HIGH PWR	111
4F25EEE	4L4' 25W T8EE/ELEE	86
4F25EEL	4L4' 25W T8EE/ELEE LOW PWR	75
1F28EEH	1L4' 28W T8EE/ELEE HIGH PWR	33
1F28EEE	1L4' 28W T8EE/ELEE	24
1F28EEL	1L4' 28W T8EE/ELEE LOW PWR	22
2F28EEH	2L4' 28WT8EE/ELEE HIGH PWR	64
2F28EEE	2L4' 28W T8EE/ELEE	48
2F28EEL	2L4' 28W T8EE/ELEE LOW PWR	42
3F28EEH	3L4' 28W T8EE/ELEE HIGH PWR	96
3F28EEE	3L4' 28W T8EE/ELEE	72
3F28EEL	3L4' 28W T8EE/ELEE LOW PWR	63
4F28EEH	4L4' 28W T8EE/ELEE HIGH PWR	126
4F28EEE	4L4' 28W T8EE/ELEE	94
4F28EEL	4L4' 28W T8EE/ELEE LOW PWR	83
1F30EEH	1L4' 30W T8EE/ELEE HIGH PWR	36
1F30EEE	1L4' 30W T8EE/ELEE	26
1F30EEL	1L4' 30W T8EE/ELEE LOW PWR	24
2F30EEH	2L4' 30WT8EE/ELEE HIGH PWR	69
2F30EEE	2L4' 30W T8EE/ELEE	52
2F30EEL	2L4' 30W T8EE/ELEE LOW PWR	45
3F30EEH	3L4' 30W T8EE/ELEE HIGH PWR	103
3F30EEE	3L4' 30W T8EE/ELEE	77

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Device Code	**Device Description**	**Rated Watts**
Four Foot T8 High Efficient / Reduce Wattage Systems (cont.)		
3F30EEL	3L4' 30W T8EE/ELEE LOW PWR	68
4F30EEH	4L4' 30W T8EE/ELEE HIGH PWR	133
4F30EEE	4L4' 30W T8EE/ELEE	101
4F30EEL	4L4' 30W T8EE/ELEE LOW PWR	89
1F32EEH	1L4' 32W T8EE/ELEE HIGH PWR	38
1F32EEE	1L4' 32W T8EE/ELEE	28
1F32EEL	1L4' 32W T8EE/ELEE LOW PWR	25
2F32EEH	2L4' 32W T8EE/ELEE HIGH PWR	73
2F32EEE	2L4' 32W T8EE/ELEE	53
2F32EEL	2L4' 32W T8EE/ELEE LOW PWR	47
3F32EEH	3L4' 32W T8EE/ELEE HIGH PWR	109
3F32EEE	3L4' 32W T8EE/ELEE	82
3F32EEL	3L4' 32W T8EE/ELEE LOW PWR	72
4F32EEH	4L4' 32W T8EE/ELEE HIGH PWR	141
4F32EEE	4L4' 32W T8EE/ELEE	107
4F32EEL	4L4' 32W T8EE/ELEE LOW PWR	95
6F32EEH	6L4' 32W T8EE/ELEE HIGH PWR	218
6F32EEE	6L4' 32W T8EE/ELEE	168
6F32EEL	6L4' 32W T8EE/ELEE LOW PWR	146
Eight Foot T8 Systems		
1F59SSE	1L8' T8/ELIG	60
1F80SSE	1L8' T8 HO/ELIG	85
2F59SSE	2L8' T8/ELIG	109
2F59SSL	2L8' T8/ELIG LOW PWR	100
2F80SSE	2L8' T8 HO/ELIG	160
LED Lighting Fixtures		
1L002	2 WATT LED	2
1L003	3 WATT LED	3
1L004	4 WATT LED	04
1L005	5 WATT LED	05
1L006	6 WATT LED	06
1L007	7 WATT LED	07
1L008	8 WATT LED	08
1L009	9 WATT LED	09
Device Code	**Device Description**	**Rated Watts**
LED Lighting Fixtures (cont.)		
1L010	10 WATT LED	10
1L011	11 WATT LED	11
1L012	12 WATT LED	12
1L013	13 WATT LED	13
1L014	14 WATT LED	14
1L015	15 WATT LED	15
1L016	16 WATT LED	16
1L017	17 WATT LED	17
1L018	18 WATT LED	18
1L019	19 WATT LED	19
1L020	20 WATT LED	20
1L021	21 WATT LED	21
1L022	22 WATT LED	22
1L023	23 WATT LED	23
1L024	24 WATT LED	24
1L025	25 WATT LED	25
1L026	26 WATT LED	26
1L027	27 WATT LED	27
1L028	28 WATT LED	28
1L029	29 WATT LED	29
1L030	30 WATT LED	30
1L031	31 WATT LED	31
1L032	32 WATT LED	32
1L033	33 WATT LED	33
1L034	34 WATT LED	34
1L035	35 WATT LED	35
1L036	36 WATT LED	36
1L037	37 WATT LED	37
1L038	38 WATT LED	38
1L039	39 WATT LED	39
1L040	40 WATT LED	40
1L041	41 WATT LED	41
1L042	42 WATT LED	42
1L043	43 WATT LED	43
1L044	44 WATT LED	44
1L045	45 WATT LED	45
1L046	46 WATT LED	46
1L047	47 WATT LED	47
1L048	48 WATT LED	48
1L049	49 WATT LED	49
1L050	50 WATT LED	50
1L055	55 WATT LED	55
1L060	60 WATT LED	60
1L070	70 WATT LED	70

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1L073	73 WATT LED	73
Device Code	**Device Description**	**Rated Watts**
LED Lighting Fixtures (cont.)		
1L075	75 WATT LED	75
1L080	90 WATT LED	90
1L085	85 WATT LED	85
1L090	90 WATT LED	90
1L095	95 WATT LED	95
1L100	100 WATT LED	100
1L106	106 WATT LED	106
1L107	107 WATT LED	107
1L116	116 WATT LED	116
1L120	120 WATT LED	120
1L125	125 WATT LED	125
1L130	130 WATT LED	130
1L135	135 WATT LED	135
1L140	140 WATT LED	140
1L145	145 WATT LED	145
1L150	150 WATT LED	150
1L155	155 WATT LED	155
1L160	160 WATT LED	160
1L165	165 WATT LED	165
1L170	170 WATT LED	170
1L175	175 WATT LED	175
1L180	180 WATT LED	180
1L185	185 WATT LED	185
1L190	190 WATT LED	190
1L200	200 WATT LED	200
Device Code	**Device Description**	**Rated Watts**
LED Lighting Fixtures (cont.)		
1L210	210 WATT LED	210
1L220	220 WATT LED	220
1L240	240 WATT LED	240
Electronic Metal Halide Lamps		
1M0150E	150W METAL HALIDE EB	160
1M0200E	200W METAL HALIDE EB	215
1M0250E	250W METAL HALIDE EB	270
1M0320E	320W METAL HALIDE EB	345
1M0350E	350W METAL HALIDE EB	375
1M0400E	400W METAL HALIDE EB	430
1M0450E	400W METAL HALIDE EB	480
MH Track Lighting		
1M0020E	20W MH SPOT	25
1M0025E	25W MH SPOT	25
1M0035E	35W MH SPOT	44
1M0039E	39W MH SPOT	47
1M0050E	50W MH SPOT	60
1M0070E	70W MH SPOT	80
1M0100E	100W MH SPOT	111
1M0150E	150W MH SPOT	162

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Table 39: Default Effective Lighting Hours by Building Type[700]

Building Type	Annual Operating Hours
Assembly	2857 (one shift)
Automobile	4056 (retail)
Big Box	4057 (retail)
Community College	3255
Dormitory	3,056
Fast Food	5110
Full Service Restaurant	5110
Grocery	6074
Heavy Industrial	4,057
Hospital	8036
Hotel	8583
Large Refrigerated Space	2602 (warehouse)
Large Office	3610
Light Industrial	4,730 (two shift)
Motel	8583
Multi Story Retail	4089
Multifamily high-rise	7665 (Common Area)
Multifamily low-rise	7665 (Common Area)
Other	3951
Religious	1955
K-12 Schools	2596
Small Office	3610
Small Retail	4089
University	3255
Warehouse	3759

Table 40: Cooling and Heating Equivalent Full Load Hours

Building (or Space) Type	Cooling Full Load Hours ($EFLH_{cool}$)	Heating Full Load Hours ($EFLH_{heat}$)
Average – CLC	1,172	530
Average – NSTAR	1,172	N/A
Average – National Grid	989	881
Average – Unitil	719	1,398
Average – WMECO	755	1,329
Site Specific - NSTAR	800, 1000-6000 at 1000 hour increments	N/A

- Average Cooling EFLHs from the 2010 NEEP HVAC Loadshape study.[701]
- Average Heating EFLHs derived from 2010 NEEP HVAC Loadshape study[702] and the Connecticut Program Savings Document for 2011 Program Year.[703]

[700] Lighting hours developed from Massachusetts Common Assumptions and New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (2010). Values are provided for use when site-specific hours are not available.
[701] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.
[702] Ibid.
[703] United Illuminating Company, Connecticut Light & Power Company (2010). *UI and CL&P Program Savings Documentation for 2011 Program Year*.

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Table 41: EPACT 1992 Baseline Motor Efficiencies[704]

Motor Horsepower	Open Drip Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	80.0	82.5	N/A	80.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	84.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	87.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5
10	90.2	89.5	88.5	89.5	89.5	89.5
15	90.2	91.0	89.5	90.2	91.0	90.2
20	91.0	91.0	90.2	90.2	91.0	90.2
25	91.7	91.7	91.0	91.7	92.4	91.0
30	92.4	92.4	91.0	91.7	92.4	91.0
40	93.0	93.0	91.7	93.0	93.0	91.7
50	93.0	93.0	92.4	93.0	93.0	92.4
60	93.6	93.6	93.0	93.6	93.6	93.0
75	93.6	94.1	93.0	93.6	94.1	93.0
100	94.1	94.1	93.0	94.1	94.5	93.6
125	94.1	94.5	93.6	94.1	94.5	94.5
150	94.5	95.0	93.6	95.0	95.0	94.5
200	94.5	95.0	94.5	95.0	95.0	95.0

[704] Energy Policy Act of 1992

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Table 42: Minimum Premium Efficiency Motors Compliance Efficiencies[705]

Motor Horsepower	Open Drip Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	N/A	82.5	85.5	77.0
1.5	86.5	86.5	84	87.5	86.5	84
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91	88.5	91	91.7	89.5
10	91.7	91.7	89.5	91	91.7	90.2
15	97.7	93	90.2	91.7	92.4	91
20	92.4	93	91	91.7	93	91
25	93	93.6	91.7	93	93.6	91.7
30	93.6	94.1	91.7	93	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93	94.1	94.5	93
60	94.5	95	93.6	94.5	95	93.6
75	94.5	95	93.6	94.5	95.4	93.6
100	95	95.4	93.6	95	95.4	94.1
125	95	95.4	94.1	95	95.4	95
150	95.4	95.8	94.1	95.8	95.8	95
200	95.4	95.8	95	95.8	96.2	95.4

[705] NEMA Premium MG1-2006 Table 12-12

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Appendix B: Common Program Names

The common Program Naming (CPN) of the efficiency programs offered by the program administrators is a work in progress. Among other things, the goals of the CPN are to:

- avoid the use of product names (e.g., OPower),
- provide a commonality for gas and electric programs (e.g., MassSAVE for electric, and weatherization for gas), and
- characterize programs such that a consistent primary name (e.g., Retrofit) is used for all sectors.

CPN was introduced to PAs in the late summer of 2009. Given the tight schedule for filing 2010-2012 program plans, the PAs agreed to work to incorporate these names at a later date.

The PAs will work with the DOER to integrate these into future plan updates.

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Appendix C: Net to Gross Impact Factors

Residential Electric Measures					
Measure	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
Residential New Construction & Major Renovation					
Dishwashers	All	86%	0%	0%	14%
ES Homes - Cooling	All	0%	0%	0%	100%
ES Homes - Heating	All	0%	0%	0%	100%
ES Homes - Water Heating	All	0%	0%	0%	100%
Indoor Fixture[706]	All	23%	0%	0%	77%
LED Fixture[707]	All	23%	0%	0%	77%
Refrigerators	All	86%	0%	0%	14%
Screw-in Bulbs[708]	All	23%	0%	0%	77%
Residential Cooling & Heating Equipment					
Brushless Furnace Fan Motor	All	15%	0%	0%	85%
CoolSmart AC (SEER >= 15 / EER >= 12.5)	All	40%	28%	0%	88%
CoolSmart AC (SEER >= 15 / EER >= 13)	All	40%	28%	0%	88%
CoolSmart AC (SEER 14.5 / EER 12)	All	35%	28%	0%	93%
CoolSmart AC (SEER 16 / EER 13)	All	42%	28%	0%	86%
CoolSmart AC Digital Check-up/Tune-up	All	25%	16%	0%	85%
CoolSmart AC QIV	All	25%	16%	0%	91%
CoolSmart HP (SEER >= 15)	All	40%	28%	0%	88%
CoolSmart HP (SEER 14.5 / EER 12)	All	35%	28%	0%	93%
CoolSmart HP Digital Check-up/Tune-up	All	25%	16%	0%	85%
CoolSmart HP MS (SEER 14.5 / EER 12.0 / HSPF 8.2)	All	45%	7%	0%	62%
CoolSmart HP MS (SEER 19 / EER 12.8 / HSPF 10.1)	All	45%	7%	0%	62%
CoolSmart HP MS (SEER 23 / EER 13 / HSPF 10.6)	All	45%	7%	0%	62%
CoolSmart HP QIV	All	25%	16%	0%	91%
CoolSmart Warm Air Furnace ECM	All	41%	22%	0%	85%
Down Size 1/2 Ton	All	25%	16%	0%	85%
Duct Sealing	All	25%	16%	0%	85%
Ductless Mini Split AC	All	45%	7%	0%	62%
Energy Star QI	All	25%	16%	0%	85%
Energy Star QI w/ Duct modifications	All	25%	16%	0%	85%
Right Sizing	All	25%	16%	0%	85%
HPWH, Electric, 80 gal	All	0%	0%	0%	100%
HPWH, Electric, 50 gal	All	0%	0%	0%	100%
HPWH, Propane, 50 gal	CLC	0%	0%	0%	100%
HPWH, Oil, 80 gal	All	0%	0%	0%	100%

[706] Based on the 2012 IECC requirement that 75% of lighting be high efficiency and the fact the that RNC Baseline Study looking at homes built under the 2009 IECC found only 23% of homes had high efficiency lighting (where the requirement was 50%); free-ridership is estimated to escalate over the three years from 23% in 2013, to 33% in 2014, and 40% in 2015.
[707] Ibid.
[708] Ibid

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HPWH, Oil, 50 gal	All	0%	0%	0%	100%
TXV Replacement of Fixed Orifice	All	15%	0%	0%	85%
Residential Retrofit 1-4					
Air Sealing, Electric	All	8%	8%	28%	129%
Air Sealing, Gas	All	8%	8%	28%	129%
Air Sealing, Oil	All	8%	8%	28%	129%
Air Sealing, Other FF	All	8%	8%	28%	129%
Boiler Reset Controls	All	0%	0%	0%	100%
DHW ISMs, Electric	All	2%	0%	0%	98%
DHW ISMs, Gas	All	2%	0%	0%	98%
DHW ISMs, Oil	All	2%	0%	0%	98%
DHW ISMs, Other FF	All	2%	0%	0%	98%
Duct Insulation, Electric	All	25%	20%	28%	123%
Duct Insulation, Gas	All	25%	20%	28%	123%
Duct Insulation, Oil	All	25%	20%	28%	123%
Duct Insulation, Other FF	All	25%	20%	28%	123%
Duct Seal, Electric	All	8%	8%	28%	129%
Duct Seal, Gas	All	8%	8%	28%	129%
Duct Seal, Oil	All	8%	8%	28%	129%
Duct Seal, Other FF	All	8%	8%	28%	129%
ES Window, Electric	All	0%	0%	0%	100%
ES Window, Gas	All	0%	0%	0%	100%
ES Window, Oil	All	0%	0%	0%	100%
ES Window, Other FF	All	0%	0%	0%	100%
Early Retirement Boiler	All	0%	0%	0%	100%
Heating System Replacement, Gas	All	28%	0%	0%	72%
Heating System Replacement, Oil	All	28%	0%	0%	72%
Heating System Replacement, Other FF	All	28%	0%	0%	72%
Indirect Water Heater, Oil	All	25%	0%	0%	75%
Indirect Water Heater, Other FF	All	25%	0%	0%	75%
Insulation, Electric	All	25%	20%	28%	123%
Insulation, Gas	All	25%	20%	28%	123%
Insulation, Oil	All	25%	20%	28%	123%
Insulation, Other FF	All	25%	20%	28%	123%
Refrigerator (ES Value)	All	14%	0%	0%	95%
Refrigerator (Retriement Value)	All	14%	0%	0%	95%
Screw-in Bulbs	All	24%	2.5%	0%	78.5%
Screw-in Bulbs (piggyback)	All	24%	2.5%	0%	78.5%
Smart Strips	All	0%	0%	0%	100%
Thermostats, Electric	All	11%	0%	0%	89%
Thermostats, Gas	All	11%	0%	0%	89%
Thermostats, Oil	All	11%	0%	0%	89%
Thermostats, Other FF	All	11%	0%	0%	89%
Torchiere	All	6%	3%	0%	97%

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Residential Retrofit Multifamily					
Air Sealing (Electric)	All	19%	0%	0%	81%
Air Sealing (FF)	All	19%	0%	0%	81%
CFL (Electric)	All	18%	0%	0%	82%
CFL (Non-Electric)	All	18%	0%	0%	82%
Common Area Interior Fixtures	All	18%	0%	0%	82%
Common Area Occupancy Sensors	All	18%	0%	0%	82%
DHW Measures (FF)	All	15%	0%	0%	85%
DHW Measures (Electric)	All	15%	0%	0%	85%
Fixtures (Electric)	NGRID	18%	0%	0%	82%
Fixtures (Non-Electric)	NGRID	18%	0%	0%	82%
Heat Pump Tune-Up (Electric)	All	3%	0%	0%	97%
Indoor Fixture	All	18%	0%	0%	82%
Insulation (Electric)	All	19%	0%	0%	81%
Insulation (FF)	All	19%	0%	0%	81%
Outdoor Fixture	All	18%	0%	0%	82%
Programmable Thermostats (Electric)	All	24%	0%	0%	76%
Programmable Thermostats (FF)	All	24%	0%	0%	76%
Refrigerator (ES Value)	All	3%	0%	0%	97%
Refrigerator (Retirement Value)	All	3%	0%	0%	97%
Refrigerators/Freezers (Electric Heat)	NGRID	3%	0%	0%	97%
Refrigerators/Freezers (Non-Electric Heat)	NGRID	3%	0%	0%	97%
Room AC	All	35%	0%	0%	65%
Screw-in Bulbs	All	18%	0%	0%	82%
Smart Strips	All	0%	0%	0%	100%
SPACE Air Sealing (Electric)	NGRID	19%	0%	0%	81%
SPACE Air Sealing (Non-Electric)	NGRID	19%	0%	0%	81%
SPACE Insulation (Electric)	NGRID	19%	0%	0%	81%
SPACE Insulation (Non-Electric)	NGRID	19%	0%	0%	81%
SPACE Thermostats (Electric)	NGRID	24%	0%	0%	76%
SPACE Thermostats (Non-Electric)	NGRID	24%	0%	0%	76%
Behavior/Feedback Program					
Group 2009 Pilot	NGRID	0%	0%	0%	100%
Group 2010 Added	NGRID	0%	0%	0%	100%
Group 2010 February	NGRID	0%	0%	0%	100%
Group 2011 February	NGRID	0%	0%	0%	100%
Group 2012 February	NGRID	0%	0%	0%	100%
2012 Dual Fuel	NSTAR	0%	0%	0%	100%
Residential Lighting					
Indoor Fixture	All	8%	4%	0%	96%
LED Fixture	All	0%	0%	0%	100%
LED Lamp	All	0%	0%	0%	100%
Outdoor Fixture	All	12%	7%	0%	95%
Screw-in Bulbs	All	57%	0%	0%	43%

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Screw-in Bulbs (Hard to Reach)	All	40%	0%	0%	60%
Screw-in Bulbs (School Fundraiser)	All	0%	0%	0%	100%
Screw-in Bulbs (Specialty bulbs)	All	40%	0%	0%	60%
Torchiere	All	6%	3%	0%	97%
Residential Appliances					
Computer Monitors	All	25%	0%	0%	75%
Dehumidifiers (ES Value)	All	25%	0%	0%	75%
Dehumidifiers (Retirement Value)	All	25%	0%	0%	75%
Freezer Rebate	All	25%	0%	0%	75%
PC Computers	All	25%	0%	0%	75%
Pool Pumps	All	0%	0%	0%	100%
Refrigerator Recycle – Secondary Replaced	All	27%	0%	0%	73%
Refrigerator Recycle – Primary	All	45%	0%	0%	55%
Refrigerator Recycle – Secondary, Not Replaced	All	29%	0%	0%	71%
Refrigerator Recycling – Combined	All	31%	0%	0%	69%
Freezer Recycling	All	41%	0%	0%	59%
Refrigerator Rebate	All	25%	0%	0%	75%
Room Air Conditioner 10.8 EER	All	36%	0%	0%	64%
Room Air Cleaner	All	25%	0%	0%	75%
Set Top Box	All	25%	0%	0%	75%
Smart Strips	All	0%	0%	0%	100%
Version 5.3 TV <60”	All	25%	0%	0%	75%
Version 5.3 TV >=60”	All	25%	0%	0%	75%
Low Income Residential New Construction & Major Renovation					
Dishwashers	All	86%	0%	0%	14%
ES Homes - Cooling	All	0%	0%	0%	100%
ES Homes - Heating	All	0%	0%	0%	100%
ES Homes - Water Heating	All	0%	0%	0%	100%
Indoor Fixture[709]	All	23%	0%	0%	77%
LED Fixture[710]	All	23%	0%	0%	77%
Refrigerators	All	86%	0%	0%	14%
Screw-in Bulbs[711]	All	23%	0%	0%	77%
Low Income 1-4 Family Retrofit					
Appliance (refrigerator or freezer) Removal	All	0%	0%	0%	100%
Baseload/Education	All	0%	0%	0%	100%
Boiler Reset Controls	All	0%	0%	0%	100%
CFLs	All	0%	0%	0%	100%
CFL Fixture	All	0%	0%	0%	100%
Dehumidifiers (ES Value)	All	0%	0%	0%	100%
Dehumidifiers (Retirement Value)	All	0%	0%	0%	100%

[709] Based on the 2012 IECC requirement that 75% of lighting be high efficiency and the fact the that RNC Baseline Study looking at homes built under the 2009 IECC found only 23% of homes had high efficiency lighting (where the requirement was 50%); free-ridership is estimated to escalate over the three years from 23% in 2013, to 33% in 2014, and 40% in 2015.
[710] Ibid.
[711] Ibid

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DHW Measures (Electric)	All	0%	0%	0%	100%
DHW Measures (Gas/Other)	All	0%	0%	0%	100%
DHW Measures (Oil)	All	0%	0%	0%	100%
Electric Weatherization	All	0%	0%	0%	100%
Freezer Replacement	All	0%	0%	0%	100%
Heating System Replacement (Oil)	All	0%	0%	0%	100%
Oil Weatherization	All	0%	0%	0%	100%
Gas Weatherization	CLC	0%	0%	0%	100%
Other FF Weatherization	CLC	0%	0%	0%	100%
Programmable Thermostats (Oil)	All	0%	0%	0%	100%
Refrigerator Replacement	All	0%	0%	0%	100%
Smart Strips	All	0%	0%	0%	100%
Torchieres	All	0%	0%	0%	100%
Waterbed	All	0%	0%	0%	100%
Window AC Replacement	All	0%	0%	0%	100%
Low Income Multi-Family Retrofit					
Baseload	All	0%	0%	0%	100%
CFL Fixtures	All	0%	0%	0%	100%
CFLs	All	0%	0%	0%	100%
DHW Measures	All	0%	0%	0%	100%
Electric Weatherization	All	0%	0%	0%	100%
Oil Weatherization	CLC, Unitil	0%	0%	0%	100%
Freezer Replacement	All	0%	0%	0%	100%
Programmable Thermostats (Oil)	CLC, Unitil	0%	0%	0%	100%
Refrigerator (ES Value)	All	0%	0%	0%	100%
Refrigerator (Retirement Value)	All	0%	0%	0%	100%
Second Refrigerator Removal	CLC	0%	0%	0%	100%
Smart Strips	All	0%	0%	0%	100%
Torchieres	All	0%	0%	0%	100%
Waterbed	All	0%	0%	0%	100%
Window AC Replacement	All	0%	0%	0%	100%

Evaluations

Unless otherwise stated below, all PA's use Massachusetts common assumptions for all residential electric measure free-ridership and spillover values.

All PAs base the NTG factors for Residential Cooling and Heating Equipment on the 2012 Cool Smart and HEHE Program Evaluation report.[712]

All PAs base the NTG factors for the ENERGY STAR Lighting Screw-In Bulbs and Screw-In Bulbs (Specialty bulbs) measures on the Massachusetts ENERGY STAR® Lighting Program: 2010 Annual Report.[713]

[712] The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing.* Prepared for Electric and Gas Program Administrators of Massachusetts; June 2013.

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All PAs base the NTG factors for Refrigerator and Freezer Recycling measures on the Massachusetts Appliance Turn-in Program Evaluation Integrated Report Findings report.[714]

All PAs base the NTG factors for the MassSAVE Screw-In Bulbs, Screw-In Bulbs (piggyback), Refrigerator, Air Sealing, Insulation, Duct Seal, Duct Insulation on the MA 2011 Residential Retrofit and Low Income Net to Gross Evaluation.[715] NTG factors for Screw-In Bulbs, Screw-In Bulbs (piggyback) are based on this study but modified by agreement with EEAC consultants of 7-2-12 to account for the potential for participants who would have bought CFLs outside of the HES program but through the Upstream Lighting program.

All PAs base the NTG factors for the MassSAVE Thermostats, Heating System Replacement and Indirect Water Heater measures on the 2010 Net-to-Gross Findings: Home Energy Assessment study.[716]

All PAs base the NTG factors for the Multifamily Program on 2011 Residential Retrofit Multifamily Program Impact Analysis[717]

[713] NMR Group, Inc (2011). *Massachusetts ENERGY STAR® Lighting Program: 2010 Annual Report.* Prepared for the Electric Program Administrators of Massachusetts; June 13, 2011.
[714] NMR Group, Inc. (2011). *Massachusetts Appliance Turn-in Program Evaluation Integrated Report Findings*. Prepared for the Electric Program Administrators of Massachusetts.
[715] The Cadmus Group (2012). Massachusetts *2011 Residential Retrofit and Low Income net-to-Gross Evaluation*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[716] The Cadmus Group, Inc. (2011). *2010 Net-to-Gross Findings: Home Energy Assessment*. Prepared for the Electric and Gas Program Administrators of Massachusetts; July 5, 2011.
[717] The Cadmus Group, Inc. (2012). *Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis*. Prepared for Massachusetts Program Administrators and the Energy Efficiency Advisory Council.

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Commercial Electric Measures					
Measure	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
C&I New Construction and Major Renovation					
Advanced Lighting Design (Performance Lighting)	NGRID	16%	29%	0%	113%
Advanced Lighting Design (Performance Lighting)	NSTAR	12%	2%	0%	90%
Advanced Lighting Design (Performance Lighting)	Unitil	19.9%	8.8%	0%	88.9%
Advanced Lighting Design (Performance Lighting)	WMECo	20%	9%	0%	89%
Advanced Lighting Design (Performance Lighting)	CLC	20%	9%	0%	89%
Lighting Controls	NGRID	33%	16%	0%	83%
Lighting Controls	NSTAR	12%	2%	0%	90%
Lighting Controls	Unitil	19.9%	8.8%	0%	88.9%
Lighting Controls	WMECo	20%	9%	0%	89%
Lighting Controls	CLC	20%	9%	0%	89%
Lighting Systems	NGRID	33%	16%	0%	96%
Lighting Systems	NSTAR	12%	2%	0%	90%
Lighting Systems	Unitil	19.9%	8.8%	0%	88.9%
Lighting Systems	WMECo	20%	9%	0%	89%
Lighting Systems	CLC	20%	9%	0%	89%
Upstream Lighting – Linear Fluorescents	All	-	-	-	74%
Upstream Lighting - LEDs	All	-	-	-	82%
Upstream Lighting – T8s/T5s	CLC	-	-	-	82%
Demand Control Ventilation (DCV)	NGRID	26%	2%	0%	75%
Demand Control Ventilation (DCV)	NSTAR	21%	14%	0%	94%
Demand Control Ventilation (DCV)	Unitil	30.6%	0%	3.6%	73%
Demand Control Ventilation (DCV)	WMECo	30%	1%	0%	71%
Demand Control Ventilation (DCV)	CLC	22%	12%	0%	90%
Dual Enthalpy Economizer Controls (DEEC)	NGRID	26%	2%	0%	75%
Dual Enthalpy Economizer Controls (DEEC)	NSTAR	21%	14%	0%	94%
Dual Enthalpy Economizer Controls (DEEC)	Unitil	30.6%	0%	3.6%	73%
Dual Enthalpy Economizer Controls (DEEC)	WMECo	30%	1%	0%	71%
Dual Enthalpy Economizer Controls (DEEC)	CLC	22%	12%	0%	90%
ECM Fan Motors	NGRID	26%	2%	0%	75%
ECM Fan Motors	NSTAR	21%	14%	0%	94%
ECM Fan Motors	Unitil	30.6%	0%	3.6%	73%
ECM Fan Motors	WMECo	30%	1%	0%	71%
ECM Fan Motors	CLC	22%	12%	0%	90%
Energy Management System (EMS)	CLC	22%	12%	0%	90%
HE Chiller	NGRID	26%	2%	0%	75%
HE Chiller	NSTAR	21%	14%	0%	94%
HE Chiller	Unitil	30.6%	0%	3.6%	73%
HE Chiller	WMECo	30%	1%	0%	71%
HE Chiller	CLC	22%	12%	0%	90%
Single-Package and SS Heat Pump Systems	NGRID	29%	2%	0%	73%
Single-Package and SS Heat Pump Systems	NSTAR	21%	14%	0%	94%
Single-Package and SS Heat Pump Systems	Unitil	30.6%	0%	3.6%	73%
Single-Package and SS Heat Pump Systems	WMECo	30%	1%	0%	71%
Single-Package and SS Heat Pump Systems	CLC	22%	12%	0%	90%
Single-Package and SS Unitary air conditioners	NGRID	29%	2%	0%	73%

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Single-Package and SS Unitary air conditioners	NSTAR	21%	14%	0%	94%
Single-Package and SS Unitary air conditioners	Unitil	30.6%	0%	3.6%	73%
Single-Package and SS Unitary air conditioners	WMECo	30%	1%	0%	71%
Single-Package and SS Unitary air conditioners	CLC	22%	12%	0%	90%
HE Air Compressor	NGRID	32%	0%	2%	70%
HE Air Compressor	NSTAR	37%	10%	1%	74%
HE Air Compressor	Unitil	30.6%	0%	3.6%	73%
HE Air Compressor	WMECo	34%	4%	2%	72%
HE Air Compressor	CLC	34%	4%	2%	72%
Refrigerated Air Dryers	NGRID	32%	0%	2%	70%
Refrigerated Air Dryers	NSTAR	37%	10%	1%	74%
Refrigerated Air Dryers	Unitil	30.6%	0%	3.6%	73%
Refrigerated Air Dryers	WMECo	34%	4%	2%	72%
Refrigerated Air Dryers	CLC	34%	4%	2%	72%
Variable Frequency Drives	NGRID	25%	0%	8%	82%
Variable Frequency Drives	NSTAR	23%	2%	8%	86%
Variable Frequency Drives	Unitil	30.6%	0%	3.6%	73%
Variable Frequency Drives	WMECo	23%	1%	8%	86%
Variable Frequency Drives	CLC	23%	1%	8%	86%
Commercial Electric Ovens	All	0%	0%	0%	100%
Commercial Electric Steam Cooker	All	0%	0%	0%	100%
Commercial Electric Griddle	All	0%	0%	0%	100%
Custom	NGRID	16%	29%	0%	113%
Custom	Unitil	20.%	11.5%	0%	92.3%
Custom - Compressed Air	NSTAR	37%	10%	1%	74%
Custom - Compressed Air	WMECo	34%	4%	2%	72%
Custom - Compressed Air	CLC	34%	4%	2%	72%
Custom - HVAC	WMECo	30%	1%	0%	71%
Custom - HVAC	NSTAR	21%	14%	0%	94%
Custom - HVAC	CLC	22%	12%	0%	90%
Custom – Envelope	CLC	75%	0%	0%	25%
Custom - Lighting	NSTAR	12%	4%	0%	92%
Custom - Lighting	WMECo	20%	9%	0%	89%
Custom - Lighting	CLC	20%	0%	0%	80%
Custom - Hot Water	CLC	0%	0%	0%	0%
Custom - Motors	NSTAR	23%	2%	8%	86%
Custom - Motors	WMECo	23%	1%	8%	86%
Custom - Motors	CLC	23%	1%	8%	86%
Custom - Process	WMECo	7%	0%	0%	93%
Custom - Process	CLC	10%	19%	0%	109%
Custom - Process Equipment	NSTAR	10%	1%	0%	91%
Custom - Refrigeration	NSTAR	13%	35%	0%	122%
Custom - Refrigeration	CLC	13%	35%	0%	122%
Custom – Refrigeration	WMECo	13%	35%	0%	122%
Custom – Other	WMECo	7%	0%	0%	93%
C&I Large Retrofit					
Lighting Controls	NGRID	17%	13%	0%	96%
Lighting Controls	NSTAR	18%	18%	0%	101%

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Lighting Controls	Unitil	16.9%	8.4%	0%	91.5%
Lighting Controls	WMECo	20%	5%	0%	85%
Lighting Controls	CLC	17%	5%	0%	88%
Lighting Systems	NGRID	17%	13%	0%	96%
Lighting Systems	NSTAR	18%	18%	0%	101%
Lighting Systems	Unitil	16.9%	8.4%	0%	91.5%
Lighting Systems	WMECo	20%	5%	0%	85%
Lighting Systems	CLC	17%	5%	0%	88%
Vending Machine and Cooler Controls (Lighting)	NSTAR	18%	18%	0%	101%
Energy Management System (EMS)	NGRID	11%	4%	0%	93%
Energy Management System (EMS)	NSTAR	13%	6%	0%	93%
Energy Management System (EMS)	Unitil	13.4%	6.4%	0%	93%
Energy Management System (EMS)	WMECo	13%	6%	0%	93%
Energy Management System (EMS)	CLC	13%	6%	0%	93%
Hotel Occupancy Sensors	NGRID	11%	4%	0%	93%
Hotel Occupancy Sensors	NSTAR	13%	6%	0%	93%
Hotel Occupancy Sensors	Unitil	13.4%	6.4%	0%	93%
Hotel Occupancy Sensors	WMECo	13%	6%	0%	93%
Hotel Occupancy Sensors	CLC	17%	5%	0%	88%
LEDs in Freezers/Coolers	CLC	17%	5%	0%	88%
Vending Machine and Cooler Controls	NGRID	11%	4%	0%	93%
Vending Machine and Cooler Controls	Unitil	13.4%	6.4%	0%	93%
Vending Machine and Cooler Controls	WMECo	13%	6%	0%	93%
Vending Machine and Cooler Controls (Refrigeration)	NSTAR	14%	56%	0%	142%
Vending Misers	CLC	9%	36%	0%	127%
HE Air Compressor	NGRID	23%	0%	2%	78%
HE Air Compressor	NSTAR	7%	0%	2%	95%
HE Air Compressor	Unitil	7%	0%	1.5%	94.5%
HE Air Compressor	WMECo	7%	0%	1%	94%
HE Air Compressor	CLC	7%	0%	2%	95%
Variable Frequency Drives	NGRID	10%	7%	8%	104%
Variable Frequency Drives	NSTAR	14%	7%	8%	101%
Variable Frequency Drives	Unitil	9.6%	6%	7.7%	104.1%
Variable Frequency Drives	WMECo	10%	6%	8%	104%
Variable Frequency Drives	CLC	10%	6%	8%	104%
CHP	NSTAR	7%	16%	0%	108%
CHP	WMECo	7%	16%	0%	108%
Custom	NGRID	14%	8%	1%	95%
Custom	Unitil	15.7%	9.1%	0.7%	94.1%
Custom - Compressed Air	NSTAR	7%	0%	2%	95%
Custom – Compressed Air	WMECo	7%	0%	2%	95%
Custom - HVAC	NSTAR	13%	6%	0%	93%
Custom – HVAC	WMECo	13%	6%	0%	93%
Custom - HVAC	CLC	13%	6%	0%	93%
Custom - Lighting	NSTAR	18%	18%	0%	101%
Custom - Lighting	WMECo	20%	5%	0%	85%
Custom - Lighting	CLC	17%	9%	0%	92%
Custom – Motors	NSTAR	14%	7%	8%	101%

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Custom – Motors	WMECo	10%	6%	8%	104%
Custom - Process Equipment	NSTAR	26%	11%	0%	85%
Custom – Process Equipment	WMECo	26%	11%	0%	85%
Custom – Refrigeration	NSTAR	14%	56%	0%	142%
Custom – Refrigeration	WMECo	9%	36%	0%	127%
Custom – Refrigeration	CLC	9%	36%	0%	127%
Custom – Other	WMECo	26%	11%	0%	85%
C&I Small Retrofit					
Lighting Controls	NGRID	5%	1%	0%	96%
Lighting Controls	NSTAR	9%	4%	0%	95%
Lighting Controls	Unitil	4.8%	8.7%	0%	103.9%
Lighting Controls	WMECo	11%	1%	0%	90%
Lighting Controls	CLC	9%	7%	0%	98%
Lighting Systems	NGRID	5%	1%	0%	96%
Lighting Systems	NSTAR	9%	4%	0%	95%
Lighting Systems	Unitil	4.8%	8.7%	0%	103.9%
Lighting Systems	WMECo	11%	1%	0%	90%
Lighting Systems	CLC	9%	7%	0%	98%
Energy Management Systems (EMS)	CLC	7%	14%	0%	107%
Hotel Occupancy Sensors	CLC	7%	14%	0%	107%
Programmable Thermostats	NGRID	2%	2%	0%	100%
Programmable Thermostats	NSTAR	10%	27%	0%	117%
Programmable Thermostats	Unitil	6.8%	14%	0%	107.2%
Programmable Thermostats	WMECo	7%	14%	0%	107%
Programmable Thermostats	CLC	7%	14%	0%	107%
Case Motor Replacement	NGRID	2%	2%	0%	100%
Case Motor Replacement	NSTAR	2%	13%	0%	111%
Case Motor Replacement	Unitil	2.2%	9.2%	0%	107%
Case Motor Replacement	WMECo	3%	2%	0%	99%
Case Motor Replacement	CLC	4%	0%	0%	96%
Cooler Night Covers	NGRID	2%	2%	0%	100%
Cooler Night Covers	NSTAR	2%	13%	0%	111%
Cooler Night Covers	Unitil	2.2%	9.2%	0%	107%
Cooler Night Covers	WMECo	3%	2%	0%	99%
Cooler Night Covers	CLC	4%	0%	0%	96%
Cooler/Freezer Door Heater Control	NGRID	2%	2%	0%	100%
Cooler/Freezer Door Heater Control	NSTAR	2%	13%	0%	111%
Cooler/Freezer Door Heater Control	Unitil	2.2%	9.2%	0%	107%
Cooler/Freezer Door Heater Control	WMECo	3%	2%	0%	99%
Cooler/Freezer Door Heater Control	CLC	4%	0%	0%	96%
Cooler/Freezer Evaporator Fan Controls	NGRID	2%	2%	0%	100%
Cooler/Freezer Evaporator Fan Controls	NSTAR	2%	13%	0%	111%
Cooler/Freezer Evaporator Fan Controls	Unitil	2.2%	9.2%	0%	107%
Cooler/Freezer Evaporator Fan Controls	WMECo	3%	2%	0%	99%
Cooler/Freezer Evaporator Fan Controls	CLC	4%	0%	0%	96%
ECM for Evaporator Fans in Walk-in Coolers and Freezers	NGRID	2%	2%	0%	100%
ECM for Evaporator Fans in Walk-in Coolers and Freezers	NSTAR	2%	13%	0%	111%
ECM for Evaporator Fans in Walk-in Coolers and Freezers	Unitil	2.2%	9.2%	0%	107%

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ECM for Evaporator Fans in Walk-in Coolers and Freezers	WMECo	3%	2%	0%	99%
ECM for Evaporator Fans in Walk-in Coolers and Freezers	CLC	4%	0%	0%	96%
Electronic Defrost Control	NGRID	2%	2%	0%	100%
Electronic Defrost Control	NSTAR	2%	13%	0%	111%
Electronic Defrost Control	Unitil	2.2%	9.2%	0%	107%
Electronic Defrost Control	WMECo	3%	2%	0%	99%
Electronic Defrost Control	CLC	4%	0%	0%	96%
LEDs in Freezers/Coolers	NGRID	5%	1%	0%	96%
LEDs in Freezers/Coolers	NSTAR	9%	4%	0%	95%
LEDs in Freezers/Coolers	Unitil	4.8%	8.7%	0%	103.9%
LEDs in Freezers/Coolers	WMECo	11%	1%	0%	90%
LEDs in Freezers/Coolers	CLC	9%	7%	0%	98%
Novelty Cooler Shutoff	NGRID	2%	2%	0%	100%
Novelty Cooler Shutoff	NSTAR	2%	13%	0%	111%
Novelty Cooler Shutoff	Unitil	2%	9%	0%	107%
Novelty Cooler Shutoff	WMECo	3%	2%	0%	99%
Novelty Cooler Shutoff	CLC	4%	0%	0%	96%
Vending Misers	CLC	4%	0%	0%	96%
Variable Frequency Drives	CLC	14%	0%	0%	86%
Hot Water	NSTAR	0%	98%	0%	198%
Process	NSTAR	17%	0%	0%	83%
Custom – Envelope	CLC	1%	0%	0%	99%
Custom – Hot Water	CLC	0%	0%	0%	0%

Evaluations

All factors, except for C&I Upstream Lighting NTG ratios, are from the National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study.[718] Upstream Lighting NTG ratios are from the Bright Opportunities Process Evaluation.[719]

[718] TetraTech (2011). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study. June 23, 2011
[719] DNV KEMA (2013), Process Evaluation of the 2012 Bright Opportunities Program, Final Report, June 14, 2013.

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Residential Natural Gas Measures						
Measure Name	**Program**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
Residential New Construction and Major Renovation						
Dishwashers		All	86%	0%	0%	14%
ES Homes - Cooling		All	0%	0%	0%	100%
ES Homes - Heating		All	0%	0%	0%	100%
ES Homes - Water Heating		All	0%	0%	0%	100%
Indoor Fixture[720]		All	23%	0%	0%	77%
LED Fixture[721]		All	23%	0%	0%	77%
Refrigerators		All	86%	0%	0%	14%
Screw-in Bulbs[722]		All	23%	0%	0%	77%
Residential Heating and Water Heating						
Boiler (AFUE >= 90%)		All	32%	8%	0%	76%
Boiler (AFUE >= 96%)		All	31%	8%	0%	77%
HTR Boiler (AFUE >= 90%)		All	11%	0%	0%	89%
HTR Boiler (AFUE >= 96%)		All	10%	0%	0%	90%
Boiler Reset Controls		All	0%	0%	0%	100%
HTR Boiler Reset Controls		All	0%	0%	0%	100%
Condensing Water Heater		All	37%	0%	0%	63%
HTR Condensing Water Heater		All	12%	0%	0%	88%
Early Replacement Boiler		All	0%	0%	0%	100%
ES Programmable Thermostats		All	58%	0%	0%	42%
HTR ES Programmable Thermostats		All	19%	0%	0%	81%
Wi-Fi Thermostat		NGRID	0%	0%	0%	100%
Furnace w/ ECM (AFUE = 95%)		All	41%	22%	0%	81%
Furnace w/ ECM (AFUE = 96%)		All	41%	22%	0%	81%
HTR Furnace w/ ECM (AFUE = 95%)		All	14%	0%	0%	86%
HTR Furnace w/ ECM (AFUE = 96%)		All	14%	0%	0%	86%
Heat Recovery Ventilator		All	0%	0%	0%	100%
HTR Heat Recovery Ventilator		All	0%	0%	0%	100%
Indirect Water Heater		All	66%	0%	0%	34%
HTR Indirect Water Heater		All	22%	0%	0%	78%
Integrated water heater/condensing boiler		All	34%	8%	0%	74%
HTR Integrated water heater/condensing boiler		All	11%	0%	0%	89%
Stand Alone Storage Water Heater (EF >= 0.67)		All	13%	13%	0%	100%
HTR Stand Alone Storage Water Heater (EF >= 0.67)		All	4%	0%	0%	96%
Tankless Water Heaters (EF >= 0.82)		All	37%	26%	0%	89%
Tankless Water Heaters (EF >= 0.95)		All	28%	26%	0%	98%
HTR Tankless Water Heaters (EF >= 0.82)		All	12%	0%	0%	88%
HTR Tankless Water Heaters (EF >= 0.95)		All	9%	0%	0%	91%
Home Energy Services (Gas Weatherization)						

[720] Based on the 2012 IECC requirement that 75% of lighting be high efficiency and the fact the that RNC Baseline Study looking at homes built under the 2009 IECC found only 23% of homes had high efficiency lighting (where the requirement was 50%); free-ridership is estimated to escalate over the three years from 23% in 2013, to 33% in 2014, and 40% in 2015.
[721] Ibid.
[722] Ibid

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Faucet Aerators	All	0%	0%	0%	100%
Low-Flow Shower Heads	All	0%	0%	0%	100%
Air Sealing	All	8%	8%	28%	128%
Exterior Doors	All	0%	0%	0%	100%
Insulation	All	25%	20%	28%	123%
Thermostats	All	11%	0%	0%	89%
Multifamily					
Faucet Aerators	All	15%	0%	0%	85%
Low-Flow Shower Heads	All	15%	0%	0%	85%
Air Sealing	All	19%	0%	0%	81%
Insulation	All	19%	0%	0%	81%
Thermostats	All	24%	0%	0%	76%
Low Income (Single Family and Multifamily)					
Gas Heating System Replacement	All	0%	0%	0%	100%
Gas Weatherization	All	0%	0%	0%	100%
Faucet Aerators	All	0%	0%	0%	100%
Low-Flow Shower Heads	All	0%	0%	0%	100%
Air Sealing	All	0%	0%	0%	100%
Insulation	All	0%	0%	0%	100%
Thermostats	All	0%	0%	0%	100%
Behavior/Feedback Program					
Group 2009 Pilot	National Grid	0%	0%	0%	100%
Group 2010 October	National Grid	0%	0%	0%	100%
Group 2011 October	National Grid	0%	0%	0%	100%
Group 2012 October	National Grid	0%	0%	0%	100%
Group 2010 August	NSTAR	0%	0%	0%	100%
Group 2011 January	NSTAR	0%	0%	0%	100%

Evaluations

All NTG factors are set to 100% based on no completed evaluations, unless noted otherwise below.

In the Residential Heating and Water Heating program, free-ridership rates are based on the results of the 2012 Cool Smart and HEHE Program evaluation[723], 2010 impact evaluation[724] or the 2011 NTG study[725]. The hard-to-reach (HTR) version of each of these measures has assumed free-ridership rates set to 1/3 the value of the non-HTR measure[726].
In the Multifamily program, NTG rates are based on the 2011 NTG Study[727] while Home Energy Services (Gas Weatherization) is based on the results of the 2010 Home Energy Assessment NTG study[728] and the 2011 HES NTG study[729]

[723] The Cadmus Group (2013). *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing.* Prepared for Electric and Gas Program Administrators of Massachusetts; June 2013.
[724] Nexus Market Research (2010). HEHE Process and Impact Evaluation. Prepared for GasNetworks
[725] Nexus Market Research (2011). *Estimated Net-To-Gross (NTG) Factors for the Massachusetts Program Administrators (PAs) 2010 Residential New Construction Programs, Residential HEHE and Multi-Family Gas Programs, and Commercial and Industrial Gas Programs.* Prepared for Massachusetts Program Administrators and the Energy Efficiency Advisory Council. Study 11 in the 2010 Massachusetts Electric Energy Efficiency Annual Report
[726] Massachusetts common assumption.
[727] The Cadmus Group, Inc. (2012). *Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis.* Prepared for Massachusetts Program Administrators and the Energy Efficiency Advisory Council.

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Commercial Natural Gas Measures						
TRM Measure Group	**Program**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
C&I New Construction & Major Renovation						
Gas Condensing Hot Water Boilers		NGRID	19.5%	7.4%	0.2%	88.2%
Gas Condensing Hot Water Boilers		NSTAR	16.0%	3.9%	0.3%	88.2%
Gas Condensing Hot Water Boilers		Columbia	24.0%	0.2%	1.1%	77.2%
Gas Condensing Hot Water Boilers		Berkshire	46.9%	49.4%	0.2%	102.7%
Gas Condensing Hot Water Boilers		NEG	23.0%	0.0%	0.5%	77.5%
Gas Condensing Hot Water Boilers		Unitil	24.5%	0%	0.2%	75.7%
Integrated Water Heater/Condensing Boiler (0.90 EF, 0.90 AFUE)		NGRID	19.5%	7.4%	0.2%	88.2%
Integrated Water Heater/Condensing Boiler (0.90 EF, 0.90 AFUE)		NSTAR	16.0%	3.9%	0.3%	88.2%
Integrated Water Heater/Condensing Boiler (0.90 EF, 0.90 AFUE)		Columbia	24.0%	0.2%	1.1%	77.2%
Integrated Water Heater/Condensing Boiler (0.90 EF, 0.90 AFUE)		Berkshire	46.9%	49.4%	0.2%	102.7%
Integrated Water Heater/Condensing Boiler (0.90 EF, 0.90 AFUE)		NEG	23.0%	0.0%	0.5%	77.5%
Integrated Water Heater/Condensing Boiler (0.90 EF, 0.90 AFUE)		Unitil	24.5%	0%	0.2%	75.7%
Condensing Stand-Alone Water Heater		NGRID	19.5%	7.4%	0.2%	88.2%
Condensing Stand-Alone Water Heater		NSTAR	16.0%	3.9%	0.3%	88.2%
Condensing Stand-Alone Water Heater		Columbia	24.0%	0.2%	1.1%	77.2%
Condensing Stand-Alone Water Heater		Berkshire	46.9%	49.4%	0.2%	102.7%
Condensing Stand-Alone Water Heater		NEG	23.0%	0.0%	0.5%	77.5%
Condensing Stand-Alone Water Heater		Unitil	24.5%	0%	0.2%	75.7%
Furnaces		NGRID	19.5%	7.4%	0.2%	88.2%
Furnaces		NSTAR	16.0%	3.9%	0.3%	88.2%
Furnaces		Columbia	24.0%	0.2%	1.1%	77.2%
Furnaces		Berkshire	46.9%	49.4%	0.2%	102.7%
Furnaces		NEG	23.0%	0.0%	0.5%	77.5%
Furnaces		Unitil	24.5%	0%	0.2%	75.7%
Infrared Heaters		NGRID	19.5%	7.4%	0.2%	88.2%
Infrared Heaters		NSTAR	16.0%	3.9%	0.3%	88.2%
Infrared Heaters		Columbia	24.0%	0.2%	1.1%	77.2%
Infrared Heaters		Berkshire	46.9%	49.4%	0.2%	102.7%
Infrared Heaters		NEG	23.0%	0.0%	0.5%	77.5%
Infrared Heaters		Unitil	24.5%	0%	0.2%	75.7%

[728] The Cadmus Group, Inc. (2011). *2010 Net-to-Gross Findings: Home Energy Assessment.* The Electric and Gas Program Administrators of Massachusetts. Study 6 in the 2010 Massachusetts Electric Energy Efficiency Annual Report
[729] The Cadmus Group, Inc. (2012). Massachusetts *2011 Residential Retrofit and Low Income net-to-Gross Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.

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Commercial Natural Gas Measures						
TRM Measure Group	**Program**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
C&I New Construction & Major Renovation						
Water Heaters		NGRID	19.5%	7.4%	0.2%	88.2%
Water Heaters		NSTAR	16.0%	3.9%	0.3%	88.2%
Water Heaters		Columbia	24.0%	0.2%	1.1%	77.2%
Water Heaters		Berkshire	46.9%	49.4%	0.2%	102.7%
Water Heaters		NEG	23.0%	0.0%	0.5%	77.5%
Water Heaters		Unitil	24.5%	0%	0.2%	75.7%
Commercial Ovens		NGRID	19.5%	7.4%	0.2%	88.2%
Commercial Ovens		NSTAR	16.0%	3.9%	0.3%	88.2%
Commercial Ovens		Columbia	24.0%	0.2%	1.1%	77.2%
Commercial Ovens		Berkshire	46.9%	49.4%	0.2%	102.7%
Commercial Ovens		NEG	23.0%	0.0%	0.5%	77.5%
Commercial Ovens		Unitil	24.5%	0%	0.2%	75.7%
Commercial Griddle		NGRID	19.5%	7.4%	0.2%	88.2%
Commercial Griddle		NSTAR	16.0%	3.9%	0.3%	88.2%
Commercial Griddle		Columbia	24.0%	0.2%	1.1%	77.2%
Commercial Griddle		Berkshire	46.9%	49.4%	0.2%	102.7%
Commercial Griddle		NEG	23.0%	0.0%	0.5%	77.5%
Commercial Griddle		Unitil	24.5%	0%	0.2%	75.7%
Commercial Fryers		NGRID	19.5%	7.4%	0.2%	88.2%
Commercial Fryers		NSTAR	16.0%	3.9%	0.3%	88.2%
Commercial Fryers		Columbia	24.0%	0.2%	1.1%	77.2%
Commercial Fryers		Berkshire	46.9%	49.4%	0.2%	102.7%
Commercial Fryers		NEG	23.0%	0.0%	0.5%	77.5%
Commercial Fryers		Unitil	24.5%	0%	0.2%	75.7%
Commercial Steamer		NGRID	19.5%	7.4%	0.2%	88.2%
Commercial Steamer		NSTAR	16.0%	3.9%	0.3%	88.2%
Commercial Steamer		Columbia	24.0%	0.2%	1.1%	77.2%
Commercial Steamer		Berkshire	46.9%	49.4%	0.2%	102.7%
Commercial Steamer		NEG	23.0%	0.0%	0.5%	77.5%
Commercial Steamer		Unitil	24.5%	0%	0.2%	75.7%
Custom Measures		NGRID	27.9%	9.6%	1.0%	82.7%
Custom Measures		NSTAR	33.1%	8.8%	0.8%	76.5%
Custom Measures		Columbia	7.8%	1.7%	0.4%	94.2%
Custom Measures		Berkshire	3.5%	13.6%	0.0%	110.1%
Custom Measures		NEG	33.1%	8.8%	0.8%	76.5%
Custom Measures		Unitil	33.1%	8.8%	0.8%	76.5%

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Commercial Natural Gas Measures						
TRM Measure Group	**Program**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
C&I Retrofit						
Boiler Reset Controls		NGRID	19.5%	7.4%	0.2%	88.2%
Boiler Reset Controls		NSTAR	16.0%	3.9%	0.3%	88.2%
Boiler Reset Controls		Columbia	24.0%	0.2%	1.1%	77.2%
Boiler Reset Controls		Berkshire	46.9%	49.4%	0.2%	102.7%
Boiler Reset Controls		NEG	23.0%	0.0%	0.5%	77.5%
Boiler Reset Controls		Unitil	24.5%	0%	0.2%	75.7%
ES Programmable Thermostats		NGRID	19.5%	7.4%	0.2%	88.2%
ES Programmable Thermostats		NSTAR	16.0%	3.9%	0.3%	88.2%
ES Programmable Thermostats		Columbia	24.0%	0.2%	1.1%	77.2%
ES Programmable Thermostats		Berkshire	46.9%	49.4%	0.2%	102.7%
ES Programmable Thermostats		NEG	23.0%	0.0%	0.5%	77.5%
ES Programmable Thermostats		Unitil	24.5%	0%	0.2%	75.7%
Pre-Rinse Spray Valve		NGRID	19.5%	7.4%	0.2%	88.2%
Pre-Rinse Spray Valve		NSTAR	16.0%	3.9%	0.3%	88.2%
Pre-Rinse Spray Valve		Columbia	24.0%	0.2%	1.1%	77.2%
Pre-Rinse Spray Valve		Berkshire	46.9%	49.4%	0.2%	102.7%
Pre-Rinse Spray Valve		NEG	23.0%	0.0%	0.5%	77.5%
Pre-Rinse Spray Valve		Unitil	24.5%	0%	0.2%	75.7%
Steam Traps		NGRID	19.5%	7.4%	0.2%	88.2%
Steam Traps		NSTAR	16.0%	3.9%	0.3%	88.2%
Steam Traps		Columbia	24.0%	0.2%	1.1%	77.2%
Steam Traps		Berkshire	46.9%	49.4%	0.2%	102.7%
Steam Traps		NEG	23.0%	0.0%	0.5%	77.5%
Steam Traps		Unitil	24.5%	0%	0.2%	75.7%
Custom Measures		NGRID	27.9%	9.6%	1.0%	82.7%
Custom Measures[730]		NSTAR	33.1%	8.8%	0.8%	76.5%
Custom Measures		Columbia	7.8%	1.7%	0.4%	94.2%
Custom Measures		Berkshire	3.5%	13.6%	0.0%	110.1%
Custom Measures		NEG	33.1%	8.8%	0.8%	76.5%
Custom Measures		Unitil	33.1%	8.8%	0.8%	76.5%

[730] Reflects the Custom Gas statewide NTG rate determined in TetraTech's 2011 C&I natural gas free-ridership and spillover study. NTG aligned with statewide to better reflect average free-ridership and spillover.

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Commercial Natural Gas Measures						
TRM Measure Group	**Program**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
C&I Direct Install						
ES Programmable Thermostats		NGRID	19.5%	7.4%	0.2%	88.2%
ES Programmable Thermostats		NSTAR	16.0%	3.9%	0.3%	88.2%
ES Programmable Thermostats		Columbia	24.0%	0.2%	1.1%	77.2%
ES Programmable Thermostats		Berkshire	46.9%	49.4%	0.2%	102.7%
ES Programmable Thermostats		NEG	23.0%	0.0%	0.5%	77.5%
ES Programmable Thermostats		Unitil	24.5%	0%	0.2%	75.7%
Pre-Rinse Spray Valve		NGRID	19.5%	7.4%	0.2%	88.2%
Pre-Rinse Spray Valve		NSTAR	16.0%	3.9%	0.3%	88.2%
Pre-Rinse Spray Valve		Columbia	24.0%	0.2%	1.1%	77.2%
Pre-Rinse Spray Valve		Berkshire	46.9%	49.4%	0.2%	102.7%
Pre-Rinse Spray Valve		NEG	23.0%	0.0%	0.5%	77.5%
Pre-Rinse Spray Valve		Unitil	24.5%	0%	0.2%	75.7%
Faucet Aerators		NGRID	19.5%	7.4%	0.2%	88.2%
Faucet Aerators		NSTAR	16.0%	3.9%	0.3%	88.2%
Faucet Aerators		Columbia	24.0%	0.2%	1.1%	77.2%
Faucet Aerators		Berkshire	46.9%	49.4%	0.2%	102.7%
Faucet Aerators		NEG	23.0%	0.0%	0.5%	77.5%
Faucet Aerators		Unitil	24.5%	0%	0.2%	75.7%
Low Flow Shower Heads		NGRID	19.5%	7.4%	0.2%	88.2%
Low Flow Shower Heads		NSTAR	16.0%	3.9%	0.3%	88.2%
Low Flow Shower Heads		Columbia	24.0%	0.2%	1.1%	77.2%
Low Flow Shower Heads		Berkshire	46.9%	49.4%	0.2%	102.7%
Low Flow Shower Heads		NEG	23.0%	0.0%	0.5%	77.5%
Low Flow Shower Heads		Unitil	24.5%	0%	0.2%	75.7%

Evaluations

All NTG factors are based on the results of the 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study conducted by TetraTech for the MA Gas PAs.[731] This study developed free-ridership and participant spillover rates for each PA for prescriptive and custom measures.

[731] TetraTech (2012). *National Grid, NSTAR, Unitil, Berkshire Gas, Columbia Gas, and New England Gas 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study,* June 2012

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Appendix D: Non-Resource Impacts

Residential Program Non-Energy Impacts

End Use	TRM Measures	NEI	Description	Value or Algorithm	Basis	Duration	Notes on Programs
Lighting	Indoor Fixture Outdoor Fixture LED Fixture	Lighting Quality and Lifetime	O&M savings due to more efficient fixtures	$3.50	per measure	One Time	Not applied for Low Income
	CFL Bulb LED Bulb	Lighting Quality and Lifetime	O&M savings due to more efficient bulbs	$3.00	per measure	One Time	Not applied for Low Income
Products	Refrigerator/ Freezer Recycling	Refrigerator/ Freezer Turn-in	Non-energy benefits of turning in a refrigerator and/or freezer as part of the MA turn-in program. The total benefit is comprised of 3 parts: $1.06 for avoided landfill space, $1.25 for recycling of plastics and glass, and $170.22 for incineration of insulating foam	$172.53	per measure	One Time	Appliance Turn-in programs, Low Income 1-4 because replaced units are recycled
HVAC	Heating System (Retrofit and Rebate)	Improved Safety	Reduced incidence of fire and carbon monoxide exposure as a result of installing a new heating system	$45.05	per measure	Annual	Low Income programs only
	Window AC (Retrofit)	Window Air Conditioner Replacement	Non-energy benefits associated with installing a new room air conditioner replacement	$45.00	per measure	Annual	Low Income programs only
Various	All Measures with oil savings	National Security	Reducing the need for foreign energy imports thereby increasing national security	MMBTU Oil Savings * $1.83	per measure	Annual	Retrofit programs only
	All electric measures with kWh savings and all gas measures with MMBTU savings	Rate Discounts	Financial savings to utility as a result of a smaller portion of energy being sold at the low income rate	Elec: (kwh savings per measure)*(R1-R2) Gas**:** (therms savings per measure)*(R3-R4)	per measure	Annual	Low Income programs only

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(1) The NEIs in this table represent impacts that accrue specifically measures in the 2012 MA portfolio of programs. Additional NEIs that accrue to participants are used in the benefit - cost analysis of the programs but are not detailed in this manual.
(2) The DHW measures NEI is applied to the DHW ISMs measures that are bundled together and are modeled in units of households, assuming one showerhead and one faucet aerator per household.
(3) Source of NEIs is "Massachusetts Program Administrators: Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation," NMR Group, Inc., Tetra Tech. August 15, 2011.

New Construction Commercial & Industrial Program Non-Energy Impacts

End Use	TRM Measures	NEI	Description	Value	Basis	Type
Lighting	New Construction CFL O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$17.93	Unit	Annual
	New Construction LED Traffic Light O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$30.02	Unit	Annual
	New Construction Control/Sensor O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$6.69	kW Saved	Annual

(1) Source is Optimal Energy, Inc. MEMO "Non-Electric Benefits Analysis Update" November 7, 2008.

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Retrofit Commercial & Industrial Program Non-Energy Impacts

Fuel	Program	Measure/End Use	NEIs Comprising Value	Value	Basis	Type
Electric	C&I Large Retrofit	Prescriptive Lighting	Administrative Costs, Material Handling, Material Movement, Other Labor Costs, O&M, Sales Revenue, Waste Disposal	$0.027	kWh	Annual
		Prescriptive HVAC	Administrative Costs, Other Costs, Other Labor Costs, O&M, Rent Revenue	$0.097	kWh	Annual
		Custom HVAC	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.024	kWh	Annual
		Custom Lighting	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.059	kWh	Annual
		Refrigeration[732]	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.047	kWh	Annual
		Other	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.056	kWh	Annual
		CHP Systems	Administrative Costs, O&M	$-0.015	kWh	Annual
	C&I Direct Install	HVAC	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.097	kWh	Annual
		Lighting	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.027	kWh	Annual
		Refrigeration	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.047	kWh	Annual
		Other	Administrative Costs, Material Handling, Material Movement, Other Costs, Other Labor Costs, O&M, Product Spoilage, Rent Revenue, Sales Revenue, Waste Disposal	$0.056	kWh	Annual

[732] Prescriptive refrigeration results from the KEMA, Inc. (2012). *Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy impacts Study* were not statistically significant; custom rate used as substitute

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Fuel	Program	Measure/End Use	NEIs Comprising Value	Value	Basis	Type
Gas	C&I Large Retrofit	Boiler Reset Controls	Administrative Costs, Fees, Material Movement, O&M, Product Spoilage, Rent Revenue	$1.35	Therm	Annual
		Steam Traps	Administrative Costs, Fees, Material Movement, O&M, Product Spoilage, Rent Revenue	$1.35	Therm	Annual
		Thermostats	Administrative Costs, Fees, Material Movement, O&M, Product Spoilage, Rent Revenue	$1.35	Therm	Annual
		Custom	Administrative Costs, Material Movement, Other Costs, other Labor, O&M, Product Spoilage, Waste Disposal	$0.25	Therm	Annual
	C&I Direct Install	Thermostat	Administrative Costs, Fees, Material Movement, O&M, Product Spoilage, Rent Revenue	$1.35	Therm	Annual
		Duct Insulation	Administrative Costs, Fees, Material Movement, O&M, Product Spoilage, Rent Revenue	$1.35	Therm	Annual

(1) Source is KEMA, Inc. (2012). *Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy impacts Study*.

In addition to the NEIs in these tables, the 2011 study of Residential and Low Income NEIs identified a number of participant-based NEIs which are claimed in the 2012 plan. These NEIs and their application are summarized in the tables below.

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Per Participant Non-Energy Impacts for Electric Programs

Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
Residential New Construction	Thermal Comfort	Greater participant-perceived comfort in home	N/A	$77.00	Annual	Values are applied to the "Heating" measure quantity in this program as an approximation of program participants.
	Noise Reduction	Less participant-perceived noise in the home		$40.00	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home		$72.00	Annual	
Residential Cooling and Heating Equipment	Thermal Comfort	Greater participant-perceived comfort in home. ROF is 50% of this value.	Heating System	$48.63	Annual	Values are applied per participant. Since program participants = rebates, measure category values are counted for every unit. The "heating and cooling system" values are applied to heat pumps. The NEI values shown in the table are the full values that can only be applied to early retirement equipment. For Replace on Failure (ROF) Equipment the values are multiplied by the percentage in the description.
			Cooling System	$3.92		
			Heating and Cooling System	$5.05		
	Noise Reduction	Less participant-perceived noise in the home. ROF is 67% of this value.	Cooling System	$2.83	Annual	
			Heating and Cooling System	$1.42		
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials. ROF is 33% of this value.	Heating System	$17.42	Annual	
			Cooling System	$1.54		
			Heating and Cooling System	$1.98		
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment. ROF is 0% of this value.	Heating System	$102.40	Annual	
			Cooling System	$7.54		
			Heating and Cooling System	$9.42		
	Health Benefits	Fewer colds and viruses, improved indoor air	Heating System	$1.56	Annual	
			Cooling System	$0.13		

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
		quality and ease of maintaining healthy relative humidity as a result of weatherization in home. ROF is 50% of this value.	Heating and Cooling System	$0.16		
	Property Value Increase	Increased value of property and expected ease of selling home. ROF is 50% of this value.	Heating System	$678.52	One Time	
			Cooling System	$62.65		
			Heating and Cooling System	$80.69		
MassSave	Thermal Comfort	Greater participant-perceived comfort in home	N/A	$125.00	Annual	
	Noise Reduction	Less participant-perceived noise in the home		$31.00	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials		$149.00	Annual	
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment		$124.00	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home		$4.00	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Property Value Increase	Increased value of property and expected ease of selling home		$1,998.00	One Time	
Multifamily Retrofit	Thermal Comfort	Greater participant-perceived comfort in home	N/A	$125.00	Annual	
	Noise Reduction	Less participant-perceived noise in the home		$31.00	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials		$149.00	Annual	
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment		$124.00	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home		$4.00	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home		$1,998.00	One Time	
Low Income Residential New Construction	Arrearages	Reduced arrearage carrying costs as a result of customers being more able to pay their lower bills	N/A	$2.61	Annual	Values are applied to the "Heating" measure quantity in this program as an approximation of program participants.

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Bad Debt Write-offs	Reduced costs to utility of uncollectable, unpaid balances as a result of customers being more able to pay their lower bills		$3.74	Annual	
	Terminations and Reconnections	Reduced costs associated with terminations and reconnections to utility due to nonpayment as a result of customers being more able to pay their lower bills		$0.43	Annual	
	Customer Calls and Collections	Utility savings in staff time and materials for fewer customer calls as a result of more timely bill payments		$0.58	Annual	
	Notices	Financial savings to utility as a result of fewer notices sent to customers for late payments and terminations		$0.34	Annual	
	Thermal Comfort	Greater participant-perceived comfort in home		$101.00	Annual	
	Noise Reduction	Less participant-perceived noise in the home		$30.00	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials		$35.00	Annual	
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment		$54.00	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home		$19.00	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home		$949.00	One Time	
Low Income 1 to 4 Family Retrofit	Arrearages	Reduced arrearage carrying costs as a result of customers being more able to pay their lower bills	N/A	$2.61	Annual	
	Bad Debt Write-offs	Reduced costs to utility of uncollectable, unpaid balances as a result of customers being more able to pay their lower bills		$3.74	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Terminations and Reconnections	Reduced costs associated with terminations and reconnections to utility due to nonpayment as a result of customers being more able to pay their lower bills		$0.43	Annual	
	Customer Calls and Collections	Utility savings in staff time and materials for fewer customer calls as a result of more timely bill payments		$0.58	Annual	
	Notices	Financial savings to utility as a result of fewer notices sent to customers for late payments and terminations		$0.34	Annual	
	Thermal Comfort	Greater participant-perceived comfort in home		$101.00	Annual	
	Noise Reduction	Less participant-perceived noise in the home		$30.00	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials		$35.00	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment		$54.00	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home		$19.00	Annual	
	Lighting Quality and Lifetime	Increased lighting quality and lifetime with program installed CFLs		$56.00	One Time	
	Property Value Increase	Increased value of property and expected ease of selling home		$949.00	One Time	
	Economic Development	Increased economic benefit due to energy savings		$5.10/MMBTU and $0.04/kWh	One Time	
	Price Hedging			$0.76/MMBTU and $0.005/kWh	One Time	
	Safety-Related Emergency Calls	Financial savings to the utility as a result of fewer safety related emergency calls being made	Heating System	$8.43	Annual	As an approximation of program participants with heating equipment, this value is applied to the 2012 planned quantity for the Heating System Replacement measure.

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
Low Income Multifamily Retrofit	Arrearages	Reduced arrearage carrying costs as a result of customers being more able to pay their lower bills	N/A	$2.61	Annual	
	Bad Debt Write-offs	Reduced costs to utility of uncollectable, unpaid balances as a result of customers being more able to pay their lower bills		$3.74	Annual	
	Terminations and Reconnections	Reduced costs associated with terminations and reconnections to utility due to nonpayment as a result of customers being more able to pay their lower bills		$0.43	Annual	
	Customer Calls and Collections	Utility savings in staff time and materials for fewer customer calls as a result of more timely bill payments		$0.58	Annual	
	Notices	Financial savings to utility as a result of fewer notices sent to customers for late payments and terminations		$0.34	Annual	
	Thermal Comfort	Greater participant-perceived comfort in home		$101.00	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Noise Reduction	Less participant-perceived noise in the home		$30.00	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials		$35.00	Annual	
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment		$54.00	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home		$19.00	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home		$949.00	One Time	
	Economic Development	Increased economic benefit due to energy savings		$5.10/MMBTU and $0.04/kWh	One Time	
	Price Hedging			$0.76/MMBTU and $0.005/kWh	One Time	
	Safety-Related Emergency Calls	Financial savings to the utility as a result of fewer safety related emergency calls being made	Heating System	$8.43	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Rental Units Marketability	Financial savings to owners of LI rental housing as a result of increased marketability of the more efficient housing.	N/A	$0.96	Annual	
	Property Durability	Financial savings to owners of LI rental housing as a result of more durable and efficient materials being installed.		$36.85	Annual	
	Reduced Tenant Complaints	Savings to owners of LI rental housing in terms of staff time and materials as a result of fewer tenant complaints with the more efficient measures.		$19.61	Annual	
	Rental Unit Increased Property Value	Owner-perceived increased property value due to more energy efficient measures		$17.03	One Time	

1. Source of NEIs is "Massachusetts Program Administrators: Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation," NMR Group, Inc., Tetra Tech. August 15, 2011. NEIs for the Residential Cooling and Heating Equipment program were further adjusted based on NMR Group, Inc. (2013) Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure
2. Source of Economic Development NEI is Environment Northeast (2009). Energy Efficiency: Engine of Economic *Growth: A Macroeconomic Modeling Assessment.*
3. Source of Price Hedging NEI is Lawrence Berkeley National Laboratory (2002). *Quantifying the Value That Wind Power Provides as a Hedge Against Volatile Natural Gas Prices.*

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Per Participant Non-Energy Impacts for Gas Programs

Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
Residential Heating and Hot Water	Thermal Comfort	Greater participant-perceived comfort in home. ROF is 50% of this value.	Heating System	$48.63	Annual	Values are applied per participant. Since program participants = rebates, measure category values are counted for every unit except for Thermostats which are counted for every 1.15 units. The average number of thermostats installed per participant is 1.15. The "heating and hot water system" values are applied to integrated water heater/condensing boilers. The NEI values shown in the table are the full values that can only be applied to early retirement equipment. For Replace on Failure Equipment the values are multiplied by the percentage in the description. Oil to gas conversions are considered ROF.
			Heating and Hot Water System	$1.83		
			Thermostats	$3.99		
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials. ROF is 33% of this value.	Heating System	$17.42	Annual	
			Hot Water System	$2.13		
			Heating and Hot Water System	$0.72		
			Thermostats	$1.33		
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment. ROF is 0% of this value.	Heating System	$102.40	Annual	
			Heating and Hot Water System	$3.41		
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home. ROF is 50% of this value.	Heating System	$1.56	Annual	
			Heating and Hot Water System	$0.06		
			Thermostats	$0.13		
	Property Value Increase	Increased value of property and expected ease of selling home. ROF is	Heating System	$678.52	One Time	
			Hot Water System	$82.56		
			Heating and Hot Water System	$29.17		

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
		50% of this value.	Thermostats	$51.49		
Weatherization	Thermal Comfort	Greater participant-perceived comfort in home	N/A	$25.00	Annual	As an approximation of program weatherization participants, values are applied to the 2012 insulation measure quantity.
	Noise Reduction	Less participant-perceived noise in the home		$11.22	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials		$9.57	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home		$0.79	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home		$381.28	One Time	
Multifamily Retrofit	Thermal Comfort	Greater participant-perceived comfort in home	Insulation	$25.15	Annual	
			Air Sealing	$10.13		
	Noise Reduction	Less participant-perceived noise in the home	Insulation	$11.54	Annual	
			Air Sealing	$4.88		

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials	Insulation	$9.82	Annual	As an approximation of program weatherization participants, values are reduced to 75% and applied to the 2012 air sealing & insulation measure. 75% represents the number of planned units that result in weatherization participants.
			Air Sealing	$3.95		
	Health Benefits	Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home	Insulation	$0.80	Annual	
			Air Sealing	$0.32		
	Economic Development	Increased economic benefit due to energy savings		$5.10/MMBTU and $0.04/kWh	One Time	
	Price Hedging			$0.76/MMBTU and $0.005/kWh	One Time	
	Property Value Increase	Increased value of property and expected ease of selling home	Insulation	$378.05	One Time	
			Air Sealing	$135.83		
Residential New Construction	Thermal Comfort	Greater participant-perceived comfort in home	N/A	$77.00	Annual	Values are applied to the "Heating" measure quantity in this program as an approximation of program participants.
	Noise Reduction	Less participant-perceived noise in the home		$40.00	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Property Value Increase	Increased value of property and expected ease of selling home		$72.00	Annual	
Low Income Single Family Low Income Multifamily	Arrearages	Reduced arrearage carrying costs as a result of customers being more able to pay their lower bills	N/A	$2.61	Annual	Values are applied to program participants.
	Bad Debt Write-offs	Reduced costs to utility of uncollectable, unpaid balances as a result of customers being more able to pay their lower bills		$3.74	Annual	
	Terminations and Reconnections	Reduced costs associated with terminations and reconnections to utility due to nonpayment as a result of customers being more able to pay their lower bills		$0.43	Annual	
	Customer Calls and Collections	Utility savings in staff time and materials for fewer customer calls as a result of more timely bill payments		$0.58	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Notices	Financial savings to utility as a result of fewer notices sent to customers for late payments and terminations		$0.34	Annual	
	Safety-Related Emergency Calls	Financial savings to the utility as a result of fewer safety related emergency calls being made	Heating System	$8.43	Annual	As an approximation of program participants with heating equipment, this value is applied to the 2012 planned quantity for the Heating System Replacement measure.
	Thermal Comfort	Greater participant-perceived comfort in home	Insulation	$25.38	Annual	
			Air Sealing	$30.23		
			Heating System	$28.01		
	Noise Reduction	Less participant-perceived noise in the home	Insulation	$13.56	Annual	As an approximation of program participants receiving each of these measure category values, insulation and air sealing values were applied to the Weatherization measure (LI SF) or the Air Sealing & Insulation Measure (LI MF) and heating system values were applied to the Heating System Replacement measure.
			Air Sealing	$16.39		
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials	Insulation	$8.76	Annual	
			Air Sealing	$10.61		
			Heating System	$9.72		
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment	Heating System	$27.43	Annual	
	Health Benefits	Fewer colds and viruses,	Insulation	$4.77	Annual	
			Air Sealing	$5.69		

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
		improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home	Heating System	$5.27		
	Property Value Increase	Increased value of property and expected ease of selling home	Insulation	$223.63	One Time	
			Air Sealing	$144.93		
			Heating System	$249.20		
	Economic Development	Increased economic benefit due to energy savings		$5.10/MMBTU and $0.04/kWh	One Time	
	Price Hedging			$0.76/MMBTU and $0.005/kWh	One Time	
Additional NEIs for Low Income Multifamily	Rental Units Marketability	Financial savings to owners of LI rental housing as a result of increased marketability of the more efficient housing.	Air Sealing	$0.07	Annual	Values are applied to the 2012 planned quantity for Air Sealing with the assumption that one air sealing job is done per household.
	Property Durability	Financial savings to owners of LI rental housing as a result of more durable and efficient materials being installed.		$2.58	Annual	

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Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Reduced Tenant Complaints	Savings to owners of LI rental housing in terms of staff time and materials as a result of fewer tenant complaints with the more efficient measures.		$1.37	Annual	
	Rental Unit Increased Property Value	Owner-perceived increased property value due to more energy efficient measures		$1.19	One Time	

(1) Source of NEIs is "Massachusetts Program Administrators: Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation," NMR Group, Inc., Tetra Tech. August 15, 2011. NEIs for the Residential Heating and Water Heating Equipment program were further adjusted based on NMR Group, Inc. (2013) Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure.

(2) Source of Economic Development NEI is Environment Northeast (2009). Energy Efficiency: Engine of Economic *Growth: A Macroeconomic Modeling Assessment.*

(3) Source of Price Hedging NEI is Lawrence Berkeley National Laboratory (2002). *Quantifying the Value That Wind Power Provides as a Hedge Against Volatile Natural Gas Prices.*

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Appendix E: Table of Referenced Documents

FULL CITATION	DIGITAL DOCUMENT FILENAME
ACEEE (2006). Emerging Technologies Report: Advanced Boiler Controls. Prepared for ACEEE.	ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls
ADM Associates, Inc. (2009). Residential Central AC Regional Evaluation. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating.	ADM_2009_Residential_Central_AC_Regional_Evaluation
Appliance Standards Awareness Project (2007). Dehumidifiers.	ASAP_2007_Dehumidifiers_2011 08 05
Cadmus Group (2012). Non-Controls Lighting Evaluation for the Massachusetts Small Commercial Direct Install Program: Multi-Season Study. Prepared for Massachusetts Utilities.	CADMUS_2012_SBDI_Non-Controls_Lighting_Multi-Season_Study.pdf
Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR. Prepared for NSTAR.	Chan_2010_Formulation_of_Prescriptive_VFD_Impact_Tables_NSTAR
Consortium for Energy Efficiency (2008). Consumer Electronics Program Guide: Information on Voluntary Approaches for the Promotion of Energy Efficient Consumer Electronics - Products and Practices.	CEE_2008_Consumer_Electronics_Program_Guide
Consortium for Energy Efficiency (2008). Technology Opportunity Assessment: Convection Ovens.	CEE_2008_Technology_Opportunity_Assessment_Convection_Ovens.doc
Consortium for Energy Efficiency (2010). Program Design Guidance: Steamers.	CEE_2010_Program_Design_Guidance_Steamers.pdf
Davis Energy Group (2008). Proposal Information Template for Residential Pool Pump Measure Revisions. Prepared for Pacific Gas and Electric Company.	Davis_2008_Residential_Pool_Pump_Measure_Revisions
DOE (2008). ENERGY STAR® Residential Water Heaters: Final Criteria Analysis. Prepared for the DOE.	DOE_2008_ENERGY_STAR_Residential_Water_Heaters_Final_Criteria_Analysis
Ecotrope, Inc. (2003). Natural Gas Efficiency and Conservation Measure Resource Assessment for the Residential and Commercial Sectors. Prepared for the Energy Trust of Oregon.	Ecotrope_2003_Natural_Gas_Efficiency_and_Conservation_Measure_Resource_Assessment
Energy Market Innovations Inc. (2007). Puget Sound Area Residential Compact Fluorescent Lighting Market Saturation Study. Prepared for Puget Sound Energy, Seattle City Light, Snohomish County PUD	EMI_2007_PacificNW_CFL_Market_Sat.pdf
Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities.	ERS_2005_Measure_Life_Study
ENERGY STAR Website. Dishwashers Key Product Criteria. Accessed 10/12/2011.	ENERGY_STAR_Website_Dishwashers_Key_Product_Criteria_2011 10 12
ENERGY STAR Website. Refrigerators & Freezers Key Product Criteria. Accessed 10/12/2011.	ENERGY_STAR_Website_Refrigerators_and_Freezers_Key_Product_Criteria_2011 10 12
ENERGY STAR Website: Learn About LEDs. Accessed 10/12/2011.	ENERGY_STAR_Website_Learn_About_LEDs_2011 10 12
ENERGY STAR Website: Light Bulbs for Consumers. Accessed on 10/12/2011.	ENERGY_STAR_Website_Light_Bulbs_for_Consumers_2011 10 12

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
ENERGY STAR Website: Televisions for Consumers. Accessed on 10/12/2011.	ENERGY_STAR_Website_Televisions_for_Consumers_2011 10 12
ENERGY STAR Program Requirements for Computers Version 5.0	EnergyStar_Version5.0_Computer_Spec.pdf
Environment Northeast (2009). Energy Efficiency: Engine of Economic Growth: A Macroeconomic Modeling Assessment	ENE_2009_Energy_Efficiency_Engine_of_Economic_Growth_NEng.pdf
Environmental Protection Agency (2002). Life Cycle Cost Estimate for ENERGY STAR Dehumidifier.	EPA_2002_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Dehumidifier.xls
Environmental Protection Agency (2008). Life Cycle Cost Estimate for ENERGY STAR Television.	EPA_2008_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Television.xls
Environmental Protection Agency (2009). Life Cycle Cost Estimate for an ENERGY STAR Qualified Boiler.	EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Qualified_Boiler.xls
Environmental Protection Agency (2009). Life Cycle Cost Estimate for an ENERGY STAR Residential Refrigerator.	EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Residential_Refrigerator.xls
Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Furnace.	EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Furnace.xls
Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Gas Fryer.	EPA_2011_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Commercial_Kitchen_Equipment.xls
Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Qualified Lighting Fixtures.	EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Qualified_Lighting_Fixtures.xls
Environmental Protection Agency (2012), Savings Calculator for Energy Star Qualified Appliances.	ENERGY_STAR_2012_Calculator_Appliances.xlsx
Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner.	EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Room_Air_Conditioner.xls
Environmental Protection Agency (2012). Savings Calculator for ENERGY STAR Qualified Office Equipment	ENERGY_STAR_Calculator_Office_Equipment.xls
Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat.	EPA_2010_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Programmable_Thermostat.xls
ENERGY STAR® Commercial Kitchen Equipment Savings Calculator	EPA_2011_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Commercial_Electric_Kitchen_Equipment.xls
Environmental Protection Agency (2012). Savings Calculator for ENERGY STAR Qualified Consumer Electronics	ENERGY_STAR_2012_Consumer_Electronics_Calculator.xls
Environmental Protection Agency (2012). ENERGY STAR Desktop & Integrated Computer Product List. August 2, 2012.	ENERGY_STAR_2012_Computers_Prod_List.xls
Environmental Protection Agency (2012). ENERGY STAR Television Product List. June 15, 2012	ENERGY_STAR_2012_TV_Product_List.xls
Environmental Protection Agency (2012). Refrigerators Qualified Product List. July 18, 2012	ENERGY_STAR_2012_Refrigerator_Product_List.xls
Environmental Protection Agency (2012). Freezers Qualified Product List. July 18, 2012	ENERGY_STAR_2012_Freezers_Product_List.xls

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
Federal Energy Management Program (2011). Energy Cost Calculator for Faucets and Showerheads. Accessed on 10/12/2011.	FEMP_2011_Energy_Cost_Calculator_for_Faucets_2011 10 12
Food Service Technology Center (2010). Gas Combination Oven Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/gcombicalc.php. Accessed 6/10/10.	Food_Service_Technology_Center_2010_Gas_Combination_Oven_LifeCycle_Cost_Calculator_Website_Screenshot.pdf
Food Service Technology Center (2010). Gas Rack Oven Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/grackovencalc.php. Accessed 6/10/10.	Food_Service_Technology_Center_2010_Gas_Rack_Oven_LifeCycle_Cost_Calculator_Website_Screenshot.pdf
Food Service Technology Center (2010). Gas Conveyor Oven Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/gconvovencalc.php. Accessed 6/10/10.	Food_Service_Technology_Center_2010_Gas_Conveyor_Oven_LifeCycle_Cost_Calculator_Website_Screenshot.pdf
Food Service Technology Center (2012). Gas Convection Oven Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/govencalc.php. Accessed 8/1/12.	Food_Service_Technology_Center_2012_Gas_Convection_Oven_LifeCycle_Cost_Calculator_Website_Screenshot.pdf
Food Service Technology Center, Electric Combination Oven Life-Cycle Cost Calculator: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php.	Food_Service_Technology_Center_2012_Elec_Combi_Oven_Lifecycle_Cost_Calc.pdf
Food Service Technology Center (2010). Gas Griddle Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/ggridcalc.php. Accessed on 10/22/10.	Food_Service_Technology_Center_2010_Gas_Griddle_LifeCycle_Cost_Calculator_Website_Screenshot.pdf
Food Service Technology Center (2011). Gas Fryer Life-Cycle Cost Calculation. Accessed on 10/12/2011.	FSTC_2011_Gas_Fryer_LifeCycle_Cost_Calculation_2011 10 12
GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group.	GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Prepared for GasNetworks.	GDS_SummitBlue_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
HEC, Inc. (1995). Analysis of Door Master Walk-In Cooler Anti-Sweat Door Heater Controls Installed at Ten Sites in Massachusetts. Prepared for New England Power Service Company.	HEC_1995_Analysis_of_Door_Master_Walk-In_Cooler_Anti-Sweat_Door_Heater_Controls
HEC, Inc. (1996). Analysis of Savings from Walk-In Cooler Air Economizers and Evaporator Fan Controls. Prepared for New England Power Service Company.	HEC_1996_Analysis_of_Savings_from_Walk-In_Cooler_Air_Economizers_and_Evap_Fan_Controls
Hewitt, D. Pratt, J. & Smith, G. (2005). Tankless Gas Water Heaters: Oregon Market Status. Prepared for the Energy Trust of Oregon.	Hewitt_Pratt_Smith_2005_Tankless_Gas_Water_Heaters_Oregon_Market_Status
ICF International (2008). Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR ® Homes Program. Prepared for Joint Management Committee.	ICF_2008_Energy_Demand_Savings_Calculation_Reporting_Methodology_MA_ESH_Program

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
ICF International (2012). 2013 Prescriptive Modeling Summary Final	ICF_2012_2013_Prescriptive_Modeling_Summary.pdf
KEMA-XENERGY (2003). California Statewide Commercial Sector Natural Gas Energy Efficiency Potential Study.	KEMA-XENERGY_2003_CA_Statewide_Commercial_Gas_EE_Report_Vol 1.pdf
KEMA (2009). 2007 Business & Construction Solutions (BS/CS) Programs - Measurement and Verification of 2007 Lighting Measures. Prepared for NSTAR.	KEMA_2009_NSTAR_BS_CS_Programs_Measurement_and_Verification_2007_Lighting_Measures
KEMA (2009). Design 2000plus Lighting Hours of Use and Load Shapes Measurement Study. Prepared for National Grid.	KEMA_2009_NGRID_D2_Lighting_HOU_Load_Shapes_Measurement_Study
KEMA (2009). National Grid USA 2008 Custom Lighting Impact Evaluation, Final Report. Prepared for National Grid.	KEMA_2009_NGRID_2008_Custom_Lighting_Impact_Evaluation
KEMA (2009). Sample Design and Impact Evaluation Analysis of the 2008 Custom Program. Prepared for National Grid.	KEMA_2009_NGRID_Sample_Design_and_Impact_Evaluation_Analysis_2008_Custom_Program
KEMA (2010). Sample Design and Impact Evaluation Analysis of the 2009 Custom Program. Prepared for National Grid.	KEMA_2010_NGRID_Sample_Design_and_Impact_Evaluation_Analysis_2009_Custom_Program
KEMA (2011). 2007/2008 Large C&I Programs Final Report. Prepared for Western Massachusetts Electric Company.	KEMA_2011_WMECO_2007-2008_Large_CI_Programs_Final_Report
KEMA (2011). C&I Lighting Loadshape Project – Final Report. Prepared for the Regional Evaluation, Measurement and Verification Forum.	KEMA_2011_NEEP_EMV_CI_Lighting_Load_Shape_Project
KEMA (2011). C&I Unitary HVAC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.	KEMA_2011_NEEP_EMV_CI_Unitary_HVAC_Load_Shape_Project
KEMA (2012). Impact Evaluation of 2010 Custom Process and Compressed Air Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.	KEMA_2012_Custom_Process_and_CAIR_Report.pdf
KEMA (2012). Impact Evaluation of the 2010 Custom Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.	KEMA_2012_Custom_Lighting_Final_Report.pdf
KEMA (2012). Prescriptive Gas Program Final Evaluation Report. Prepared for Massachusetts Energy Efficiency Program Administrators	KEMA_2012_Prescriptive_Gas_Report.pdf
KEMA (2012). 2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo. Prepared for National Grid and NSTAR; Table 1-1	KEMA_2012_CHP_Impact_Eval_Memo.pdf
KEMA and DMI (2011). Impact Evaluation of 2009 Custom HVAC Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.	KEMA_DMI_2011_LCIEC_Impact_Evaluation_2009_Custom_HVAC_Installations

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
KEMA and SBW (2011). Impact Evaluation of 2008 and 2009 Custom CDA Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.	KEMA_SBW_2011_LCIEC_Impact_Evaluation_2008-2009_Custom_CDA_Installations
KEMA ERS (2012). Impact Evaluation of 2010 Custom Gas Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council; Page 8.	KEMA_2012_Custom_Gas_Impact_Eval.pdf
KEMA, Inc (2008). The Opportunity for Energy Efficiency that is Cheaper than Supply in Rhode Island – Phase I Report. Prepared for Rhode Island Energy Efficiency and Resource Management Council	KEMA_2008_The_Opportunity_for_Energy_Efficiency_that_is_Cheaper_than_Supply_in_RI_Phase_I_Report.pdf
KEMA, Inc. (2010). 2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures. Prepared for Western Massachusetts Electric Company.	KEMA_2010_2007_2008_Large_C_I_Programs_Report_Memo_for_Lighting_and_Process_Measures.pdf
KEMA, Inc. (2012). Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy impacts Study.	KEMA_2012_MA_CI_NEI_REPORT.pdf
KEMA, Inc. and DMI, Inc. (2013). 2011-2012 Massachusetts Prescriptive VSD Impact Evaluation. Prepared for the Massachusetts Program Administrators and the Massachusetts Energy Efficiency Advisory Council.	KEMA_2013_Prescriptive_VSD_Report.pdf
KEMA, Inc. and SBW (2013). Impact Evaluation of 2011 Custom Refrigeration, Motor, and Other Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.	KEMA_2013_Custom_Refrig_Motor_Other.pdf
KEMA (2013). Project 25 Prescriptive Gas Program Final Evaluation Report. Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-2.	KEMA_2013_Prescriptive_Gas.pdf
KEMA ERS (2013). Impact Evaluation of 2011 Custom Gas Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council	KEMA_2013_Custom_Gas_Impact_Report.pdf
Keena, Kevin (2008). Analysis of CO2 Control Energy Savings on Unitary HVAC Units. Prepared for National Grid.	Kenna_2008_Analysis_of_CO2_Ctrl_Energy_Savings_on_Unitary_HVAC.XLS
Lawrence Berkeley National Laboratory (2002). Quantifying the Value That Wind Power Provides as a Hedge Against Volatile Natural Gas Prices	LBL_2002_Hedge_Value.pdf
MA PAs (2012). 2013-15 MA Lighting Worksheet	MAPA_2013-2015 MA Lighting Worksheet.xls
MA PAs (2013). 2012 HEHE Application of Results Excel Workbook	2012 HEHE Application of Results.xls
MA PAs (2013). 2012 Cool Smart Application of Results Excel Workbook	2012 Cool Smart Application of Results.xlsx
MassSave (2010). C&I New Construction Lighting Baseline Wattage Tables.	MassSave_2010_C_and_I_New_Construction_Lighting_Baseline_Wattage_Tables.pdf

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
MassSave (2010). C&I New Construction Lighting Wattage Tables.	MassSave_2010_CI_New_Construction_Lighting_Wattage_Tables.pdf
National Grid (2008). National Grid 2008 Steam Trap Savings Calculation.	National Grid 2008 steam trap loss chart.xls
National Grid Staff Calculation (2010). Pipe insulation for SBS DI measures 2010 Excel Workbook	NGrid_Pipe_insulation_for_SBS_DImeasures_2010.pdf
National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings	NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10.pdf
National Grid and NSTAR (2010). Energy Analysis: Hotel Guest Occupancy Sensors. Prepared for National Grid and NSTAR.	NGRID_NSTAR_Energy_Analysis_Hotel_Guest_Occupancy_Sensors
Nexus Market Research (2011). Estimated Net-To-Gross (NTG) Factors for the Massachusetts Program Administrators (PAs) 2010 Residential New Construction Programs, Residential HEHE and Multi-Family Gas Programs, and Commercial and Industrial Gas Programs.	TetraTech_2011_Estimated_NTG_2010_Gas_Programs.pdf
Nexus Market Research and RLW Analytics (2004). Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, N	NMR_RLW_2004_Impact_Evaluation_MA_RI_VT_2003_Residential_Lighting_Programs
Nexus Market Research and RLW Analytics (2008). Residential Lighting Measure Life Study. Prepared for New England Residential Lighting Program Sponsors.	NMR_RLW_2008_Residential_Lighting_Measure_Life_Study
Nexus Market Research and The Cadmus Group (2010). HEHE Process and Impact Evaluation - Volume 1 Integrated Report of Findings. Prepared for GasNetworks.	NMR_Cadmus_2010_HEHE_Proces_Impact_Evaluation_Vol1_Integrated_Report_Findings
Nexus Market Research, RLW Analytics and GDS Associates (2009). Residential Lighting Markdown Impact Evaluation. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.	NMR_RLW_GDS_2009_Residential_Lighting_Markdown_Impact_Evaluation
NMR Group (2011). Massachusetts Appliance Turn-In Program Evaluation Integrated Report Findings. Prepared for National Grid, NSTAR Electric, Cape Light Compact, and Western Massachusetts Electric Company.	NMR_2011_MA_Appliance_Turn-In_Program_Evaluation
NMR Group, Inc (2011). Massachusetts ENERGY STAR® Lighting Program: 2010 Annual Report. Prepared for the Electric Program Administrators of Massachusetts; June 13, 2011.	NMR_2011_ES_Lighting_Annual_Report.pdf
NMR Group, Inc., KEMA Inc., Dorothy Conant (2012). Massachusetts Mini-Baseline Study of Homes Built at the end of the 2006 IECC Cycle; June 15, 2012	NMR_2012_MA_Mini_Baseline_Rpt.pdf
NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for Massachusetts Program Administrators	Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation.pdf

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
NMR Group, Inc., KEMA, Inc., The Cadmus Group, Inc., Dorothy Conant (2012). Massachusetts 2011 Baseline Study of Single-family Residential New Construction, Final Report	NMR_2012_MA_RNC_2011 Baseline_Revised 10-5-12.pdf
NMR Group, Inc., KEMA, Inc., The Cadmus Group, Inc., Dorothy Conant (2012). Final UDRH Inputs: Addendum to Massachusetts 2011 Baseline Study of Single-family Residential New Construction, Final Report.	NMR_2012_MA_Baseline_UDRH_Addendum.pdf
NMR Group (2012). Baseline Sensitivity Analysis Spreadsheet, Three-Year Planning Version. Prepared for the Massachusetts PAs.	NMR_2012_Baseline Sensitivity Analysis 3YP Version.xlsx
NMR Group (2012). Baseline Sensitivity Analysis Net Savings Spreadsheet, Three-Year Planning Version. Prepared for the Massachusetts PAs.	NMR_2012_Baseline Sensitivity Analysis Net Savings 3YP Version.xlsx
NMR Group, Inc. (2013). Results of the Massachusetts Onsite Lighting Inventory. Prepared for the Massachusetts PAs.	NMR_2013_MA_Lighting_Onsite_Report.pdf
NMR Group, Inc. (2013) Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure	NMR_2013_Residential_HVAC_Replace_On_Failure NEIs.pdf
Northeast Energy Efficiency Partnerships (2006). Strategies to Increase Residential HVAC Efficiency in the Northeast. Prepared for National Association of State Energy Offices.	NEEP_2006_Strategies_Increase_Residential_HVAC_Efficiency_Northeast
Opinion Dynamics Corporation (2007). Evaluation Study of KeySpan's Commercial and Industrial High Efficiency Heating Equipment Program. Prepared for KeySpan Energy Delivery.	ODC_2007_Evaluation_Study_KeySpan_CI_HEHE_Program
Opinion Dynamics Corporation (2009). Massachusetts Residential Saturation Survey (RASS) - Volume 1: Summary Results and Analysis. Prepared for Cape Light Compact, National Grid, NSTAR Electric, Unitil and Western Massachusetts Electric Company.	ODC_2009_MA_Residential_Appliance_Saturation_Survey_Vol1_Summary_Results_Analysis
Opinion Dynamics Corporation and Navigant Consulting (2013). Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report	ODC_2013_Cross_Cutting_Behavioral_Program_Evaluation.pdf
Optimal Energy, Inc. (2008). MEMO: Non-Electric Benefits Analysis Update. Prepared for NSTAR.	Optimal_2008_NonElectric_Benefits_Analysis_Update
Patel, Dinesh (2001). Energy Analysis: Dual Enthalpy Control. Prepared for NSTAR.	Patel_2001_Energy_Analysis_Dual_Enthalpy_Controls
RLW Analytics (2002). Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating.	RLW_2002_Market_Research_RI_MA_CT_Residential_HVAC_Market

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
RLW Analytics (2003). Small Business Solutions Program Year 2002 Impact Evaluation - Final Report. Prepared for NSTAR.	RLW_2003_NSTAR_Small_Business_Solutions_PY2002_Impact_Evaluation
RLW Analytics (2004). 2003 Energy Initiative "EI" Program Lighting Impact Evaluation - Final Report. Prepared for National Grid.	RLW_2004_NGRID_2003_EI_Lighting_Impact_Evaluation
RLW Analytics (2006). Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs. Prepared for National Grid.	RLW_2006_NGRID_Sample_Design_and_Impact_Evaluation_Analysis_Prescriptive_Compressed_Air_Measures
RLW Analytics (2006). Custom Services Impact Evaluation - Final Report: 2004 Measure Installations. Prepared for Northeast Utilities.	RLW_2006_Custom_Service_Impact_Evaluation_Final_Report_2004_Measure_Installations.pdf
RLW Analytics (2007). Coincidence Factor Study: Residential and Commercial Industrial Lighting Measures. Prepared for the New England State Program Working Group.	RLW_2007_Coincidence_Factor_Study_Residential_and_Commercial_Industrial_Lighting_Measures
RLW Analytics (2007). Impact Evaluation Analysis of the 2005 Custom SBS Program. Prepared for National Grid.	RLW_2007_NGRID_Impact_Evaluation_Analysis_2005_Custom_SBS_Program
RLW Analytics (2007). Lighting Controls Impact Evaluation - Final Report, 2005 Energy Initiative, Design 2000plus and Small Business Services Programs. Prepared for National Grid.	RLW_2007_NGRID_Lighting_Controls_Impact_Evaluation
RLW Analytics (2007). Small Business Services Custom Measure Impact Evaluation. Prepared for National Grid.	RLW_2007_NGRID_SBS_Custom_Measure_Impact_Evaluation
RLW Analytics (2007). Validating the Impact of Programmable Thermostats. Prepared for GasNetworks.	RLW_2007_Validating_Impacts_of_Programmable_Thermostats
RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas.	RLW_2008_NSTAR_BS_CS_Programs_Measurement_and_Verification_2006_Final_Report
RLW Analytics (2008). Coincidence Factor Study: Residential Room Air Conditioners. Prepared for Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group.	RLW_2008_Coincidence_Factor_Study_Residential_Room_Air_Conditioners
Sachs, Harvey (2003). Energy Savings from Efficient Furnace Air Handlers in Massachusetts.	Sachs_2003_Energy_Savings_Efficient_Furnace_Air_Handlers_MA
SAIC (1995). Motor Run-Time and Persistence Study - Final Report. Prepared for New England Power Service Company.	SAIC_1995_Motor_Run_Time_and_Persistence_Study.pdf
SAIC (1998). 1998 Impact Evaluation of the Design 2000 Unitary HVAC Program. Prepared for New England Power Service Company.	SAIC_1998_Impact_Eval_of_the_Design_200plus_Unitary_HVAC_Program.pdf
Select Energy Services (2004). Analysis of Cooler Control Energy Conservation Measures. Prepared for NSTAR.	SelectEnergy_2004_NSTAR_Analysis_Cooler_Control_Energy_Conservation_Measures

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
Summit Blue Consulting, LLC (2008). Large Commercial and Industrial Retrofit Program Impact Evaluation 2007 – Final Report. Prepared for National Grid.	SummitBlue_2008_NGRID_LCI_Retrofit_Program_Impact_Evaluation_2007
Summit Blue Consulting, LLC (2008). Multiple Small Business Services Programs Impact Evaluation 2007 – Final Report Update. Prepared for Cape Light Compact, National Grid, NSTAR, Unitil and Western Massachusetts Electric Company.	SummitBlue_2008_Multiple_Small_Business_Service_Programs_Impact_Evaluation_2007
Tetra Tech and NMR Group (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for Massachusetts Program Administrators.	TetraTech_NMR_2011_MACC_Res_LI_NEI_Evaluation
TetraTech (2011). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study. June 23, 2011	TetraTech_2011_MACC_2010_CI_FRSO_Study.pdf
TetraTech (2012). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study. June 2012	TetraTech_2012_CI_Gas_FR_SO_Report.docx
The Cadmus Group (2011). 2010 Net-to-Gross Findings: Home Energy Assessment. The Electric and Gas Program Administrators of Massachusetts.	Cadmus_2011_2010_NTG_HES.pdf
The Cadmus Group (2009). Impact Evaluation of the 2007 Appliance Management Program and Low Income Weatherization Program. Prepared for National Grid.	Cadmus_2009_Impact_Evalulation_2007_AMP_and_LI_Weatherization_Program
The Cadmus Group (2010). EnergyWise 2008 Program Evaluation. Prepared for National Grid.	Cadmus_2010_EnergyWise_2008_Program_Evaluation
The Cadmus Group (2010). Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008. Prepared for Western Massachusetts Electric Company.	Cadmus_2010_WMECO_SBEA_Impact_Evalulation_Report_PY2008
The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit and Low Income Net-to-Gross Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts	CADMUS_2012_ HES Net-to-Gross Impact Evaluation.pdf
The Cadmus Group, Inc. (2012) Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation. Prepared for: The Electric and Gas Program Administrators of Massachusetts	CADMUS_2012_BFM_Impact_Evaluation_Report.pdf
The Cadmus Group, Inc. (2012). Demand Impact Model. Prepared for the Massachusetts Program Administrators	Cadmus_2012_Demand_Impact_Model_User_Guide.pdf
The Cadmus Group, Inc. (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Analysis. Prepared for the Massachusetts Program Administrators	Cadmus_2012_Multifamily_Impacts_Analysis_Report.pdf

© 2013 Massachusetts Electric and Gas Energy
Efficiency Program Administrators, ALL RIGHTS RESERVED

FULL CITATION	DIGITAL DOCUMENT FILENAME
The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts.	CADMUS_2012_Single_Family_Low_Income_Impact_Eval.docx
The Cadmus Group (2012). Home Energy Services Impact Evaluation. Prepared for Massachusetts Program Administrators.	CADMUS_2012_ HES_Impact_Evaluation_Report.pdf
The Cadmus Group, Inc. (2012) Memo to HEHE Program Administrators Re: Impacts of Upcoming Federal Standards on HEHE. Gas Space and Water Heating Measures; June 8, 2012.	CADMUS_2012_HEHE_Codes_and_Standards_Impacts.pdf
The Cadmus Group (2012). Final Report, Small Business Direct Install Program: Pre/Post Occupancy Sensor Study	CADMUS_2012_SBDI_PrePostLightingControl_Final.pdf
The Cadmus Group (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing. Prepared for the Electric and Gas Program Administrators of Massachusetts.	CADMUS_2013_HEHE_Cool Smart_NTG_Evaluation_Report.pdf
The Cadmus Group (2013). HES Realization Rate Results Memo. June 2013	CADMUS_2013_HES_Realization_Rate_Results_Memo.pdf
The Fleming Group (1994). Persistence of Commercial/Industrial Non-Lighting Measures, Volume 3, Energy Management Control Systems. Prepared for New England Power Service Company.	Fleming_Group_1994_Persistence_of_Commercial_Industrial_Non_Lighting_Measures_Volume_3_Energy_Management_Control_Systems.pdf
United Illuminating Company and Connecticut Light & Power Company (2010). UI and CL&P Program Savings Documentation for 2011 Program Year.	2011_CT_PSD
USA Technologies Energy Management Product Sheets (2006).	USATech_2006_Energy_Management_Product_Sheets
Veritec Consulting (2005). Region of Waterloo Pre-Rinse Spray Valve Pilot Study, Final Report.	Veritec_2005_Pre-Rinse_Spray_Valve_Pilot_Study
Waste Reduction Partners (2004). Occupancy Sensors - Utility Savings Initiative - Fact Sheet.	WRP_2004_Occupancy_Sensors_Utility_Savings_Initiative_Fact_Sheet

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Appendix F: Acronyms

ACRONYM	DESCRIPTION
AC	Air Conditioning
AFUE	Annual Fuel Utilization Efficiency (see the Glossary)
AHU	Air Handling Unit
Btu	British Thermal Unit (see the Glossary)
CF	Coincidence Factor (see the Glossary)
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
COP	Coefficient of Performance (see the Glossary)
DCV	Demand Controlled Ventillation
DHW	Domestic Hot Water
DOER	Department of Energy Resources
DSM	Demand Side Management (see the Glossary)
ECM	Electrically Commutated Motor
EER	Energy Efficiency Ratio (see the Glossary)
EF	Efficiency Factor
EFLH	Equivalent Full Load Hours (see the Glossary)
ES	ENERGY STAR® (see the Glossary)
FCM	Forward Capacity Market
FR	Free-Ridership (see the Glossary)
HE	High-Efficiency
HID	High-Intensity Discharge (a lighting technology)
HP	Horse Power (see the Glossary)
HSPF	Heating Seasonal Performance Factor (see the Glossary)
HVAC	Heating, Ventilating, and Air Conditioning
ISO	Independent System Operator
ISR	In-Service Rate (see the Glossary)
kW	Kilo-Watt, a unit of electric demand equal to 1,000 watts
kWh	Kilowatt-Hour, a unit of energy (1 kilowatt of power supplied for one hour)
LED	Light-Emitting Diode (one type of solid-state lighting)
LCD	Liquid Crystal Display (a technology used for computer monitors and similar displays)
MMBtu	One million British Thermal Units (see “Btu” in the Glossary)
MW	Megawatt – a measure of electric demand equal to 1,000 kilowatts
MWh	Megawatt-hour – a measure of energy equal to 1,000 kilowatt-hours
NEB	Non-Electric Benefit (see the Glossary)
NEI	Non-Energy Impact
NE-ISO	New England Independent System Operator
NTG	Net-to-Gross (see the Glossary)
O&M	Operations and Maintenance
PA	Program Administrator (see the Glossary)
PARIS	Planning And Reporting Information System (a DOER database - see the Glossary)
PC	Personal Computer
RR	Realization Rate (see the Glossary)
SEER	Seasonal Energy Efficiency Ratio (see the Glossary)
SO	Spillover (see the Glossary)
SPF	Savings Persistence Factor (see the Glossary)
SSL	Solid-State Lighting (e.g., LED lighting)
VSD	Variable-Speed Drive

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Appendix G: Glossary

This glossary provides definitions as they are applied in this TRM for Massachusetts' energy efficiency programs. Alternate definitions may be used for some terms in other contexts.

TERM	DESCRIPTION
Adjusted Gross Savings	Gross savings (as calculated by the measure savings algorithms) that have been subsequently adjusted by the application of all impact factors except the net-to-gross factors (free-ridership and spillover). For more detail, see the section on Impact Factors for Calculating Adjusted Gross and Net Savings.
AFUE	Annual Fuel Utilization Efficiency. The measure of seasonal or annual efficiency of a furnace or boiler. AFUE takes into account the cyclic on/off operation and associated energy losses of the heating unit as it responds to changes in the load, which in turn is affected by changes in weather and occupant controls.
Baseline Efficiency	The level of efficiency of the equipment that would have been installed without any influence from the program or, for retrofit cases where site-specific information is available, the actual efficiency of the existing equipment.
Btu	British thermal unit. A Btu is approximately the amount of energy needed to heat one pound of water by one degree Fahrenheit.
Coefficient of Performance (COP)	Coefficient of Performance is a measure of the efficiency of a heat pump, air conditioner, or refrigeration system. A COP value is given as the Btu output of a device divided by the Btu input of the device. The input and output are determined at AHRI testing standards conditions designed to reflect peak load operation.
Coincidence Factor (CF)	Coincidence Factors represent the fraction of connected load expected to occur concurrent to a particular system peak period; separate CF are found for summer and winter peaks. The CF given in the TRM includes both coincidence and diversity factors multiplied into one number. Coincidence factors are provided for peak periods defined by the NE-ISO for FCM purposes and calculated consistent with the FCM methodology.
Connected Load kW Savings	The connected load kW savings is the power saved by the equipment while in use. In some cases the savings reflect the maximum power draw of equipment at full load. In other cases the connected load may be variable, which must be accounted for in the savings algorithm.
Deemed Savings	Savings values (electric, fossil fuel and/or non-energy benefits) determined from savings algorithms with assumed values for all algorithm parameters. Alternatively, deemed savings values may be determined from evaluation studies. A measure with deemed savings will have the same savings per unit since all measure assumptions are the same. Deemed savings are used by program administrators to report savings for measures with well-defined performance characteristics relative to baseline efficiency cases. Deemed savings can simplify program planning and design, but may lead to over- or under-estimation of savings depending on product performance.
Deemed Calculated Savings	Savings values (electric, fossil fuel and/or non-energy benefits) that depend on a standard savings algorithm and for which at least one of the algorithm parameters (e.g., hours of operation) is project specific.
Demand Savings	The reduction in demand due to installation of an energy efficiency measure, usually expressed as kW and measured at the customer's meter (see Connected Load kW Savings).
Demand Side Management (DSM)	Strategies used to manage energy demand including energy efficiency, load management, fuel substitution, and load building.
Diversity	A characteristic of a variety of electric loads whereby individual maximum demands occur at different times. For example, 50 efficient light fixtures may be installed, but they are not necessarily all on at the same time. See Coincidence Factor.

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TERM	DESCRIPTION
Diversity Factor	This TRM uses coincidence factors that incorporate diversity (See Coincidence Factor), thus this TRM has no separate diversity factors. A diversity factor is typically calculated as: 1) the percent of maximum demand savings from energy efficiency measures available at the time of the company's peak demand, or 2) the ratio of the sum of the demands of a group of users to their coincident maximum demand.
End Use	Refers to the category of end use or service provided by a measure or technology (e.g., lighting, cooling, etc.). For the purpose of this manual, end uses with their PARIS codes include: ALght Lighting HVAC HVAC CMoDr Motors & Drives DRefr Refrigeration EHoWa Hot Water FComA Compressed Air GProc Process* HEUBe Behavior Ienvl Insulation & Air Sealing JGchp Combined Heat & Power KSdhw Solar Hot Water LDmdR Demand Response MPvEl Photovoltaic Panels *For residential measures, "process" is used for products that have low savings, such as consumer electronics, or do not conform to existing end use categories. For commercial and industrial measures, "process" is used for systematic improvements to manufacturing or pump systems, or efficient models of specialty equipment not covered in other end uses.
Energy Efficiency Ratio (EER)	The Energy Efficiency Ratio is a measure of the efficiency of a cooling system at a specified peak, design temperature, or outdoor temperature. In technical terms, EER is the steady-state rate of heat energy removal (i.e. cooling capacity) of a product measured in Btuh output divided by watts input.
ENERGY STAR® (ES)	Brand name for the voluntary energy efficiency labeling initiative sponsored by the U.S. Environmental Protection Agency.
Energy Costing Period	A period of relatively high or low system energy cost, by season. The energy periods defined by ISO-NE are: • **Summer Peak**: 6am–10pm, Monday–Friday (except ISO holidays), June–September • **Summer Off-Peak:** Summer hours not included in the summer peak hours: 10pm–6am, Monday–Friday, all day on Saturday and Sunday, and ISO holidays, June–September • **Winter Peak:** 6am–10pm, Monday–Friday (except ISO holidays), January–May and October–December • **Winter Off-Peak:** Winter hours not included in the sinter peak hours: 10pm–6am, Monday–Friday, all day on Saturday and Sunday, and ISO holidays, January–May and October–December.
Equivalent Full Load Hours (EFLH)	The equivalent hours that equipment would need to operate at its peak capacity in order to consume its estimated annual kWh consumption (annual kWh/connected kW).
Free Rider	A customer who participates in an energy efficiency program, but would have installed some or all of the same measure(s) on their own, with no change in timing of the installation, if the program had not been available.
Free-Ridership Rate	The percentage of savings attributable to participants who would have installed the measures in the absence of program intervention.
Gross kW	Expected demand reduction based on a comparison of standard or replaced equipment and equipment installed through an energy efficiency program.
Gross kWh	Expected kWh reduction based on a comparison of standard or replaced equipment and equipment installed through an energy efficiency program.

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TERM	DESCRIPTION
Gross Savings	A saving estimate calculated from objective technical factors. In this TRM, "gross savings" are calculated with the measure algorithms and do not include any application of impact factors. Once impact factors are applied, the savings are called "Adjusted Gross Savings". For more detail, see the section on Impact Factors for Calculating Adjusted Gross and Net Savings.
High Efficiency (HE)	Refers to the efficiency measures that are installed and promoted by the energy efficiency programs.
Horsepower (HP)	A unit for measuring the rate of doing work. One horsepower equals about three-fourths of a kilowatt (745.7 watts).
Heating Seasonal Performance Factor (HSPF)	A measure of the seasonal heating mode efficiencies of heat pumps expressed as the ratio of the total heating output to the total seasonal input energy.
Impact Factor	Generic term for a value used to adjust the gross savings estimated by the savings algorithms in order to reflect the actual savings attributable to the efficiency program. In this TRM, impact factors include realization rates, in-service rates, savings persistence, peak demand coincidence factors, free-ridership, spillover and net-to-gross factors. See the section on Impact Factors for more detail.
In-Service Rate	The percentage of units that are actually installed. For example, efficient lamps may have an in-service rate less than 100% since some lamps are purchased as replacement units and are not immediately installed. The in-service rate for most measures is 100%.
Measure Life	The number of years that an efficiency measure is expected to garner savings. These are generally based on engineering lives, but sometimes adjusted based on observations of market conditions.
Lost Opportunity	Refers to a measure being installed at the time of planned investment in new equipment or systems. Often this reflects either new construction, renovation, remodeling, planned expansion or replacement, or replacement of failure.
Measure	A product (a piece of equipment), combination of products, or process designed to provide energy and/or demand savings. Measure can also refer to a service or a practice that provides savings. Measure can also refer to a specific combination of technology and market/customer/practice/strategy (e.g., direct install low income CFL).
Net Savings	The final value of savings that is attributable to a program or measure. Net savings differs from gross savings (or adjusted gross savings) because it includes adjustments due to free-ridership and/or spillover. Net savings is sometimes referred to as "verified" or "final" savings. For more detail see the section on Impact Factors for Calculating Adjusted Gross and Net Savings.
Net-to-Gross Ratio	The ratio of net savings to the adjusted gross savings (for a measure or program). The adjusted gross savings include any adjustment by the impact factors other than free-ridership or spillover. Net-to-gross is usually expressed as a percent.
Non-Electric Benefits (NEBs)	Quantifiable benefits (beyond electric savings) that are the result of the installation of a measure. Fossil fuel, water, and maintenance are examples of non-electric benefits. Non-electric benefits can be negative (i.e. increased maintenance or increased fossil fuel usage which results from a measure) and therefore are sometimes referred to as "non-electric impacts".
Non-Participant	A customer who is eligible to participate in a program, but does not. A non-participant may install a measure because of a program, but the installation of the measure is not through regular program channels; as a result, their actions are normally only detected through evaluations.
On-Peak kW	See Summer/Winter On-peak kW
Operating Hours	Hours that a piece of equipment is expected to be in operation, not necessarily at full load (typically expressed per year).

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TERM	DESCRIPTION
PARIS	Planning And Reporting Information System, a statewide database maintained by the Department of Energy Resources (DOER) that emulates the program administrators' screening model. As a repository for quantitative data from plans, preliminary reports, and reports, PARIS generates information that includes funding sources, customer profiles, program participation, costs, savings, cost-effectiveness and program impact factors from evaluation studies. DOER developed PARIS in 2003 as a collaborative effort with the Department of Public Utilities and the electric program administrators. Beginning with the 2010 plans, PARIS holds data from gas program administrators.
Participant	A customer who installs a measure through regular program channels and receives any benefit (i.e. incentive) that is available through the program because of their participation. Free-riders are a subset of this group.
Prescriptive Measure	A prescriptive measure is generally offered by use of a prescriptive form with a prescribed incentive based on the parameters of the efficient equipment or practice.
Program Administrator (PA)	Those entities that oversee public benefit funds in the implementation of energy efficiency programs. This generally includes regulated utilities, other organizations chosen to implement such programs, and state energy offices. The Massachusetts electric PAs include Cape Light Compact, National Grid, NSTAR, Western Massachusetts Electric Company (WMECo), and Unitil. The Massachusetts natural gas PAs include Bay State Gas, Berkshire Gas, and New England Gas.
Realization Rate (RR)	The ratio of measure savings developed from impact evaluations to the estimated measure savings derived from the TRM savings algorithms. This factor is used to adjust the estimated savings when significant justification for such adjustment exists. The components of the realization rate are described in detail in the section on Impact Factors.
Retrofit	The replacement of a piece of equipment or device before the end of its useful or planned life for the purpose of achieving energy savings. "Retrofit" measures are sometimes referred to as "early retirement" when the removal of the old equipment is aggressively pursued.
Savings Persistence Factor (SPF)	Percentage of first-year energy or demand savings expected to persist over the life of the installed energy efficiency equipment. The SPF is developed by conducting surveys of installed equipment several years after installation to determine the operational capability of the equipment. In contrast, *measure persistence* takes into account business turnover, early retirement of installed equipment, and other reasons the installed equipment might be removed or discontinued. Measure persistence is generally incorporated as part of the measure life, and therefore is not included as a separate impact factor.
Seasonal Energy Efficiency Ratio (SEER)	A measurement of the efficiency of a central air conditioner over an entire season. In technical terms, SEER is a measure of equipment the total cooling of a central air conditioner or heat pump (in Btu) during the normal cooling season as compared to the total electric energy input (in watt-hours) consumed during the same period.
Seasonal Peak kW	See Summer/Winter Seasonal Peak kW, and Summer/Winter On-Peak Peak kW.
Sector	A system for grouping customers with similar characteristics. For the purpose of this manual, the sectors are Commercial and Industrial (C&I), Small Business, Residential, and Low Income.
Spillover Rate	The percentage of savings attributable to the program, but additional to the gross (tracked) savings of a program. Spillover includes the effects of (a) participants in the program who install additional energy efficient measures outside of the program as a result of hearing about the program and (b) non-participants who install or influence the installation of energy efficient measures as a result of being aware of the program.
Summer/Winter On-Peak kW	The average demand reduction during the summer/winter on-peak period. The summer on-peak period is 1pm-5pm on non-holiday weekdays in June, July and August; the winter on-peak period is 5pm-7pm on non-holiday weekdays in December and January.

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TERM	DESCRIPTION
Summer/Winter Seasonal Peak kW	The demand reduction occurring when the actual, real-time hourly load for Monday through Friday on non-holidays, during the months of June, July, August, December, and January, as determined by the ISO, is equal to or greater than 90% of the most recent 50/50 system peak load forecast, as determined by the ISO, for the applicable summer or winter season.
Ton	Unit of measure for determining cooling capacity. One ton equals 12,000 Btu.
Watt	A unit of electrical power. Equal to 1/1000 of a kilowatt.

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APPENDIX B

COST-EFFECTIVENESS SUPPORTING TABLES AND DOCUMENTATION

SECTION 3

TECHNICAL REFERENCE MANUAL

Please see the CD-ROM provided under separate cover.

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APPENDIX C

PROGRAM AND PILOT PROGRAM EM&V STUDIES

Please see the CD-ROM provided under separate cover.

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APPENDIX D

PERFORMANCE INCENTIVES SUPPORTING DOCUMENTATION

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APPENDIX D
SECTION 1

PERFORMANCE INCENTIVE CALCULATION

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2012 Energy Effiency Performance Incentives - Western MA Electric
2012 Annual Report Results

	WMECo	Segment %	Residential	Low Income	C&I	Total	Comment
1	Pre-evaluated Benefits		74,060,225	11,959,898	65,892,916	151,913,040	Pre-evaluated Benefits
2	Achieved Benefits		55,545,169	14,949,873	73,750,319	144,245,360	IV. D. Cost Effectiveness 1. Summary Table (except Residential and Low Income which hit the bandwidth)
3	Savings Payout Rate 2012		0.0066	0.0066	0.0066	0.0066	Exhibit D, Attachment 2 in WMECo, D.P.U. 11-112 dated 02/15/13
4	**Savings Incentives**		**$ 368,732**	**$ 99,244**	**$ 489,586**	**$ 957,561**	Line 2 times Line 3
5	Actual Costs		14,901,646	4,853,489	20,377,777	40,132,913	Total TRC Costs (which includes Line 6 below)
6	Performance Incentive Included in Cost		1,085,533	236,549	1,093,712	2,415,794	Estimated Performance Incentive before final run
7	Achieved Net Benefits (excluding performance incentives)		41,729,056	10,332,932	54,466,254	106,528,241	Line 2 - (Line 5 - Line 6)
8	Value Payout Rate 2012		0.0064	0.0064	0.0064	0.0064	Exhibit D, Attachment 2 in WMECo, D.P.U. 11-112 dated 02/15/13
9	**Value Incentives**		**$ 268,297**	**$ 66,436**	**$ 350,191**	**$ 684,924**	Line 7 times Line 8
10	**Performance Metrics**		**$ 139,871**	**$ 108,788**	**$ 51,158**	**$ 299,817**	Line 47
11	**Total Peformance Incentives**		**$ 776,900**	**$ 274,468**	**$ 890,935**	**$ 1,942,303**	Line 4 + Line 9 + Line 10
	Performance Metric Allocation - Targets (2012)						
12	Targets		$ 118,284	$ 91,999	$ 118,284	$ 328,566	Exhibit D, Attachment 2 in WMECo, D.P.U. 11-112 dated 02/15/13
13	All Sector Metrics					20.0%	Exhibit D, Attachment 2 in WMECo, D.P.U. 11-112 dated 02/15/13
14	1. Financing Metric	25%	$ 5,914	$ 4,600	$ 5,914	$ 16,428	Line 13* Line 12 * segment%
15	2. Cost-Effiency of Program Expenditures	75%	$ 17,743	$ 13,800	$ 17,743	$ 49,285	Line 13* Line 12 * segment%
16	Total All Sector Metrics		$ 23,657	$ 18,400	$ 23,657	$ 65,713	Line 14 + Line 15
17	Remaining Peformance Metrics after All Sector Metrics		$ 94,627	$ 73,599	$ 94,627	$ 262,853	Line 12 - Line 16
	Residential						
18	1. MassSAVE/Weatherization: Deeper Savings	60.0%	$ 56,776			$ 56,776	Line 17 * segment %
19	2. MassSAVE/Weatherization: Lost/Marketing Opportunity	40.0%	$ 37,851			$ 37,851	Line 17 * segment %
	Low Income						
20	1. Best Practices Technical Review Sub-committee/New Measures	50.0%		$ 36,799		$ 36,799	Line 17 * segment %
21	2. Multi-Family Building Inventory	50.0%		$ 36,799		$ 36,799	Line 17 * segment %
	Commercial & Industrial						
22	1. Retrofit -- Depth of savings	25.0%			$ 23,657	$ 23,657	Line 17 * segment %
23	2. New Construction -- Comprehensiveness and depth of savings	25.0%			$ 23,657	$ 23,657	Line 17 * segment %
24	3. Direct Install Electric and Gas Integration	25.0%			$ 23,657	$ 23,657	Line 17 * segment %
25	4. Combined Heat & Power	25.0%			$ 23,657	$ 23,657	Line 17 * segment %
26	Total Target Peformance Metrics		$ 118,284	$ 91,999	$ 118,284	$ 328,566	Line 14+ line 15 + Line 18 to 25

2012 Energy Effiency Performance Incentives - Western MA Electric
2012 Annual Report Results

	Performance Metric Allocation - 2012 Achievement Percentage	Residential	Low Income	C&I	Total	
	All Sector Metrics					
27	1. Financing Metric	125%	125%	125%		Appendix D, Section 2
28	2. Cost-Effiency of Program Expenditures	80%	80%	80%		Appendix D, Section 2
	Residential					Appendix D, Section 2
29	1. MassSAVE/Weatherization: Deeper Savings	125%				Appendix D, Section 2
30	2. MassSAVE/Weatherization: Lost/Marketing Opportunity	125%				Appendix D, Section 2
	Low Income					
31	1. Best Practices Technical Review Sub-committee/New Measures		125%			Appendix D, Section 2
32	2. Multi-Family Building Inventory		125%			Appendix D, Section 2
	Commercial & Industrial					
33	1. Retrofit -- Depth of savings			125%		Appendix D, Section 2
34	2. New Construction -- Comprehensiveness and depth of savings			0%		Appendix D, Section 2
35	3. Direct Install Electric and Gas Integration			0%		Appendix D, Section 2
36	4. Combined Heat & Power			0%		Appendix D, Section 2

	Performance Metric Allocation - 2012 Achievement Value	Residential	Low Income	C&I	Total	
	All Sector Metrics					
37	1. Financing Metric	$ 7,393	$ 5,750	$ 7,393	$ 20,535	Line 14 * Line 27
38	2. Cost-Effiency of Program Expenditures	$ 14,194	$ 11,040	$ 14,194	$ 39,428	Line 15 * Line 28
	Residential					
39	1. MassSAVE/Weatherization: Deeper Savings	$ 70,970			$ 70,970	Line 18 * Line 29
40	2. MassSAVE/Weatherization: Lost/Marketing Opportunity	$ 47,314			$ 47,314	Line 19 * Line 30
	Low Income					
41	1. Best Practices Technical Review Sub-committee/New Measures		$ 45,999		$ 45,999	Line 20 * Line 31
42	2. Multi-Family Building Inventory		$ 45,999		$ 45,999	Line 21 * Line 32
	Commercial & Industrial					
43	1. Retrofit -- Depth of savings			$ 29,571	$ 29,571	Line 22 * Line 33
44	2. New Construction -- Comprehensiveness and depth of savings			$ -	$ -	Line 23 * Line 34
45	3. Direct Install Electric and Gas Integration			$ -	$ -	Line 24 * Line 35
46	4. Combined Heat & Power			$ -	$ -	Line 25 * Line 36
47	Total Performance Metric Achievement Value	$ 139,871	$ 108,788	$ 51,158	$ 299,817	Sum lines 37 to 46
48	Percent of Goal				91%	Line 47 / Line 26

2012 Energy Effiency Performance Incentives - Western MA Electric
Calculation of the Sector +/- 25% Cap

WMECo	Residential	Low Income	C&I	Total
Pre-evaluated Benefits	$ 74,060,225	$ 11,959,898	$ 65,892,916	151,913,040
Evaluated Benefits	$ 54,954,121	$ 15,670,157	$ 73,750,319	144,374,596
%	74%	131%	112%	95%
	cap at 75%	cap at 125%		
Achieved Benefits	$ 55,545,169	$ 14,949,873	$ 73,750,319	$ 144,245,360

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APPENDIX E

OTHER SUPPORTING DOCUMENTATION

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APPENDIX E

OTHER SUPPORTING DOCUMENTATION

SECTION 1

COMPETITIVE PROCUREMENT DOCUMENTATION

REQUEST FOR PROPOSALS/SCOPE OF WORK

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APPENDIX E

Competitive Procurement
In 2012

RFP #	ISSUED ON BEHALF OF	TOPIC	WINNER OF BID	NUMBER OF VENDORS RECEIVING RFP	NUMBER OF RESPONSES RECEIVED
1	Statewide – All Electric & Gas PAs	Builder's Guide to Deep Energy Renovation	Building Science Group	6	1
2	Statewide – All Electric & Gas PAs	Mass Save Upstream HVAC and Heat Pump Initiative	Energy Federation Inc.	9	3
3	Statewide – All Electric & Gas PAs	Massachusetts Statewide Education, Marketing, and Outreach Working Coalition for Mass Save	Kelliher Samets Volk	8	4
4	All Electric PAs	Appliance Initiative Refrigerator/Freezer Recycling Program	Jaco Environmental	4	2
5	All Electric PAs	Mass Save – Quality Assurance/Quality Control for C&I Upstream Lighting Initiative (MA)	Competitive Resources Inc.	9	1

For each RFP's scope of work, which describes the proposal requested, please see Appendix E - Section 1. For a sample of the Program Administrator's Terms and Conditions, please see Appendix E - Section 2.

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RFP for Builder's Guide to Deep Energy Renovation

RFP Objective
The Mass Save® program administrators would like a price to produce a Builder's Guide for the Deep Energy Renovation measures in the 2013-2015 residential energy efficiency programs.

A Builder's Guide will be a critical component of the delivery of the 2013-2015 residential Deep Energy Renovation measures. The DER would be available for download (as a PDF) from the Mass Save® website for homeowners, designers, and contactors to understand exactly what is required in the Deep Energy Renovation measures.

The Builder's Guide would provide several benefits:
Benefit One: DER Technical Review and Support costs - The Builder's Guide would dramatically reduce the required building science technical support. Additional building science technical review support would be needed only to address unusual conditions that are not covered in the Builder's Guide.
Benefit Two: DER Construction Inspections - The Builder's Guide would create a finite number of envelope assemblies in the Deep Energy Renovation measures. This would aid a broader array of vendors in developing expertise to inspect these allowed assemblies.
Benefit Three: Increased Spillover - An easy-to-read Builder's Guide would allow homeowners and developers to create DER projects throughout Massachusetts and Rhode Island whether or not they participate in an energy efficiency incentive program (for example in municipal electric areas). In addition, homeowners could use these details even if they are only renovating a kitchen or part of the basement (insufficient area to qualify for DER program). The homeowner could capture the opportunity at the time of renovation to increase the efficiency of their home with confidence that the new envelope will not have moisture or durability issues.
Benefit Four: Integration with Industry
The Builder's Guide finite number of envelope assemblies would enable partnership with retail partners, such as Home Depot and Lowes. The retail partners could create a materials list for each envelope assembly. Please note, the Builder's Guide would refer to all products **generically**, such as "rigid 2 inch XPS (extruded polystyrene)" and would not use brand names. The materials list from the retail partners would eliminate the guesswork for homeowners, architects, and contractors in determining which products to use in their projects.

Required Credentials
At least one member of the contractor team must have master's degree. in a field of or relating to building science and more than 10 years of experience designing, implementing, and evaluating building assemblies.

The contractor team must have previous experience creating and publishing an illustrated Builder's Guide - at least one hardcopy and one PDF version of previously created Builder's Guide must be included in RFP response.

Scope of Work

Format of Builder's Guide

The DER Builder's Guide will be distributed both as a hardcopy book as well as a downloadable PDF available on the Mass Save® participant websites. The hardcopy DER Builder's Guide would be an approximately 4X8 (perhaps 5X8) spiral-bound book. The DER Builder's Guide will be branded as a Mass Save® product.

All enclosure assemblies must detail a continuous air barrier, thermal barrier, and robust moisture management. The enclosure assemblies must meet the following thermal requirements:

- R60 roof
- R40 exterior wall and frame floors (overhangs)
- R20 foundation wall
- R10 basement slab

The Builder's Guide must describe and provide illustrations (section view) of the following enclosure assemblies, as well as how the different assemblies interconnect with each other to maintain a continuous air, vapor, and thermal barriers:

- At least 3 distinct roof assemblies, including cathedral ceiling, flat ceiling with attic, and intersections between ceiling types and walls. At least one roof assembly must show location where additional building materials (such as firerating materials) may be supported.
- At least 3 distinct wall assemblies, including treatment of window and door installation, fire separation walls, and at rim/band joist areas. At least one wall assembly must show location where additional building materials (such as firerating materials) may be supported.
- At least 3 (2 of which are from the inside) distinct below grade foundation wall assemblies, including poured concrete, concrete block or panels, and 'rubble' foundation types. Foundation assemblies shown must also list their flooding / drying tolerance; the contractor is encouraged to show assemblies that range from "bone dry" to "floods regularly". At least one foundation wall assembly must show location where additional building materials (such as firerating materials) may be supported.
- At least 3 distinct basement slab assemblies, including insulation above and below the concrete.
- At least 3 distinct insulated crawlspace ceiling or exposed frame floor (overhang) assemblies at the recommended insulation level
- At least 3 distinct attached garage wall and ceiling assemblies at the recommended insulation level, including how un-insulated garage planes intersect with insulated house planes.

All materials shown in the illustrations shall be rated for the illustrated purpose and shall have at least a 25 yr service life under expected conditions, aside from maintenance related to normal wear and tear.

Batt or blown fiberglass, mineral wool, and cellulose are considered interchangeable and do not comprise "distinct" wall assemblies.

Illustrations (section view) must be provided for all transitions. Appropriate details must be shown to connect to adjacent building components:

- All DER wall assemblies to all DER-treated roof assemblies,
- All DER wall assemblies to standard roof,
- All DER roof assemblies to standard wall,
- All DER wall assemblies to standard foundation wall,

- All DER wall assemblies to all DER foundation wall assemblies,
- All DER foundation wall assemblies to all DER slab assemblies

Sequencing illustrations for building materials installation (one illustration per step) for affected exterior wall and roof areas:

- Window, door, and skylight penetrations,
- Porch roofs and attached un-insulated frame structures
- Electrical, HVAC and plumbing penetrations,
    - Electrical: service entrance (SE) on wall, through wall, or through roof, exterior exposed wiring and meter socket mounting means, outdoor wiring box in ceiling or wall assembly, exterior low voltage wiring retrofit (to be left with homeowner)
    - HVAC and plumbing: gas or oil piping entry or exit, refrigerant lines, exterior piping mounting means, flues and intakes for combustion appliances, intakes and exhausts for ventilation, including kitchen, dryer, and radon venting, soil pipe exit, sewer system venting
- Chimney/flue penetrations for gas, liquid, or solid fuel burning devices (furnace, boiler, fireplace, woodstove, pellet stove, etc.) including air intake associated with flue

Products Recommendations:
Provide generic names of recommended products that facilitate a DER retrofit:

- Insulation, siding, roofing, weatherstripping products
- Gaskets, flashings, and sheathing tapes
- Uncommon fasteners
- Products that result in improved air-tightness, such as floating shuttle vents for dryer, back-flow preventing dampers on bathroom exhaust fan, etc. Include performance requirements that customers should use when selecting products.

Mechanical Requirements

All combustion appliances (except ranges) shown must be isolated from indoor air, and interact only with outdoor air (sealed combustion).

Ventilation Requirements

The Builder's Guide must provide guidance for both balanced and exhaust-only ventilation (manual kitchen hood and continuous bathroom fan) as well as Heat Recovery Ventilation design. The Builder's Guide shall provide guidance on how to calculate ventilation CFM requirements to meet ASHRAE 62.2.
The Builder's Guide must provide building air-tightness threshold at which exhaust-only ventilation will not provide adequate ventilation.

- All homes must include kitchen range hood directly exhausted to the outdoors.
- All homes must have a mechanical means for exhausting bathroom air to the outdoors.

DER program Verification Requirement:

For each enclosure assembly a mid-construction DER field verification point will be determined. This point will be clearly noted in the DER Builder's Guide.

Lessons learned:
Demolition considerations for energy retrofits

- What to do with different conditions found during demolition / how best to get to end result
    - Board sheathing, lathe & plaster, working around old wiring, old plumbing, etc.
    - How to separate adjoining building features: porches, overhangs, etc.
    - Lead Safe recommendations
- Lessons learned on how to strip and re-clad a building for an energy retrofit

Material change-out section, due to having fewer details

- What materials are interchangeable
- Considerations when substituting materials

Include brief section on savings and benefits per renovated element.

Contract Requirements
The Builder's Guide does not need to be original work; reuse of existing illustrations and intellectual property is allowable, and any pre-existing illustrations and intellectual property included in the Builder's Guide can be reused and reproduced by the contractor team.

One time 6-18 months after the first printing, the Mass Save® program administrators will submit any typos and errors for correction and receive an updated digital version at no additional cost.

If other energy efficiency programs would like to rebrand the DER Builder's Guide for use in their energy efficiency programs, the interested party would need to negotiate a licensing agreement with the Mass Save® Program Administrators.

The Mass Save® Program Administrators will be able to reproduce and distribute the Builder's Guide in hardcopy and/or as a PDF file as needed.

The contractor team that creates the Builder's Guide will be able to reproduce and distribute the Builder's Guide as a hardcopy and/or PDF file as needed.

Contract Timeline

- RFP responses (no longer than 10 pages) must be submitted by June 15th. Work experience and education profiles of at least three of the DER Builder Guide project leads for must be attached to the proposal.
- Draft version must be complete and submitted for review by November 1, 2012
- Final version must be complete and submitted for review by December 1, 2012

SCOPE OF WORK

Mass Save Upstream HVAC and Heat Pump Initiative

3rd Party Program Manager

This attachment provides the scope of work to be provided by the 3rd Party Program Manager for the proposed Mass Save Upstream HVAC and Heat Pump initiative.

1. Program Description

The goal of this initiative is to transform the market for HVAC and Heat Pump (HP) equipment in MA by increasing the market share and availability of high efficiency equipment. This innovative approach will accelerate the adoption of new technologies by removing or reducing the initial cost hurdle for customers at the point of sale. Providing incentives upstream will enable us the Massachusetts PAs to influence a large portion of the market through fewer communication points while impacting the greatest possible number of purchase decisions. This approach complements the traditional downstream approach in which Energy-efficiency Program Administrators (PAs) work directly with customers and installers. Massachusetts PAs successfully launched a C&I lighting program (*Bright Opportunities*) in 2011 based on the upstream model[1].

Massachusetts PAs will partner with HVAC/HP distributors, and certain manufacturers that do not deploy their product through distributors, to offer incentives to buy down the incremental cost between standard and higher efficiency HVAC/HP equipment at the wholesale level as shown in Figure 1. A third-party party Program Manager will be selected to administer the program on behalf of PAs. When launched, this program will replace the current incentives for eligible equipment in the Mass Save *Cool Choice* and *Cool Smart* programs.

The PAs expect to begin integrating certain pre-launch tasks in November and December 2012. Program will be officially launched in January 1, 2013 for the C&I segment. Residential products may be added later in 2013.

[1] Mass Save C&I Upstream Lighting, www.masssave.com/upstreamlighting

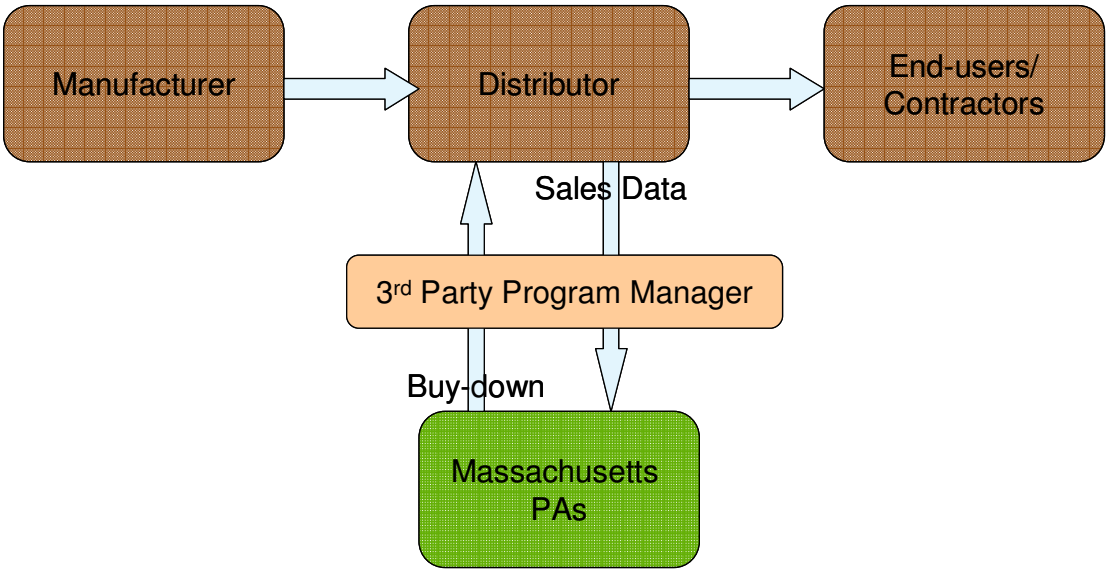

Figure 1: Upstream Program Model

2. General Program Scope

Territories: Massachusetts

Program Administrators: Cape Light Compact, National Grid, Northeast Utilities (NSTAR and Western Massachusetts Electric Company), and Unitil

3rd Party Program Manager Services: Overall management of the program which includes:

- Program launch and ongoing implementation
- Monthly invoice processing and distribution of incentives to participating distributors/manufacturers
- Collection, Verification, and Reporting of sales and incentives for eligible products
- Distributor enrollment, coordination and training
- Reviewing program progress with respect to goals and providing recommendations to improve performance, as applicable.

3. Eligible Equipment

Incentives are available for residential and commercial unitary air conditioners and heat pumps according to the size and efficiency levels found in the following table. All incentives are subject to change, additional measures may be added.

Commercial AC

CEE Tier I

Unit Size (Tons)	SEER	EER
5 (split)		
5 (packaged)	14	11.6
7.5		11.5
10		11.5
12.5		11.5
15		11.5
20		10.5

CEE Tier II

Unit Size (Tons)	SEER	EER
5 (split)	15	12.5
5 (packaged)	15	12
7.5		12
10		12
12.5		12
15		12
20		10.8

Commercial HP

CEE Tier I

Unit Size (Tons)	SEER	EER	HSPF	COP
5	14	12	8.5	
5	14	11.6	8	
7.5		11.5		3.4
10		11.5		3.4
12.5		11.5		3.2
15		11.5		3.2
20		10.5		3.2

CEE Tier II

Unit Size (Tons)	SEER	EER	HSPF	COP
5	15	12.5	9	
5	15	12	8.5	
7.5		12		3.4
10		12		3.4
12.5		12		3.2
15		12		3.2
20		10.8		3.2

Residential AC

Type	SEER	EER
Central AC	14.5	12
Central AC	15	12.5
Central AC	16	13

Residential HP

Type	SEER	EER
Cool Smart HP	14.5	12
Cool Smart HP	15	12.5
Mini-Split HP	19	12
Mini-Split HP	23	13

Energy Saving Control and Fan Motor Options (When installed with new qualifying equipment)

Dual Enthalpy Economizers

Demand Control Ventilation

ECM Motor Fans

4. 3rd Party Program Manager Responsibilities

4.1. Program Implementation

- Identify relevant manufacturers, distributors, and contractors (Note: Mass Save PAs has already discussed the proposed program model with the key manufacturers and distributors in Massachusetts).
- Develop materials to be approved by the PAs to sell the program to manufacturers, distributors, and contractors.
- Facilitate relationships with stakeholders and document agreed upon obligations by getting the relevant manufacturers, distributors, and contractors to sign Memorandum of Understanding (MOU) and contracts, as applicable.

4.2. Program Management

- Provide overall program management of the initiative including primary responsibility for all program management, processing, coordination, and necessary reporting to ensure the success of the initiative.
- Provide a single point-of-contact Program Manager to the PAs to oversee the effort and coordinate with the PAs.
- Maintain on-going communications with the PAs -- their marketing and product development, strategy, and/or vendor management representatives -- to ensure program needs are being met.
- Provide on-going feedback to the PAs regarding progress, problem areas, and possible enhancements to the initiative.
- Attend regularly scheduled meetings (as often as once per month) with the PAs (as a group, not individually).
- Design and maintain an electronic database for all program data and activity in a format approved by the PAs. The PAs will work with the selected Program Manager to define the specific data to be collected and reported, and the final database formats.
- Conduct meetings/webinars with distributors to educate and train distributors' staff on data collection, reporting, and submittal process.
- Coordinate and work with distributors, including underperforming distributors, to ensure success of the initiative.
- Seek prior approval before undertaking any significant planning or development tasks.
- Educate and train local HVAC contractors to transform the market to more efficient HVAC equipment.

4.3. Incentive Processing

- Collect and track product invoices, bills of lading, shipping invoices, and/or sales report data to verify requests for reimbursement from distributors. Sales data

collected from distributors will include at a minimum the following for all standard and high efficiency units
    - The Date of each sale
    - The Invoice Number of each sale
    - The P.O. Number or job name
    - The Ship-To address, if applicable
    - The Purchaser (contractor)
    - The End-use customer name and contact information including installation and billing address
    - Quantity, make, model, efficiency rating etc. of qualifying equipment sold
- Allocate sales data to each PA based on end-user installation address. This installation address will determine the PA that the savings will be allocated to, as well as the incentive amounts owed by each PA.
- Provide processing of payments to distributors for eligible products sold based on sales data. Payments to distributors will be made on a monthly basis within 30 days of receipt of sales data. The Program Manager shall remit payments to distributors and then submit invoices to the appropriate PA(s) for reimbursement as detailed below.
- Provide monthly billing to each PA within 10 days of the close of the month. Each PA will be billed individually based on their savings allocation, and each bill will detail both joint and any PA-specific charges along with the claimed savings and sales data.
- Store and maintain all supporting documents required for reimbursement.
- Resolve data and report discrepancies with Participating Distributors.

4.4. Incentive Reporting

- The Program Manager will develop and maintain a web-based tracking system on a secure site which will provide dashboard reporting to each PA. The collected data shall uploaded into the web-based tracking system. This data shall also be exportable to an Excel or a database format acceptable to each PA. The reporting system will allow easy manipulation of the data and have a user-friendly printing capability. The system will be able to track and report all key information and metrics required to track the overall success of the initiative. This includes, but is not limited to:
    - Overall initiative summary, to date and by month, by PA and in total
    - Product group summary – for example, Tier 1 or Tier 2, Heat pump or AC, residential or commercial – by PA and in total
        - Residential equipment must match 08-50 measure lines
    - Distributor sales summary, by PA
    - Distributor sales summary, aggregated across all PA
    - Invoiced vs. sales summary – current and year-to-date product quantities and dollar amounts – by Distributor and in total
    - Current and year-to-date product quantities and incentive amounts – by Distributor and in total

- Provide monthly reports to each PA in a format acceptable to each PA that provides information necessary for each PA to claim program energy-savings.
- Report on the number of unprocessed forms and on the average and maximum number of days before a distributor is reimbursed after submittal of the necessary incentive documentation.
- Provide reports from the database to each PA on a monthly basis. The reports shall contain both PA specific and aggregate reporting. The Supplier will electronically transfer data in a format specified by each PA, as required for each PA to claim and report program savings. In addition, the Program Manager shall have the ability to produce ad-hoc reports upon request of a PA

5. Desired Qualifications

Ideal 3rd party Program Manager candidates will have:

- Proven expertise in managing similar Energy Efficiency incentive programs that work at the manufacturer and distributor level
- Electronic database with capabilities to track equipment data (types, model number, efficiency ratings, etc.) installation data and associated savings
- IT systems to process incentives, invoice PAs and distribute incentives to participating distributors in a timely manner
- Established relationships with equipment manufacturers and distributors including those active in the MA market. [Local presence and field support is preferred.]
- Familiarity with existing HVAC and HP equipment including manufacturers, types, models, efficiency ratings, and industry nomenclature
- Commercial and residential HVAC expertise, especially pertaining to air conditioners and heat pumps
- Prior experience in effective communication and coordination with manufacturers, distributors, and utilities/PAs

6. Program Administrator Responsibilities

Each of the PAs will contract individually with the selected Program Manager in accordance with a cost-allocation schedule that will be established with the Program Manager prior to the start of work. Mass Save, collectively funded and operated by the PAs, will coordinate and conduct advertising in support of this initiative. A common marketing theme will be developed that will form the strategic basis for the overall campaign. Note that the actual implementation of specific elements of the marketing campaign may vary among PAs.

Request for Proposal

Massachusetts Statewide Education, Marketing, and Outreach Working Coalition for Mass Save

Scope of Work

July 1, 2012

Introduction

The Statewide Education, Outreach, and Marketing Working Group (Sponsors), in anticipation of the approval of the Massachusetts three-year statewide energy efficiency plan on or before January 31, 2013, requests proposals to provide public education, outreach, marketing, and public relations services in support of the Massachusetts utilities and energy efficiency providers' three-year energy efficiency plan (the Plan, [see Attachment I for the 2010-2012 Plan text]).

Background

Mass Save is a joint effort of energy efficiency providers in Massachusetts who collectively implement a three year energy efficiency plan in Massachusetts. The Sponsors are Berkshire Gas, Cape Light Compact, Columbia Gas of Massachusetts, National Grid USA, NSTAR, New England Gas, Unitil and Western Massachusetts Electric Company. The Sponsors, also known as Program Administrators, seek to develop and implement a range of marketing activities that include public education, outreach, and public relations. The objective is to:

- Increase consumer awareness of energy efficiency and its benefits ("Consumers" include residential, low-income, commercial, industrial and municipal customer sectors as well as trade/industry professionals).
- Encourage and facilitate consumers' subsequent participation in energy efficiency programs.
- Foster behavioral changes that lead to energy savings, the reduction of greenhouse gas emissions, and monetary savings.
- Apply evaluation results from the Statewide Evaluation, Measurement and Verification (EM&V) framework to better understand the unique drivers, demographics, economic parameters, and behavioral differences among residential customers and among various key subsectors of non-residential customers, then design and deliver messaging accordingly. Please see http://www.ma-eeac.org/docs/090908-EMVresolution.pdf for the Energy Efficiency Advisory Council's Resolution on EM&V.

An effective statewide education and marketing plan is central to the statewide three-year plan, and will help transform markets for energy efficiency. The table below lays out the market size for this campaign:

Fuel Type	Number of Residential Consumers	Number of Commercial, Industrial, and Municipal Consumers
Electric	2,323,128	341,385
Gas	1,419,291	139,532

Program Benefits

The Sponsors expect this public energy efficiency campaign to:

- Use messaging that clearly describes the benefits and importance of energy efficiency for both residential and the various non-residential customer segments.
- Reach the maximum number of consumers possible.
- Market to differentiated consumer types and communities throughout the state includes communities where English is not the primary language.
- Utilize multiple media (e.g. Internet, website, social media, bill inserts, television, radio, billboards, public transit, trade, business, print, newspaper, SEO, Google and professional associations), as appropriate in reaching the targeted audiences.
- Leverage statewide and program marketing strategies together to achieve deeper and broader savings.
- Carry the value proposition and look and feel from the statewide brand of Mass Save® as well as Sponsor brands as the architects.
- Recognize that commercial and industrial customers respond differently to various channels used in traditional marketing. For instance C&I programs rely heavily on personal business contacts through Sponsor key account managers for their large managed accounts and use other cross channels for their mid- non-managed commercial accounts. These would include trade allies and other design professionals engaged in promoting better building design and construction practices.

Program Strategy

The strategies and messages developed for statewide energy efficiency education, outreach and marketing will augment the efforts thus far across the Commonwealth, including ongoing program marketing. Program marketing will be coordinated with the statewide efforts, and the statewide efforts will complement program marketing wherever possible, to leverage program and individual Sponsors' efforts.

The education, outreach, and marketing efforts should move consumers from awareness to action.

Program Objectives

To realize the potential for public education, outreach, and marketing, the Sponsors have identified the following steps in the process:

- Identify consumers' values related to energy efficiency, what will motivate them to take action, and whether there are any barriers to taking action. These values are different in the two markets of residential and commercial customers. Develop and test tactics to bridge the gap between awareness and action.
- Make public education a priority and provide information that clearly outlines the benefits of energy efficiency and the value of going beyond simple actions to deeper savings.
- Encourage behavioral changes that will conserve energy, manage costs, and reduce greenhouse gas emissions.
- Broaden awareness of available resources and actions.
- Maximize the number of individuals, organizations, and businesses that take action to reduce energy use.
- Support the Sponsors with targeted initiatives at the statewide level.

Scope of Work

The Sponsors' overarching priority is to create powerful, engaging, and motivating strategies that will increase Massachusetts' consumer and business awareness of the benefits of energy efficiency and will also increase their subsequent actions to reduce usage, primarily through the Sponsors' available energy efficiency programs. These efforts should build on the Mass Save® name and establish that name and the Sponsors as the recognized, reliable sources for all things about energy efficiency in Massachusetts. The strategies will take into account the unique motivational differences between residential and the various subsets of non-residential customers. While these actions may include commonly recognized multi-channel campaigns for residential customers, it is expected that the bidders will identify the most effective touch points for residential and non-residential customer targets, sectors and motivations. In addition it is necessary that the different tactics used for these sectors will be measurable so that feedback will inform changes to deployment of the marketing and communication campaigns. The bidders' statewide marketing plan should be based on an approximate budget of $3.5 million. Task 3 (website support and maintenance) may be bid individually or as part of a team approach that includes all tasks. Sponsors anticipate this to be a 2 year contract with an option to renew for an additional year. Proven ability to deliver and monitor digital and social media campaigns should be included.

Consultant Responsibilities:

The Sponsors request proposals from firms that can plan and execute an integrated education, outreach and marketing strategy. The successful bidder will develop an overarching program to submit to the Sponsors for approval prior to implementation. Then with input from the Sponsors, the successful bidder and any sub-contractors will be expected to provide at least the following services:

Task 1 Statewide Brand Building and Messaging

- Creation of collateral and support materials, including creative concepts (e.g., themes, slogans, design, layout, copy writing, graphics) for attractive, plain language publications such as brochures, tip strips, posters and other printed materials.

- Development and execution of integrated media strategy, including a mass media (television, radio, print, "out of home" [e.g. billboards, bus cards, subway platform posters], web, social media, organic and paid online search) communications plan, including creative development, production and placement and results measurement.

- Creation, maintenance, storage and transport of exhibit and display materials (including maintenance, storage and transport), and educational materials branded with campaign messages. The Sponsors already have a portable tent, tablecloths, and banner stands with the Mass Save® look and feel. Please see Attachment II for the Brand Guidelines and Color Palette.

- Coordinate with Statewide Evaluation Efforts including tracking, monitoring, and evaluation of subsequent initiatives to determine campaign effectiveness and ROI of specific tactics and strategies. The successful bidder will track market response including website statistics, ad responses, reach and frequency of media, or other forms of data that can be monitored and used to positively impact the implementation the campaign.

- All elements of the campaign must consider the following:
  - Materials must be appropriate for widely diverse consumer groups in the Commonwealth as well as specific targeted groups.
  - The influence and importance of trade allies on program success.
  - Language must be simple, non-technical, and accessible to laypersons (while understanding motivational distinctions between diverse customer classes). Depending on campaign tactics materials may need to be accessible for specialized audiences (e.g., elderly, non-English speaking, etc.).

Task 2 Public Relations

- Development and execution of public relations plan designed to extend the reach of priority messages.

- Outreach strategy may include events and presentations (e.g., fairs and home shows, business or trade conferences, etc.), participation in special events, sponsorships/advertisements at arenas and sporting venues (where feasible), community events, and newspaper supplements.

Task 3 Website Support and Maintenance

The current framework for the Mass Save website is Sitecore CMS system based. Currently, Sponsors are able to update day-to-day, minor content in the site. It is anticipated this will continue, however, there may be a need for the successful bidder to update the website for the Sponsors. Please see Attachment III for the current requirements for hosting and maintenance.

The core goals for the website are:

- Enhanced user experience – Make finding information easy, logical, and fluid. Present information in a consistent and productive manner and automate wherever possible.

- Increased Participation – Improve the program participation rate by quickly informing customers which programs they qualify for and streamlining the application and approval process.
- Reduced Costs – Ensure CMS and other common elements are automated where possible and easily accessible.
- Ease of Maintenance – Reduce inaccuracies, outdated information and labor by creating a standard and centralized workflow for updating the energy efficiency program content.

The successful bidder will meet with the Working Group to identify future needs for the website to enhance the usability of the website to make it easier for customers to get information and participate in Mass Save's energy efficiency programs.

Bidders will be required to host and maintain the website as well as provide necessary training and support for Sponsors. If bidder opts to use a CMS system other than Sitecore, the new system and reason for change must be provided.

Task 4 Other Contractor Responsibilities

In addition to completing the tasks above, the selected marketing contractor will need to accomplish the following:

- From campaign tactics and initiatives performed, perform appropriate consumer facilitation to sponsor partner programs and/or statewide website (i.e., phone, Web, etc.).

- Maintain regular communications with the Sponsors and their contractors to ensure that statewide and program needs are being met and to identify additional marketing, website and public relations opportunities.

- Seek collective sponsor approval before undertaking any significant planning, development or implementation tasks.

- Attend monthly Statewide Working Group meetings as requested by the Sponsors.

- Attend selected conferences as directed by Sponsors.

- Assist sponsors in identifying potential partner organizations and opportunities for coordinated outreach and education activities.

- Provide monthly billing to each Sponsor within 10 days of the close of the month. Each Sponsor will be billed individually, and each bill will detail both joint and any sponsor specific charges as well as applicable reporting. The Sponsors will establish a billing allocation system based on customer counts. Invoices should account for time and materials previously incurred with a collective budget recap each month.

- As directed by the Sponsors, review campaigns and recommend changes for marketing efforts for 2013, 2014 and, if renewed, 2015.

- Meeting/conference call summaries will be issued within 24 hours.

Evaluations Process

Successful proposals should include the following elements:

1. A one-year (12 months for 2013) draft education, outreach and marketing plan and schedule as well as time required for execution of the recommended proposal. This plan shall include the full mix of media types as described above, as well as others that the respondent may suggest, for the different consumer segments - residential, low-income, and the various commercial/industrial segments.
2. Completed bid form detailing estimated costs, by key program tasks, on a time and material basis, indicating hourly rates for personnel, travel, total hours and total cost for completing the project.
3. Description of capabilities and results achieved in marketing and website support (i.e., collateral, advertising, website, public relations, events, etc.) including examples of prior work.
4. Experience marketing energy efficiency programs, if any.
5. A description of the personnel who would be assigned to the project and their specific project responsibilities including:
    i. A project staff organization chart
    ii. Statement of qualifications of the bidding firm and team members
    iii. Statement of qualifications of any proposed sub-contractors and their assigned project personnel. This should include:
        1. Media buying services
        2. Website
        3. Ads
        4. Collateral
        5. Events, if applicable
        6. PR
6. Three references specific to the proposal submitted.
7. Explanation of data security measures employed by the bidder regarding confidential consumer information that may be shared with firm(consumer name and one of the following: social security number or financial account number or utility account number) and confirmation that security measures comply with applicable federal, state laws covering protection of Personal Information of residents of the applicable state. (In Massachusetts the applicable Regulation is 201 CMR 17.00 - STANDARDS FOR THE PROTECTION OF PERSONAL INFORMATION OF RESIDENTS OF THE COMMONWEALTH.
8. Bidders should be able to work collaboratively with multiple sponsors with different territories, however, efforts should be taken to provide a cohesive statewide marketing plan.

Proposals are limited to 15 pages of text describing the bidder's approach and draft plan.

Selection of the successful proposal will be made by the Sponsors based upon the bidder's:

1. Responsiveness to work scope and program needs
2. Proven ability to meet schedules
3. Cost effectiveness
4. Comprehensiveness
5. Relevant experience
6. Oral Presentation, if requested

After review, Sponsors may invite selected bidders to present examples of the firm's work that demonstrate their capabilities as well as to provide more details on their plans and budget for the campaign. This meeting will be scheduled, if needed, following the review of proposals received in response to this RFP. Following the proposal review and any requested presentations, the Sponsors will select a company to provide these services. The successful firm will then be required to develop a detailed scope of work in concert with Sponsors. The detailed scope of work will address the development and the implementation of the education, outreach and marketing plan and will reflect the expected results. This scope of work will be included in the contract with the selected firm.

The Sponsors reserve the right to refuse any proposal or to negotiate the specifics of any submitted proposal.

ATTACHMENT I

Excerpt from 2010 – 2012 Massachusetts Joint Statewide Three-Year Energy Efficiency Plan

G. Special Public Education and Action Activities

1. *Introduction*

In order to achieve the aggressive goals set forth in this Plan, the Program Administrators will undertake a comprehensive energy efficiency public education and awareness outreach campaign. The core goals of the Program Administrators in any public education and promotion campaign include: reaching the maximum level of residential and business customers possible; providing messages that are not overly technical and that clearly describe the benefits of energy efficiency; exploring targeted marketing to unique or specific communities throughout the state (including communities where English is not the primary language); utilizing diverse media (*e.g.*, internet, bill inserts, television, radio, billboards, public transit) to disseminate consistent and clear messages; and ensuring that the various strategies work together to ultimately achieve deeper and broader savings. The Program Administrators are aware that, in addition to their efforts, the Commonwealth seeks to promote energy efficiency and the Program Administrators will look to coordinate activities with applicable governmental initiatives, such as the efforts contemplated under Section 108 of the Green Communities Act, which provides for a collaborative pilot effort by the DOER and the University of Massachusetts at Boston to establish an educational outreach program, that includes programs to be provided at community colleges and community centers. The Program Administrators will look to the DOER for further guidance with respect to this pilot effort. The Program Administrators will also continue to work with local schools, including technical vocational high schools and community colleges, to support comprehensive standards-based education in order to promote a more energy-conscious and educated society. These efforts are discussed in more detail below.

2. *Updated Statewide Education and Outreach Efforts*

During the summer of 2009, the Program Administrators commenced collaborative efforts with the DOER to address public education and participation-oriented efforts in more detail, with a particular focus on statewide efforts. The overall purpose of energy efficiency education, community outreach, and marketing efforts will be to increase residential and business customer awareness and encourage customers' subsequent participation in energy efficiency programs, while fostering behavioral changes that lead to energy savings, the reduction of greenhouse gas emissions, and increased customer savings. A successful and effective statewide education and marketing plan is fundamental for the Statewide three-year Plan, and will play an important role in achieving the goal of transforming markets for energy efficiency. In addition to the current program level education and marketing efforts, the Program Administrators will undertake the development of a comprehensive statewide energy efficiency campaign in order to achieve the savings goals proposed in this updated Plan. The Program Administrators will develop strategies to deliver this campaign to targeted

customer profiles. While much of the educational focus has been on residential markets, the Program Administrators will also consider specific strategies targeting the business sector. Ultimately, the educational and marketing effort should move residential and business customers through a process of awareness, attitude change, and finally action.
In order to realize their public education, community outreach, and marketing potential, the Program Administrators have identified the following goals:

- Prioritizing public education.

- Providing information that clearly outlines the benefits of energy efficiency and a path to a Zero Net Energy future.

- Broadening awareness of available resources and actions to all potential audiences, including residential and business customers.

- Identifying and understanding the barriers to action, and developing potential motivators to bridge the gap between awareness and action.

- Communicating with the general public and with targeted audiences in the most effective ways possible to reach those audiences.

- Maximizing the number of individuals, organizations, and businesses that take action to reduce their energy consumption.

- Educating customers on the benefits of, and ways to achieve, deeper savings through deep energy retrofits.

- Educating service providers and equipment suppliers on the benefits of, and ways to deliver energy efficient products and services to achieve savings across their broader customer base.

- Encouraging behavioral change to conserve energy, save money, and reduce greenhouse gas emissions.

The Program Administrators will expand and develop outreach strategies while creating seamless customer experiences that offer integrated portfolios of energy efficiency information and program options that are clear, relevant to the customer, and available to all Massachusetts residents, businesses, and other organizations. Some of the expanded statewide energy efficiency efforts currently underway that will assist in implementing this education and marketing plan include the following:

i. Education & Training
The Program Administrators continue to participate in existing and burgeoning efforts to create a standardized energy curriculum where one does not already exist. Some Program Administrators currently offer curriculum and educational information and guidance to schools; these efforts will be expanded to Program Administrators through collaboration with

the DOER, Massachusetts Department of Education, the University of Massachusetts, and with local community colleges to create and disseminate additional educational curriculum. The Program Administrators are considering developing a standard introduction to energy and energy efficiency that will be common to all education and training efforts. Further, the Program Administrators will continue to support ongoing efforts to reach targeted audiences (*e.g.*, teachers, schools, contractors, architects, realtors, building inspectors).

The Program Administrators have learned over the years that trade ally relationships, events, and training sessions prove to be a critical and effective means of promoting energy efficiency. Thus, the Program Administrators will expand the promotion of programs through various PA-sponsored training events, trade shows, and trade ally events in conjunction with large-scale, statewide GasNetworks training seminars, which to date have proven very successful. For example, over 360 HVAC professionals attended the September 24, 2009 conference in Randolph, which featured a myriad of expert trainers and speakers who explored subjects such as high efficiency natural gas heating equipment and installation practices, hydronic heating, on demand water heating, and condensing and modulating boilers, and which also included 25 equipment manufacturers and suppliers who displayed new products and technology, and a trade show. To date, GasNetworks has provided expert training to over 7,300 HVAC contractors. The Program Administrators recently established an education and training center in Fitchburg. In this "hands-on" classroom environment, contractors experienced in energy efficiency installations are trained in the proper techniques of air sealing and insulation installation in order to ensure consistency across service providers. The Program Administrators have plans to open a second center in Springfield. In addition, the MassSAVE team is currently creating a comprehensive education package designed as a tool to inform all residents about how to contemplate energy savings in their homes over the long-term, and to direct them on a path of energy efficiency that could lead to Zero Net Energy.

Moreover, the Program Administrators are joining with the Massachusetts Energy Efficiency Partnership ("MAEEP") to present US DOE-sponsored energy efficiency workshops on various technologies. The Program Administrators have also joined with the Northeast Energy Efficiency Council ("NEEC") Building Operator Certification ("BOC") regional training program that focuses on how O&M procedures and processes impact energy costs. The Program Administrators also offer Advanced Building™ ("AB") seminars as a suite of technical and training resources to improve the way buildings are designed, built and used. Using whole building patterns, design process tools, and education, this AB effort provides designers with the resources to incorporate integrated design strategies on their next project to reduce energy usage and improve indoor environmental quality. In addition, the Program Administrators will work with the Massachusetts Clean Energy Center ("CEC"), a quasi-public agency that serves as a clearinghouse and support center for the clean energy sector and focuses in part on workforce development and training.

ii. Energy Efficiency "Brands"

Building upon successful regional and statewide energy efficiency brands, the Program Administrators are currently working towards developing a complementary, statewide energy efficiency brand (or brands) with the expectation that once adopted, it will have created a

clear, consistent, and recognizable message about the individual and social value of energy efficiency. This "branding" will serve as the foundation for all residential and business customer information on energy efficiency products and incentive programs, and will encourage customers to strive for deeper savings. In addition, as the electric and gas programs become more integrated and "fuel blind," joint branding will allow the Program Administrators to further pool resources and create targeted educational and marketing collateral materials that will provide residential and business customers with an increased understanding of the full array of energy efficiency options available in Massachusetts.

iii. Mass Media

Newspaper articles, radio, and television news reports highlighting energy efficiency programs have consistently increased activity in the relevant spotlighted program. Consequently, the Program Administrators have utilized limited mass media advertising to educate and promote their energy efficiency program offerings. As the branding efforts described above are finalized, a larger scale, more frequent, mass media advertising plan will be implemented to create the desired effect of increased and broader customer awareness for available programs, while striving to encourage deeper customer savings. Moreover, the ability to promote a common, integrated website to a mass market will allow for further economies of scale and, in turn, more frequent, cost-effective mass media advertising in order to increase customer awareness.

iv. Community Based Outreach/Social Education and Marketing

The Program Administrators see an important opportunity to expand and develop relationships with community organizations that have existing influential relationships within cities, towns, regions, and demographic and special interest groups. Some of these organizations have already promoted efficiency to their members, while others have strong networks but have not yet focused on energy issues. The Program Administrators will seek to develop enhanced strategies to reach out to non-English speaking customers, low-income customers, and groups that have historically low participation, and explore increased efforts with representative community organizations. The potential to leverage community-based organizations to educate and promote energy efficiency actions is significant and will be developed in the "community mobilization initiatives" being launched as pilot programs. The Program Administrators can learn from, and build upon, successful programs such as the Marshfield Energy Challenge (NSTAR), the MAPS Pilot which included outreach to the Portuguese-speaking community (NSTAR), and Energy Smack Down (National Grid/NSTAR), and will take note of positive developments experienced with the Western Mass Saves (WMECO) launch in August. The lessons learned from these community outreach programs will be the catalyst to the creation of future similar educational outreach efforts throughout the Commonwealth.

The Program Administrators will also explore a new pilot collaboration with community-based organizations that have long-standing relationships with homeowners, tenants and small businesses in economically marginalized communities, to assess the feasibility of a "community mobilization outreach model" that implements a neighborhood approach to energy efficiency service. This model has the potential to offer effective and appropriate

energy education to underserved communities, including limited English speakers and economically marginalized groups.
The Program Administrators will also explore how "word of mouth" contact can be tapped to heighten motivation towards energy efficiency action. The Program Administrators will explore offering "incentives" for referrals that lead to other customers participating in energy efficiency programs.

v. Internet—"Integrated Website"
The Program Administrators are engaged in developing a single point of entry for all residential and business audiences through a new integrated website. The Internet offers a powerful, cost-effective platform to provide energy efficiency information, promote programs, and inspire action. The integrated website will provide a point of access to a multitude of residential and commercial energy efficiency programs in a user-friendly environment. The statewide "brands" will be prominently featured throughout the website. The increase in program participation levels over time indicates that the traditional education, outreach, and marketing efforts (such as direct mail, ethnic outreach, radio and print media, bill inserts, trade ally relationships, and training events, sponsorships, educational seminars, and program brochures) have been successful to a significant degree. In order to create even broader energy efficiency public awareness, however, and establish even deeper participation in the programs offered, additional methods of market defining techniques and barrier identification should be implemented, and the Program Administrators believe that an integrated website provides a distinct opportunity to reach a broader audience, increase energy efficiency awareness, and encourage deeper savings.

vi. Behavioral Research
Program Administrators understand that identifying the motivational factors that cause residential and business customers to take action and participate in programs is important in developing energy efficiency programs capable of achieving long-term sustainable success. Equally important is the ability to identify those barriers that could potentially block a motivated customer from participating in energy efficiency programs. The Program Administrators will research successful motivational actions that have worked in other states, determining which motivational strategies have succeeded, and which might be best suited for application with the Plan. Additionally, the Program Administrators will sponsor primary market research in Massachusetts in order to answer critical questions regarding behavior related to energy efficiency. The Program Administrators will solicit input, through the Council and its Consultants, on existing barriers involving non-English speaking groups and members of communities in the state which have historically low rates of participation in energy efficiency programs. The Program Administrators will then incorporate the successful methods determined by the research in Massachusetts and other states into their education, outreach, and marketing programs.

One successful organization upon whose work the Program Administrators would like to build is Positive Energy, a corporation that is committed to persuading customers to save energy through a combination of technology, analytic direct marketing, and behavioral science. Several Program Administrators have engaged the services of Positive Energy to "rate" customers' energy usage in comparison to their neighbors. This "normative

information" approach has been successful in California and will be considered for implementation in Massachusetts. In addition, focus groups, such as the recent series of meetings organized as part of the MassSAVE RCS effort, will be expanded to include all market segments, including residential, C&I, and low-income, to garner as much customer information as possible to further identify barriers to participation and to assist the Program Administrators in formulating outreach efforts.

vii. Segmentation Research

Recently, through the use of the Warren Group Report, the Program Administrators have initiated an effort to better understand the demographics in each service territory. The Warren Group Report identifies the population of single homes, multi-family properties, and low-income residences that exist in each of the service areas. Other internal and external resources to identify the characteristics and demographics of customer populations—such as information that can be provided by local community groups—will be examined to assist in further identifying consumption, motivations, and barriers to positive action. Such reports and information will be used to identify specific customer profiles and will facilitate targeted outreach to these groups.

viii. Message Development

In creating energy efficiency messages, both high level and targeted, the ultimate goal is to have customers understand the many benefits of energy efficiency and then take action. Further, to engage customers who have already implemented energy efficiency measures, the message will include and highlight the additional benefits and importance of going "deeper" by implementing additional energy efficiency measures, such as deep retrofits. Traditional messages focusing on self interest ("*save money*"), the environment ("*help the planet*"), and social responsibility ("*do your part*") used in previous education and marketing campaigns have been effective to an important degree, but new messages need to be developed to help foster broader and deeper participation. In addition to the overall message, the Program Administrators will also develop messaging at the program level and at the sector level, in order to engage varied customers and other important market actors (contractors, equipment suppliers, opinion leaders) with differing motivations. The Program Administrators plan to conduct qualitative and quantitative research to identify what customers believe to be conservation and energy efficiency behaviors, and to determine what motivates customers to practice more energy efficient behavior. This research will lead to the creation of a "call to action" for the residents and businesses of Massachusetts.

ix. Maintenance of Complementary Individual Efforts

While working diligently on the statewide public education efforts, the Program Administrators will also continue to maintain customer awareness, satisfaction, and participation goals. As the Program Administrators have noted in Section II.A.7.iii, consistency is a high priority and the Program Administrators will also continue outreach efforts utilizing customer representatives and company-specific efforts that complement and are consistent with statewide efforts.

x. Next Steps and Conclusion

The Program Administrators will be optimizing the budget for the statewide education action plan, and will continue to collaborate with the DOER, the Council, and its Consultants, and other interested parties as the budget is developed. The Program Administrators will explore how the rules governing cost-effectiveness could present challenges to this effort, despite the importance of the education and outreach campaign to the saving goals in the Plan, and are confident that these issues can be resolved and that overall program cost-effectiveness, even including increased public education and marketing costs, will remain robust. Additionally, the Program Administrators will be developing and issuing RFPs for partners in some or all of the following areas: market research; segmentation research; message development; community-based education; and integrated education/behavior change campaigns. As noted in the following "Evaluation and Monitoring Section," applicable RFPs (e.g. behavioral research) will be addressed under the Special Cross-Sector Studies area.

By way of example, the Program Administrators are reviewing including outreach efforts in the "hard to measure" category. *See* D.P.U. 08-50-A, at 24-31; *see also* G.L.c.25, §21(b)(2)(iv)(I). The DOER has noted in its memorandum titled Guidance on the Impact of 08-50 on Public Education Efforts for Energy Efficiency, dated June 30, 2009, that there is clear regulatory support to develop and implement public education programs on energy efficiency. The DOER specifically stated that market research to assess, *inter alia*, customer attitudes is allowed and strongly encouraged within the scope of education efforts.

The ultimate goal of these educational, community outreach, and marketing efforts is to develop a broad system of communication with Massachusetts citizens and businesses and deliver comprehensive energy efficiency programs. Through an array of effective messages and valuable information resources, the Program Administrators will engage with a large portion of the population to assist in delivering value to residential and business customers and achieving the aggressive energy efficiency goals set forth in this Plan.

Appliance Initiative
Refrigerator/Freezer Recycling Program
Massachusetts, Rhode Island, and New York

REQUEST FOR PROPOSAL
Information and Instructions

August 17, 2012

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SPONSOR LIST
The list of Sponsors for this RFP includes:

- Cape Light Compact
- National Grid
- NSTAR Electric
- Western Massachusetts Electric
- Unitil/Fitchburg Gas & Electric

Objective

Sponsors (as listed above) request proposals for Secondary Refrigerator/Freezer Early Retirement and Recycling Services (*Please note that Primary Refrigerators are eligible in Rhode Island only). Sponsors seek to develop a cross-program, potentially multi-state campaign for National Grid jurisdictions, that effectively removes and responsibly recycles inefficient, working secondary Refrigerator/Freezers units from their respective residential customer's homes. The objective, through the removal of non-essential energy-intensive appliances, is to reduce energy use and simultaneously lessen power demand. All customers within the respective service territories of the various Sponsors will be eligible to participate in this program. The refrigerators/freezers that are collected as part of this promotion must be recycled in accordance to specified requirements (with any ozone-depleting substances being captured and destroyed). Promotional incentives, made available through Sponsor resources, will be provided to participating customers. While this may involve establishing a new collection/recycling infrastructure, bidders may also incorporate this new promotion into an existing collection system which they are already a part of. Targeted goals for total units recycled are included in the attached below.

Proposed Scope of Work

Sponsors seek a contractor who will be responsible for the "turn key" operation of a Secondary Refrigerator/freezer Recycling Program which will include infrastructure development, physical collection, reporting/evaluation, quality assurance, Rebate processing, etc. Individual tasks are laid out below.

Task 1: Program Setup and Customer Service

The Contractor will provide the facilities, equipment, and personnel to operate the Program which includes interacting directly with the Sponsor customers. These services will include:

- Establish a toll-free telephone number and **website** for customer enrollment, appointment scheduling, and questions.
- Provide trained, knowledgeable customer service staff for assisting customers with questions about the Program, qualifying customers and facilitating participation. Call center must be minimally open from 8 AM to 5 PM Monday thru Saturday with at one week night until 8:00 PM.
- Verify customer eligibility verifying that caller is a Sponsor customer and qualifying their refrigerator or freezer.

- Schedule in-home appliance removal appointments. Offer choices of service dates, including Saturday, and morning/afternoon collection, handle reschedule and cancellation requests. Provide 24 hour cancellation policy by the contractor.
- Maintain a database to store and track interactions with the customers as well as detailed information about each refrigerator/freezer unit collected.
- Provide customers with information about preparing their appliance for removal (appliance must be empty, plugged in and working at the time of pickup).
- Provide customers with a day-ahead confirmation call.
- Provide professional crews who know they are representing the Sponsors. Presenting valid picture id required during collection.
- Produce written confirmation of appliance collection.
- Ensure fulfillment of incentive payments within four weeks after collection of the qualifying appliance
- Providing quality control of customer visits by conducting surveys of serviced customers to ensure customer satisfaction, with monthly reporting of the QC activities.

*Marketing of this program will be down by a third party marketing contractor. Bidders will be asked to work cooperatively with the Sponsors and their marketing contractors in an effort to incorporate the overarching program campaigns into this program.
Cooperative marketing efforts may include attending PR event(s), website content, promotions, newspaper and TV advertising, truck signs and point-of-sale materials at appliance retailers.

Task 2: Collect and Transport Refrigerators and Freezers
The Contractor will provide the means to collect the refrigerators and/or freezers from the customer locations and transport them to the recycling location as needed. Components of this service will include:

- Hire, screen and train drivers and refrigerator collection staff (all drivers and collection staff require thorough background checks).
- Provide up-to-date and well maintained collection vehicles, tools, and equipment necessary for safe and efficient removal.
- Deface/disable the appliance before transporting.
- Safely remove units from within the home.
- Enter unit into database reporting system.
- Record unit collection and secure customer acknowledgement of collection and disabling of the appliance.
- Transport units to a licensed processing and recycling facility.

Task 3: Recycle Refrigerators and Freezers
The Contractor will provide the means to completely, safely, and legally recycle all refrigerator components. The Sponsors are seeking to have retired refrigerators and freezers recycled such that materials are reclaimed and reused to the greatest degree possible and amounts of materials sent to landfills or incinerated are limited to the greatest extent. All greenhouse gases and ozone depleting substances should be captured and destroyed and other hazardous waste handled responsibly.

Through this program, the Sponsors are interested in qualifying as a partner in the Environmental Protection Agency's Responsible Appliance Disposal (RAD) program.

The recycling activities must include:

- Ensure the recycling facility is in compliance with all federal, state and local hazardous-waste management and recycling regulations, including the federal Clean Air Act and Heath and Safety Code (HSC).
- Recover, reclaim, and/or destroy all chlorofluorocarbon (CFC), hydro chlorofluorocarbon (HFC-134a), and non-CFC refrigerants in compliance with all applicable hazardous-waste regulations. Facilities with independent certification of 95% (CFC/HFC) capture are preferred.
- Recover and destroy all CFC-11 and HCFC 141b blowing agents in the polyurethane foam insulation of the refrigerators and freezers in a manner that complies with all applicable hazardous-waste regulations. Facilities with independent certification of 95% CFC/HCFC capture are preferred.

- Remove, label, and store, in compliance with all applicable regulations, all materials requiring special handling, such as capacitors containing polychlorinated biphenyls (PCBs), mercury-containing switches, and used oils prior to shipment to licensed facilities for disposal or recycling.
- Recycle all glass, metals, plastics and foam (free of blowing agents).
- Recycling processes that meet the requirements for the EPA's RAD program are preferred.
    - Recycling Processes and Facilities may be subject to Environmental audit by Sponsor's internal Environmental department or third party supplier.

Task 4: Program Reporting

The Contractor is expected to keep the Sponsors well informed of the Program's progress. This communication is expected to be both informal (i.e., phone calls and e-mails), and through formal reporting.

a. Database and automated reporting systems - The Contractor must maintain a program reporting database that tracks all aspects of the Program from scheduling pick-ups through the recycling process, including detailed tracking of all materials recovered from the process. Key metrics include the number of units recycled, the amount of budget spent/remaining and energy savings, compared to targets.

b. Submit monthly invoices to each Sponsor (within 15 days of months end) documenting services provided, including:
    - Customer name and address
    - Number of appliances collected or rejected, by zip code
    - Reasons for rejection of appliance
    - Number of appliances recycled
    - Model/style (single-door, top freezers, side-by-side, and bottom freezer refrigerators, upright and chest freezers), defrost type, presence of icemaker, capacity (in cubic feet), estimated vintage,

amperage/BTU's, and location in the home from which it was removed
- Incentive payments made to Program participants

c. Submit monthly reports to each Sponsor (within 15 days of months end) summarizing Program activities and results, including data from invoices and the following:
- Number of units collected and/or rejected and recycled
- Status of Program compared with projections
- Financial summary
- Unit information (Refrigerator or standalone freezer, location, primary or secondary, age, size, defrost type, etc.)
- Estimated energy savings
- Estimated environmental benefits of the Program (estimated pounds of CFCs/HCFCs/HFCs, PCBs, mercury, oil, and metals removed for disposal or recycling).
- Summary of customer complaints

d. Annual Reports

e. Attend bi-monthly Sponsor meetings either in person or on the phone, to give overall performance updates, when necessary.

- Provide an overall program report for the calendar year by February 1 of the following year to each Sponsor.
- Must include an electronic report with a database (Excel or Access) of all units collected as well as a hard copy report.
- Reporting systems that meet the requirements of the EPA's RAD program are preferred.

Task 5: Incentive Fulfillment

Ensure fulfillment of incentive payments within four weeks after collection of the qualifying appliance.

Successful bidder will pay customer in advance and will bill sponsors on a monthly basis.

Please describe your process for handling these incentive payments. This is a critical piece of customer satisfaction.

Eligible Products:

Only certain standard sized residential style refrigerators and freezers are eligible for collection through this promotion. With a future potential for the recycling of additional appliances (air conditioners, dehumidifiers, etc). Customers may turn in up to 2 units per account per year. In exchange for each secondary refrigerator and freezer collected, customers will receive an incentive.

- Qualifying refrigerators and freezers must be full-size and between 10-30 cubic feet.

Qualifying refrigerators and freezers must be operational (in working order)

- Qualifying refrigerators and freezers must be used on a full-time basis as a secondary unit. Units that have been recently replaced as primary units are not eligible (with the exception of Rhode Island).
- Sponsors will look to contractors to recommend a potential age threshold for eligible products.

Preparing a Proposal

To expedite and simplify proposal evaluation and to assure that each proposal receives the same orderly review, it is recommended that proposals address the following areas:

1. Introduction and Executive Summary of Proposal.

2. Company/Team profile: Provide a description of the management team along with qualifications. Please include the qualifications of key field managers as well.

3. Experience: Provide a description of your team's past experiences/involvement with similar appliance recycling programs or energy efficiency programs. Include dates, number of units processed, incentive levels and any other key facts. Include contact information for references to previous projects.

4. Scope of Work: Please address each of the 5 main tasks outlined in the Scope of Work section above.
    a. Program set-up and customer service
        i. Please include samples of forms used to schedule appointments, customer sign-off sheet, and screen shots of on-line registration system

    b. Detailed description of the appliance collection and transportation process.

    c. Detailed description of the recycling process, the components to be recycled, and environmental compliance. Describe the plant and equipment to be used for this program.
        i. Provide a description of the recycling process
        ii. Provide diagrams, photos, video, if possible
        iii. Describe recycling channels and waste disposal of all components
        iv. Provide a list of facilities currently being operated by your firm and/or facilities planned/proposed to be constructed.
        v. Provide evidence of third-party certification of process/facilities
        vi. Provide environmental permit information for existing facilities
    e. Database and reporting systems: Provide a description of the database system used by your team and the methods for reporting. Describe

how your system can interface/export to the various Sponsor's tracking databases.

5. Energy Savings: Provide a detailed estimate of potential savings including recommended per unit and total Program net savings, measure life and levelized cost per kWh saved for your proposal. If available, support your estimate with references to applicable evaluation, measurement and verification (EM&V) results.

6. **Cost proposal:**
Discuss and present (on attached workbook/Bid Pricing Sheet) your firm's proposed fees to provide the scope of services requested in this RFP. The bid response must include the Program budget including the incentive level(s) paid to the customer ($50 in MA & RI, $30 in NY), if applicable, and administrative expenses, itemized by task. Then also please break down these total costs into per unit costs given the unit goals in the table below. These are current one (1) Year unit goals for each sponsor. The contract is estimated to be for three (3) or more years with similar unit goals. Please keep in mind volume based pricing and any start-up fees. The bid response must also provide the hourly rates of the staff expected to work on program implementation activities. Please see the Bid Pricing Sheet attached for more instructions.

7. Proof of sufficient insurance liability coverage

8. Appendices: Bidders should use the following structure for any appendices. Note that appendices should be used for supplemental information. Any information that you consider critical to your proposal should be included in the sections described above.

Appendix 1: Resumes
Appendix 2: Supplemental Qualifications Information (any additional project descriptions, if any, that the bidder wishes to provide).
Appendix 3: **Program Materials** – Include any samples of incentive forms, participation forms or other materials that you might have developed
Appendix 4: **Other** - Other material that the bidder may wish to include

Selection Criteria:

Selection and funding of any submitted proposal will be based on:

- Ability to demonstrate a logical projection of energy and demand savings
- Ability to meet the Sponsors goals (units collected, kWh saved)
- Clarity and comprehensiveness of implementation plan
- Proposed cost -effectiveness
- Experience of Contractor

- Ability to meet schedules in a timely manner
- Ability to maintain and operate the database of program activities.
- Ability to communicate effectively with customers and Program Sponsors.
- Oral Presentation, if requested
    - Pricing: Cost competitiveness

Conditions:

This RFP does not commit the Sponsors to pay any costs incurred in the preparation of a proposal or to procure or contract for services. The Sponsors reserve the right to accept or reject any or all proposals received as a result of this RFP, to negotiate with all qualified bidders, and to cancel the RFP, in part or in its entirety at its sole discretion.

The proposed contract period for services is through the end of 2014, with an option to renew for a third year (2015). The contractor will be compensated by invoicing each sponsoring company for their portion of the work monthly, based upon an allocation that will be established during contract negotiations. Bidders are advised that individual contracts with each sponsor will need to be established in accordance with their specific terms and conditions.

Regulatory oversight of the Sponsors' energy efficiency programs may affect the ability of Sponsors to maintain planned funding levels for this programs' activities. The Sponsors will not be liable for changes in their budgets due to such oversight.

All material produced, data collected, and reports generated by the contractor on behalf of the Sponsors are confidential and become the exclusive property of the Sponsors. The contractor may not share program materials, customer data, industry or program participant contact information, etc. unless explicitly authorized by the Sponsors to do so. The individual sponsor contracts with the selected firm will contain confidentiality agreements addressing these matters in greater detail.

Performance:

The contract ultimately awarded is expected to tie at least a portion of the Contractor's revenue to performance. Bidders may, at their discretion, propose a pay-for-performance option based at least in-part on achievement of verified kWh savings. Bidders are not bound to these optional pricing proposals, and the Sponsors are not bound to accept any optional pricing proposal offered by the winning bidder. However, bidders should be prepared to negotiate final terms based on the performance-based proposals that they offer. The Sponsors will select the bid that, in their judgment, represents the best value.

Contract Term:

The Sponsors will award the contract(s) for a period from as early September/October, 2012 extending through December 31, 2014 with the possibility of a one year contract extension based on program performance. **It should be well noted that due to varying program procurement/contract processes, start dates may vary among Sponsors.** Bidders should expect that the contract

negotiated between the successful bidder and the individual Sponsors will contain performance provisions that will include early termination for non-performance. Any or all Sponsors reserve the right to “opt out” of participation, refuse any proposal or to negotiate the specifics of any submitted promotion, including funding levels. Incentive funds will be available only upon written confirmation from each of the participating Sponsors. This contract serves as a form of agreement with individual Sponsors, outlining the terms of the proposals (each organization’s requirements). Target Promotion start date is **January 1, 2013**

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SCOPE OF WORK

Quality Assurance / Quality Control for C&I Upstream Lighting Initiative (MA)

This document describes the scope of work and other requirements to be provided by the 3rd Party vendor for QA/QC of the Upstream Lighting (*Bright Opportunities*) initiative.

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1.0 Program Description

Mass Save Electric PAs[1] have partnered with electrical distributors and lighting manufacturers to offer discounted LED and linear fluorescent lamps to Massachusetts non-residential facilities. The goal of this program is to transform the market from less efficient standard lighting technology to more efficient technologies such as reduced wattage linear fluorescent and LEDs.

Through an agreement with participating electrical distributors, the higher cost of select eligible lamps is paid directly to the distributor by Massachusetts energy efficiency service providers. This innovative approach accelerates the adoption of new technologies by removing the initial cost hurdle for customers. As a result, customers get premium replacement technology at a comparable cost to conventional products.

More details about the program including a list of eligible lamp types can be accessed at: www.masssave.com/upstream_lighting

In the future, the PAs plan to build upon the upstream lighting initiative through expanding upstream offerings that may include other high efficiency gas and electric equipment within the replacement-on-failure market such as HVAC equipment.

The purpose of this RFP is to seek qualified vendor(s) to provide third party quality control services in support of this statewide program. The selected Vendor(s) will play a crucial role in the PAs achieving verifiable savings, regulatory requirements, quality installations, and energy savings goals.

2.0 Scope of work and requirements

2.1 Overview

The purpose of the third party QA/QC inspection includes, but is not limited to, verification of program assumptions, measure installations, improve customer satisfaction, and provide feedback to PAs. The vendor will provide monthly reporting of QA/QC results to each individual PA, as well as to the appropriate statewide working group upon request.

Respondents may be qualified companies or teams and must have demonstrated experience in successful completion of projects on time and within budget. Respondents must demonstrate an understanding of commercial and Industrial energy efficiency and should provide a background or resumes of team members. Respondents should be flexible and responsive to changing program needs.

[1] Cape Light Compact, National Grid, NSTAR Electric Company, Western Massachusetts Electric Company, Unitil

All proposals received by the PAs will be evaluated and selected based on price, quality and comprehensiveness, prior experience, ability and resources to provide the services within the specified time period, local presence, and the demonstrated skills and financial viability of the Vendor, among other factors.

2.2 Site Visit Selection Criteria

The QA/QC vendor will inspect approximately 5% of sites completed on a monthly basis. Inspections will be randomly selected, for each PA, by the QA/QC vendor based on the following criteria:

- The monthly sales data will be sorted by incentive amounts and divided into "large" and "small" sites/projects based on a quartile analysis. For example, the top two quartiles ranked by incentive amounts can be considered large sites while the bottom two quartiles can be considered small sites.
- A total of 5% of sites will be selected for inspections
  - 70% of the effort will be directed towards large sites and 30% of the effort will be towards small sites.

  Note that the number of customer sites will vary month to month but the PAs expect it to range from 200 to 800 sites each month with some exceptions.
- At least one site from each PA and each distributor (on a statewide basis) shall be included in the monthly selection criteria

Example of site selection process

Proposed Upstream Program QC Sampling Process

Example

Total Sites =	600	rank ordered by incentive $s
% inspected =	5%	
Total sites inspected =	30	

Project Size	# of sites	% of sites	% sites sampled	# sites inspected	% sites inspected
Large	250	42%	70%	21	8%
Small	350	58%	30%	9	3%
Total	600	100%	100%	30	5%

Note: Large and small projects will be based on quartile analysis on monthly incentive $s, which will differ month to month

PAs recommend the above methodology, at least initially, to favor inspections of LED projects since LED lamps account for the majority of incentive payouts. PAs reserve the right to adjust the sampling methodology including the % of sites inspected as the program develops, and may request the QA/QC Vendor to inspect specific sites of special interest to the PA. PAs are open to alternative sampling approaches.

By the 20th of each month, the Upstream 3rd Party Program Manager will provide an electronic transmission of customers who have participated in the program for inspection to the Quality Control (QC) Vendor. All potential site inspection data from the Program sent to the third party QA/QC Vendor will include:

- Customer Name
- Service address
- Phone Number
- Email address (if provided)
- Sales data including type and quantity of lamps purchased

Note that the first few months of program data has incomplete customer contact information available.

2.3 Inspection Scheduling Process

Respondents should explain how a customer inspection list will be generated based upon the PA recommended Site Visit Selection Criteria in Section 2.2. A procedure for creating an inspection list, contacting customers, and scheduling visits should be provided. Respondents should supply a timeline for these activities and other related tasks.

The Vendor should describe its process and systems to track all program data including which customers are contacted, which sites are inspected and the inspection results on a monthly basis. Historic data should be made available to PAs for analysis, tracking and evaluation purposes.

2.4 Inspection Process

Respondents should describe how their inspectors will conduct the inspection starting from arrival at the customer site, equipment/technology used for inspections, data collection procedure and any script used.

The QA/QC Vendor should also specify how it will document and track accordingly the customer's level of satisfaction with the services they received from the Program.

See Appendix A for suggested QA/QC Site Visit Protocol.

2.5 Completed Inspections

Respondents should provide a procedure for collecting and compiling the results of site visits. Sample data tracking and reporting formats should be supplied with the response.

2.6 Reporting and Invoicing

Respondents should provide a sample site inspection report, a monthly summary and a PA invoice. A timeline for how inspection results will be reported on a monthly basis should be included. The Vendor will invoice each PA based on an established cost share structure between PAs.

The QA/QC Vendor will note and record any discrepancies identified in the sales data provided by the Program Manager when compared to the actual conditions at the location where the work was performed. The Vendor will review and determine if there appears to be any unusual patterns at the PA, distributor or product level and include these observations in the monthly report.

The Vendor will maintain and make available upon request, duplicate copies of site inspection reports and supporting documentation which are generated in the delivery of the services provided.

Appendix A – QA/QC Site Visit Protocols/Qualifications

QA/QC Vendors will use inspectors that, at a minimum, meet the qualifications of the program being inspected i.e., inspectors should have the necessary knowledge and experience in lighting technologies and site inspections. Optional future inspections of HVAC and other measures may be requested by PAs and the QA/QC Vendor shall have the necessary knowledge, qualifications and experience in these other end use technologies.

Data Requirements

The following actions will be performed at each customer location:

I) Lighting Equipment Verification

Inspect lighting fixtures installation which could include Reduced-Watt T8 and/or T5 lamps, LED replacement lamps (MR, PAR, "A" and Decorative types) and categorize as either: Pass, Fail, or Pass with Notes.

a) Verify quantities and types of lamps purchased. Document any spare lamps purchased to account for failures or other purposes.
b) Open a minimum of 5 fixtures per site to verify lamps meet program sales data
c) If 100% of the lamps are not available for inspections (e.g. occupied hotel rooms), it should be noted in the site report with the % of lamps inspected.
d) Verify lighting hours of operation per lamp type. If not available for the particular application, verify lighting hours for the facility.
e) Document type of lamp replaced (incandescent, halogen, CFL, or other)
f) Document average wattage replaced per lamp type
g) Verify that all fixtures and controls operate properly (test and note any LED dimmer compatibility issues)
h) Optional: note missed opportunities or inappropriate applications
i) Optional photographs may be included

II) Customer Survey

a) Note customer satisfaction (on a scale of 1 to 5) about the program or products.
b) Document any problems or issues with the program or products.

APPENDIX E

OTHER SUPPORTING DOCUMENTATION

SECTION 2

COMPETITIVE PROCUREMENT DOCUMENTATION

SAMPLE TERMS & CONDITIONS

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NORTHEAST UTILITIES SERVICE COMPANY
GENERAL TERMS AND CONDITIONS
CONSULTING SERVICES

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NORTHEAST UTILITIES SERVICE COMPANY
GENERAL TERMS AND CONDITIONS
CONSULTING SERVICES

1. DEFINITIONS.

All capitalized terms used herein, or elsewhere in the Contract, shall have the meanings ascribed to them in this Article 1, unless such terms are otherwise defined in the Contract.

1.1 ACCEPTANCE**:** Upon the Consultant's completion of all requirements in Article 11 "REQUIREMENTS FOR ACCEPTANCE", all or any portion of the Work shall be deemed to have been accepted as complying with the terms of the Contract sixty (60) days following the completion of the Work in full compliance with the Contract, unless Owner provides Consultant within such sixty (60) day period written objections describing how the Work is incomplete or is not in compliance with the Contract.

1.2 BUSINESS DAYS**:** Any day other than Saturday, Sunday and days observed as legal holidays by the federal or state government applicable to the Owner's Site(s) of Contract performance.

1.3 CONFIDENTIAL INFORMATION: Confidential and/or proprietary information of a party to this Contract. Owner's Confidential information includes written, oral, or electronic information and Information containing personnel information, customer information, personally identifiable information, protected health information, proprietary information or any other information that Owner designates as confidential and desires to protect against unrestricted disclosure or competitive use, including, without limitation, business plans, marketing strategies, bidding activities, commercial, technical and performance information, contracts, financial Information, research documentation, information about investors or any company or individual with whom Owner does business, information considered by Owner to be a trade secret and/or of a commercially valuable and sensitive nature or information that may otherwise be deemed confidential by law or regulatory agency, including Information described in Section 34.9 "CONFIDENTIAL INFORMATION". The parties intend that the designation of Consultant's Information as Confidential Information shall be limited to financial information and Information that has unique commercial value and was developed independently from the Work.

1.4 CONTRACT**:** The collective term used to describe all documents comprising each agreement between the parties for the Work, including, without limitation, the Purchase Order, General Terms and Conditions, Special Terms and Conditions (if applicable), Specifications, any items specifically incorporated by reference and/or issued (including any documents issued with respect to any change order, modification or amendment) or provided by Owner to Consultant in connection herewith, and any amendments to the foregoing agreed to in writing by the parties. The preprinted terms set forth on the back of each page of Owner's Purchase Order shall not bind either party.

1.5 CONSULTANT: The entity issued a Purchase Order by Owner.

1.6 CONSULTANT'S REPRESENTATIVE**:** The individual identified by Consultant with authority to act on behalf of Consultant in performance of the Contract.

1.7 CONSULTANT RESOURCES: Consultant's and any Subcontractor's employees, contract employees, consultants, agents, and all other persons or entities employed by or under the control of Consultant or any Subcontractor.

1.8 DIRECT ACTUAL COSTS: Reasonable direct expenses actually incurred, supported with adequate documentation, to perform a task

1.9 ENVIRONMENTAL LAWS**:** Shall mean all applicable laws and any administrative or judicial

interpretations thereof relating to: (a) the regulation, protection or use of the environment; (b) the conservation, management, development, control and/or use of natural resources and wildlife; (c) the management, manufacture, possession, use, generation, transportation, treatment, storage, disposal, release, threatened release, abatement, removal, remediation, or handling of, or exposure to, any Hazardous Materials; or (d) noise.

1.10 RESERVED.

1.11 FINAL ACCEPTANCE**:** Owner's written acknowledgement, determined in its sole discretion, that Consultant has completed all or a specified portion, if required or contemplated by the Contract, of the Work in accordance with the requirements of the Contract.

1.12 FINAL PAYMENT**:** That payment to be made to Consultant by Owner after Final Acceptance.

1.13 HAZARDOUS MATERIALS: The collective term used to describe (a) any petrochemical or petroleum products, oil, waste oil, asbestos in any form that is or could become friable, urea formaldehyde foam insulations, lead-based oil paint and polychlorinated biphenyls; (b) any products, mixtures, compounds, materials or wastes, air emissions, toxic substances, wastewater discharges and any chemical, material or substance that may give rise to liability pursuant to, or is listed or regulated under, or the human exposure to which or the release of which is controlled or limited by applicable Environmental Laws; and (c) any materials or substances defined in Environmental Laws as "hazardous", "toxic", "pollutant', or "contaminant", or words of similar meaning or regulatory effect.

1.14 INFORMATION**:** All intellectual property, computer software and documentation, studies, data, reports, documents, designs, plans, drawings, calculations, test results, specifications, electronic communications and data, or other information, in whatever form or media. This includes any patents, trademarks, servicemarks, copyrights, or trade secrets or any devices, designs, methods, or written works developed or capable of being developed during the course of this agreement

1.15 OWNER: "Owner" shall mean Northeast Utilities Service Company, a Connecticut corporation ("NUSCO"), as agent for itself and any business entity that directly or indirectly controls or is controlled by, or is under common control or ownership with NUSCO on or after the effective date of the Contract, including, without limitation, the company or companies listed in the "Primary Ship to" block of the Purchase Order under which the Contract is issued.

1.16 OWNER'S REPRESENTATIVE: The individual(s) identified in Owner's Purchase Order with authority to act on behalf of Owner concerning the Contract, or otherwise identified by the Owner in writing in the Contract.

1.17 PURCHASE ORDER: Owner's Purchase Order(s) referenced in the Contract; provided; however, that the preprinted terms on the back of Owner's Purchase Order(s) and any additional or conflicting terms and conditions in Consultant's confirmation hereof, or documentation, including invoices, are hereby expressly rejected and excluded from the Contract, are inapplicable to the Contract, shall not be considered part of the Purchase Order(s), and shall be of no force and effect.

1.18 RESERVED.

1.19 SERVICES: A specific service furnished by or on behalf of Consultant under the Contract and as part of the Work. Such Services may include, without limitation the following services: design, engineering, technical, consulting; preparation and/or compilation of Information; procurement, inspection, supervision; supply, installation, startup, testing of materials and equipment; the supply of labor; and any other services to be performed as specified and in accordance with the Contract.

1.20 SITE: The location other than Consultant's facilities at which the Work is to be performed. The Site can include Owner's property, Owner rights of way, or other property not owned by Owner where Work is to be performed.

1.21 SPECIAL TERMS AND CONDITIONS: The Special Terms and Conditions, if any, attached hereto and made a part of the Contract.

1.22 SPECIFICATIONS: The Work requirements, specifications or technical specifications, which may include instructions, scope or statement of work, written requirements for materials, equipment, construction, systems, standards, Information and workmanship for the Work and performance of Services.

1.23 SUBCONTRACTOR**:** Any subcontractor, licensor or supplier, at any tier, who furnishes materials, supplies, facilities and/or Services to Consultant to meet Consultant's obligations to perform Work under the Contract.

1.24 WORK: The terms used to describe collectively, all materials, Information and Services, and all duties, obligations and responsibilities undertaken or required to be undertaken by Consultant under the Contract.

2. CONSULTANT'S BILLING RATES.

Whenever Consultant performs Work on a time and materials basis (including but not limited to Work performed as a change or addition to the scope of Work described in the Contract) Consultant shall be compensated at the billing rates set forth in the Purchase Order. Any adjustments to billing rates that are in compliance with Contract terms must be provided to Owner for review in the form of a new rate schedule in advance of any invoicing based on such new rates. Owner may reject any invoices which contain billing rates that are inconsistent with Owner's current rate schedule on file.

3. TERMS OF PAYMENT.

3.1 Owner shall pay each correct invoice, or provide written objections to all or any portion of each disputed invoice, within thirty (30) days after receipt by Owner. If Owner disputes a portion of an invoice, at Owner's request Consultant shall submit a revised invoice for the undisputed amount and Owner shall pay such undisputed portion within thirty (30) days after receipt thereof. Upon Consultant's receipt of payment from Owner, Consultant shall pay any amounts due any Subcontractor for Work furnished in a timely fashion. Upon Owner's request, Consultant shall provide documentation regarding unvouchered liabilities including, without limitation, a) the estimated dollar amount of all Work performed but not invoiced for that month or previous months, and b) any invoice submitted but not yet paid. Documentation must include Owner's Purchase Order number and, if applicable, release number.

3.2 Owner shall pay Consultant the charges indicated in properly itemized and supported invoices for Work performed by Consultant and Accepted by Owner in accordance with the terms of the Contract, less adjustments for prepayment, retainage, defective Work, or disputed items, and received by Owner at the address indicated in the Contract within one hundred eighty (180) days of the completion of the Work being invoiced unless another invoicing period has been agreed to by the parties.

3.3 Each invoice shall (a) be certified in writing as correct by Consultant's Representative; (b) be itemized (with reasonable detail and supporting documentation for any authorized reimbursable expenses in excess of $25.00 per receipt) to fully describe each element of cost charged to Owner and any negotiated early payment discounts and (c) if applicable, contain a certification acceptable to Owner

to the effect that all Subcontractors have been paid in full for completed Work as reflected in the immediately preceding invoice. For time and material Work, Consultant shall bill in accordance with Owner's billing instructions.

3.4 Owner may withhold payment of all or part of any invoice to such extent as may be necessary to protect itself from loss caused by: (a) defective Work not remedied; (b) claims filed or reasonable evidence indicating probable filing of claims by other parties against Consultant and/or Owner in connection with the Work; (c) failure of Consultant to make payments properly to Subcontractors for material or labor; (d) reasonable indication that the unpaid balance is insufficient to cover the cost to complete the Work; (e) reasonable indication that the Work will not be completed within the Contract schedule; (f) unsatisfactory performance of the Work by Consultant; (g) failure of Consultant to perform any of its obligations under the Contract; or (h) failure of Consultant to pay any amounts due Owner. Owner shall notify Consultant of the grounds for any withholding, and when the above grounds are removed, or Consultant provides performance assurance satisfactory to Owner that will protect Owner for the amount withheld, payment will be made of the amounts withheld. When deemed reasonable by Owner, Owner may use such funds to rectify the situation causing the withholding of funds.

3.5 To the extent permitted by law, Owner shall have the right to set-off against any sums due Consultant under the Contract any claims Owner may have against Consultant under such Contract, under any other contract between Owner and Consultant, or that Owner may otherwise have against Consultant without prejudice to the rights of the parties with respect to such claims. In the case of Work incorrectly performed or incomplete, an equitable deduction from the Contract price may be made.

3.6 Except for Work performed at a fixed price, Consultant shall make available to Owner during the Work and for a period of three (3) years following Final Acceptance of all Work, all source documents necessary to verify the elements of all billable charges, including but not limited to: each worker's name, charge classification, and hours worked; computer usage summaries; and original documentation of all reimbursable expenses (e.g. receipts for travel, business expense and employee expense). Upon five (5) business days prior notice by Owner, this information shall be available for audit by Owner during normal business hours, at Consultant's principal office or at any other location agreed to by the parties.

3.7 RESERVED

3.8 RESERVED

4. TAXES.

4.1 Taxes on Owner's Purchases from Consultant
Consultant's price(s) and any Billing Rates that apply under the Contract exclude any and all present and future Federal, state, county, municipal or other jurisdiction's sales, use, excise or other taxes that may apply to Owner's purchase of the Work. For a period of three (3) years following completion of the Work, Owner shall pay to Consultant any such taxes that Consultant is obligated by law to collect from Owner for Work accepted and purchased by Owner, provided that Consultant submits written notice to Owner within fourteen (14) days of Consultant's receipt of notification of any imposition of such taxes. Owner may direct Consultant to withhold payment and elect to contest the amount or validity of any such tax imposition. Consultant shall fully cooperate with Owner in any such tax contest. Owner shall reimburse Consultant for any interest or penalties actually paid by Consultant as a result of Owner's exercise of its right to contest the imposition of any taxes.

4.2 Taxes on Consultant's Purchases If Owner informs Consultant that Owner has a tax exemption certificate or a direct pay permit that applies to a specified portion of the Work, Consultant shall notify its Subcontractors and suppliers that their Services performed for, or materials supplied for

Consultant's use in, and/or equipment supplied for installation as part of the specified "tax exempt portion" or "direct pay portion" of the Work are either exempt from sales and use taxes or Owner pays such taxes directly. Consequently, these Subcontractors and suppliers should not collect such taxes from Consultant and Consultant's prices and Billing Rates to Owner should reflect such tax exemption or Owner's direct payment on Consultant's purchases from Subcontractors and suppliers for the tax exempt or direct pay portion of the Work. Subcontractors and suppliers providing Services or, materials and or equipment for any portions of the Work that are neither tax exempt nor direct pay shall apply any normally applicable sales or use taxes to such "normal tax" portions of the Work and Consultant's prices and Billing Rates will be deemed to include any and all applicable taxes on such normal tax portions of the Work. If Owner does not inform Consultant that it has a tax exemption certificate or a direct pay permit that applies to a portion of the Work, Consultant should presume that its purchases from Subcontractors and suppliers associated with the Work are subject to any applicable sales and/or use taxes on such purchases and Consultant will be deemed to have included any and all applicable taxes on its purchases from Subcontractors and suppliers in the prices and Billing Rates stated in the Contract provided that any Billing Rates using markup percentages will not apply to taxes paid for such purchases.

4.3 Income, Property and Payroll Taxes Notwithstanding any provision of the Contract, Owner shall not be required to pay or reimburse Consultant for any taxes levied against Consultant's income, property or payroll.

4.4 RESERVED.

5. CHANGES AND ADDITIONS.

5.1 Either party may request changes or additions to the Work by submitting a written request to the other. Changes requested by Consultant shall not, however, be implemented until approved in writing by Owner. All changes shall be made in accordance with approved Owner procedures provided to Consultant.

5.2 Owner shall have the right to require Consultant to delete from, change or add to the Work, in each case to the extent that any such deletions, changes, additions or other alterations are of the character described in the scope of Work, and to the extent such deletions, changes or additions are within the general expertise of Consultant Resources performing the Work. If such deletions, changes or additions are scheduled to be completed by or within six (6) months following the then-scheduled completion date for the Work as specified in the Contract, such Work shall be performed at Consultant's time and material rates in effect for the Contract, unless the parties agree in writing to another method of compensation.

5.3 If a deletion, change or addition will increase or decrease the cost or time required to complete the Work, the party requesting the change or addition will set forth in its request the appropriate adjustment to compensation or completion deadlines. Written acceptance by the party receiving the request for change or addition shall be a binding resolution between parties of the issues set forth in the request.

5.4 At no time shall the Work be delayed by Consultant due to a dispute between the parties concerning the cost or time required to accomplish a deletion, change or addition requested by either party.

5.5 Consultant shall not commence or undertake any portion of any Work for which it contends that any extra compensation or schedule adjustment is or will be owed or due or payable, without prior written authorization from Owner, and such authorization shall be required for payment of any extra compensation to, or adjustment of any schedule requirement for the benefit of, Consultant. In all instances, Consultant shall orally notify the Owner's Representative of any circumstances that could result in a change in the scope of the Work (or a claim therefor) as soon as possible after the occurrence of the event or incident, and in writing within twenty-four (24)

hours after such occurrence. Thereafter, Consultant shall submit to Owner appropriate detailed supporting documentation, justifying the basis for the claim, within ten (10) Business Days after the date of the event or incident giving rise to such claim. Without relieving Consultant of its obligations hereunder, any claims by Consultant for increased compensation or extension of completion deadlines shall be irrevocably waived and released unless Consultant provides such immediate oral notice and twenty-four (24) hour written notice and thereafter submits such detailed supporting documentation for the claim to Owner within such ten (10) Business Day period.

5.6 RESERVED

6. INFORMATION.

6.1 If Consultant is required to provide Information, complete and accurate Information shall be submitted in sufficient time for review and approval by Owner prior to starting Work affected by such documents. All Work shall conform to the details shown on Information approved by Owner.

6.2 Once Information has been approved by Owner, Consultant shall not make any changes in Information without the prior written approval of Owner.

6.3 Consultant shall immediately notify Owner and request additional instruction whenever Owner-provided Information is found to be unclear, incorrect or conflicting. Consultant shall not undertake any Work based upon such Information until such discrepancy has been resolved by Owner.

6.4 Preliminary, certified for manufacture, or certified for construction drawings shall be submitted to Owner in the form requested by Owner. Any drawing shall be produced in accordance with any Specifications and acceptable industry practices, as each may be amended and supplemented, and shall be legible such that Owner is able to clearly distinguish all characters and lines.

6.5 For Work that includes Information that is not prepared exclusively and solely for Owner, Consultant shall retain title to any such Information (excluding any portion thereof that contains Owner's Confidential Information) that is subject to Consultant's patents, copyrights, trademarks, service marks, intellectual property rights or proprietary interests provided that Owner shall have unrestricted and non-exclusive rights and license to use such Information. For Work that includes Information that is prepared exclusively and solely for Owner, all such Information is the proprietary Information of Owner and shall be subject to the requirements applicable to Owner's Confidential Information as set forth in Article 34 "CONFIDENTIAL INFORMATION" herein, whether or not each such document is so identified.

6.6 Consultant shall be responsible for the completeness and accuracy of the Information it provides and shall correct, at its expense, all errors or omissions therein. Without limitation of any and all other rights and remedies available to Owner, the reasonable cost necessary to correct matters attributable to such errors shall be chargeable to Consultant.

6.7 Consultant shall provide Owner with all Information necessary for Owner's use and understanding of the Work and the installation, operation, maintenance and repair thereof, and to allow Owner to satisfy any mandate of any governmental body or court. Except for Information deemed to be proprietary to Consultant under the terms of the Contract, and except as set forth in this Article 6, all Information supplied or delivered to Owner pursuant to the Contract shall be the property of Owner. Consultant may retain for its records only, copies of any Information furnished to Owner, and unless otherwise agreed to by the parties, shall treat such Information in accordance with the requirements applicable to Owner's Confidential Information.

6.8 Consultant shall keep such full and detailed accounts for proper financial management under this Contract as Owner may reasonably request. Consultant shall also promptly provide other

information, copies of such reports, and other information reasonably requested at no cost to Owner.

7. ELECTRONIC DELIVERY OF INFORMATION.

In performing Services under this Contract, Owner and/or Consultant may wish to exchange business data or information electronically using a point-to-point connection or a value added network either directly or through a third party E-Business provider (collectively, "E-Business"). The parties recognize and agree that the electronic transmission of information, including attachments, and access to E-Business systems by Owner employees, cannot be guaranteed to be secure from third party interception, error free or free from viruses or other damaging computer code, and that such information could be intercepted, corrupted, infected, lost, destroyed or incomplete, or otherwise be adversely affected during transmission or harmful to the recipient's computer system. Owner and Consultant have each taken steps within their organization to reduce the foregoing risk, consistent with the industry practices; however, there can be no assurance that outgoing E-Business is free of the foregoing faults or that engaging in E-Business will not create any harm to electronic systems. If Consultant elects to transmit information or documents relating to this Contract using E-Business, Consultant shall be deemed to have accepted and be bound by the terms of this Contract and the NUSCO Purchasing Department E-Business Trading Partner Agreement executed by the parties (required for establishing EDI E-Business arrangements for electronic transmission of purchase orders or invoices – see www.NU.com/Business/edi) and on file with the NUSCO Purchasing Department.

8. DELAYS.

8.1 Notice. Each party shall give the other prompt written notice of any circumstances that may delay performance of the Work including any Force Majeure (as defined in Section 9.1). Consultant shall notify Owner's Representative of any such circumstance orally as soon as possible after such circumstance occurs and in writing within twenty-four (24) hours after the occurrence of such circumstance. Consultant shall record the cause of any resulting delay and the time lost in its reports and in its time sheets and shall submit such reports and time sheets to Owner's Representative.

8.2 Delays in Performance For Reasons Other Than Force Majeure.

8.2.1 Owner may at any time request Consultant to delay performance, fabrication or delivery of all or any portion of any Work to be provided under the Contract. Consultant shall use its best efforts to accommodate such delay. However, if Consultant is unable to accommodate all or a portion of Owner's request, it shall notify Owner in sufficient time for Owner to take alternative measures.

8.2.2 RESERVED.

8.2.3 If Work or any portion thereof is ready for performance, but performance is delayed beyond the scheduled performance by Owner, the parties will adjust the payment schedule and any additional costs resulting from such delays.

8.2.4 Consultant shall use best efforts to complete the Work in accordance with the Work schedule. If the Work falls behind schedule due to acts or omissions of Consultant or any Consultant Resources, Consultant shall, at its sole cost and expense, use its best efforts to restore the Work to schedule, including but not limited to placing Consultant Resources on extended working hours, assigning additional resources to the Work, and establishing expedited, priority treatment for the provision of Services, necessary to complete the Work within the time set forth in the Contract.

8.3 RESERVED.

8.4 RESERVED.

9. FORCE MAJEURE.

9.1 Neither party shall be liable to the other for loss or damage resulting from any delay or failure of a party to perform its contractual obligations due to conditions or circumstances which are beyond that party's control, including: acts of God; war; acts of a public enemy; riot; civil commotion, sabotage; Federal, state or municipal action, inaction or regulation; strikes or other labor troubles (excluding those involving such party's employees); fire; flood; accidents; epidemics; quarantine restrictions; embargoes; damage to or destruction in whole or in part of office equipment or manufacturing plant, to the extent such facilities are necessary to proper performance of the party's obligations under any Contract and alternate facilities are not reasonably available; and inability to obtain raw material, labor, fuel or supplies; provided however, that such failure or delay is not caused by that party's violation of the Contract and could not have been prevented by reasonable precautions taken by the non-performing party and could not reasonably be circumvented by the non-performing party through the use of alternate sources or plans or other means.

9.2 Force majeure shall extend the time for Consultant's performance to the extent such condition directly affects completion of Work. Consultant shall use its best efforts to reschedule its Work to mitigate the effect of such condition and to eliminate such condition as soon as possible. If the Work falls behind schedule due to a Force Majeure, Owner may direct Consultant to accelerate the Work by whatever means Owner may deem necessary, including subcontracting Work or working additional hours or shifts, and Owner shall pay Consultant for the Direct Actual Costs incurred by Consultant in connection with any such directed acceleration. Unless Owner agrees to pay the Direct Actual Costs of such measures, Consultant shall not be required to undertake such measures that, but for the Force Majeure, would not have been required to meet the schedule for completing all or any portion of the Work.

9.3 Neither this Article nor any other provision of the Contract shall excuse the non-performance or delayed performance of Consultant due to any commercial impracticability experienced by Consultant, including but not limited to market changes, increased costs or insufficient money.

10. INSPECTION.

10.1 RESERVED.

10.2 Consultant shall provide Owner timely notice of the date of all tests affecting the Work and test results and provide Owner timely delivery of intermediate or draft Work, as required. Owner's approval of Work shall in no way reduce or modify Consultant's obligations to meet performance and other requirements of the Contract. By such approval, Owner in no way assumes any part of Consultant's responsibility for the satisfactory performance of Work.

10.3 Owner shall have the right to inspect the status of all Work at any time. No Acceptance of Work shall be construed to result from such inspections by Owner.

10.4 RESERVED

11. REQUIREMENTS FOR ACCEPTANCE.

Acceptance of Work shall be conditioned upon Consultant submitting to Owner's Representative the following:

11.1 RESERVED.

11.2 properly executed, unconditional waivers or releases of lien from Consultant and all Subcontractors, conditioned upon payment, who provide labor, materials, equipment, or supplies for the Work;

11.3 evidence of satisfactory completion of Work;

11.4 all Information required under the Contract; and

11.5 return of all property provided by Owner.

12. PARTIAL COMPLETION AND ACCEPTANCE.

If at any time prior to Acceptance as referred to in Article 11 "REQUIREMENTS FOR ACCEPTANCE", any portion of the Work has been completed and if Owner determines that such portion of the Work is of value, Owner will, if applicable, issue to Consultant a certificate or other written acknowledgement of partial completion. Upon the issuance of such certificate or other written acknowledgement, or at any time thereafter, Owner may take over and use the portion of the Work described in such certificate and may exclude Consultant therefrom. The issuance of a certificate of partial completion or other written acknowledgement will not release the Consultant from any obligations under the Contract unless such prior use delays the Work or increases its cost. In this event, the Consultant will be entitled to extra compensation or extension of time, or both, as Owner may determine.

13. SUSPENSION OF WORK.

Owner may at any time suspend the Work or any part thereof upon oral notice to Consultant. Such oral notice shall be confirmed in writing by Owner. The Work shall be resumed by Consultant promptly after written notice from Owner to Consultant to do so. Owner will reimburse Consultant for the Direct Actual Costs incurred by it as a result of such suspension. If the Work or any part thereof is stopped by notice aforesaid, and if Owner does not give notice in writing to Consultant to resume work at a date within sixty (60) days after the date fixed in the written notice to suspend, then Consultant may abandon that portion of the Work so suspended upon ten (10) days prior written notice to Owner and it will be entitled to payment for all Work completed and accepted by Owner on the abandoned portion, including commitments relating thereto, plus proportionate profit on Work completed and accepted by Owner.

14. TERMINATION FOR CAUSE.

14.1 Without prejudice to any other right or remedy Owner may have under the Contract, at law and/or in equity and upon providing written notice of such termination to Consultant, Owner may terminate the Contract without any liability being owed thereby by Owner to Consultant, in the event of the occurrence of any of the following:

14.1.1 insolvency of Consultant;

14.1.2 filing of a voluntary petition in bankruptcy by Consultant;

14.1.3 filing of an involuntary petition in bankruptcy against Consultant;

14.1.4 appointment of a receiver or trustee for Consultant;

14.1.5 execution by Consultant of an assignment or any general assignment (other than an assignment undertaken in connection with a financing) for the benefit of creditors;

14.1.6 commencement of any legal proceeding against Consultant that, in Owner's opinion, may interfere with Consultant's ability to perform in accordance with the Contract; or

14.1.7 Consultant consolidates with, or merges with or into, or transfers all or substantially all of its assets to, another entity and/or sells, assigns or otherwise transfers the Contract; in each case without Owner's advance written consent.

14.2 If Consultant fails to diligently perform the Work in accordance with the Contract or if Consultant otherwise breaches any of the terms of the Contract, in addition to Owner rights set forth in Section 25.7 regarding safety or environmental violations, Owner shall have the right without any liability being owed thereby by Owner to Consultant, upon giving Consultant written notice of default and allowing Consultant a period of five (5) Business Days or such other period as may be agreed upon by the parties or as may be determined by Owner to be necessitated by exigent circumstances to remedy such deficiency, to: cancel the Contract in whole or in part upon giving written notice to

Consultant; and obtain the Services from another Consultant with any excess cost resulting therefrom chargeable to Consultant.

14.3 Upon receipt of any notice of termination as described in Section 14.1 or Section 14.2 above, Consultant shall immediately cease Work, commence demobilization of any affected Consultant Resources and shall promptly settle the liabilities and claims arising out of the termination of subcontracts and orders and shall use its best efforts to minimize any associated costs.

14.4 Consultant shall promptly deliver to Owner completed or partially completed Work and/or contract rights of Consultant relating to the Work for which Owner has made payment, and Consultant shall execute and deliver such documents and take all such actions as Owner may require for the purpose of vesting in Owner such ownership, rights and benefits of Consultant with respect to the Work.

14.5 In the event any termination under this Article 14 is subsequently determined pursuant to the dispute resolution process set forth in Article 39 "DISPUTE RESOLUTION; NEGOTIATION; MEDIATION; ARBITRATION", to have been made without cause, such termination shall be deemed a Termination for Convenience under Article 15 hereof.

15. TERMINATION FOR CONVENIENCE.

15.1 Owner shall have the right to terminate and/or cancel the Contract or all or any portion of the Work for any reason, or for Owner's convenience, and at its sole and exclusive discretion, upon at least one (1) day's prior written notice to Consultant specifying when such termination becomes effective. Upon such effective date, Consultant shall immediately cease Work, commence demobilization of any affected Consultant Resources, and, if requested by Owner, promptly remove from the Site all materials and equipment which have not been either fully or partially paid for by Owner. Consultant shall promptly settle the liabilities and claims arising out of the termination of subcontracts and orders and shall use its best efforts to minimize any associated costs. After termination, Consultant shall cooperate with Owner to the fullest extent for the purpose of allowing Owner or its designee to fully perform all functions previously performed by Consultant under the Contract.

15.2 Upon Owner's request, Consultant shall promptly deliver to Owner completed or partially completed Work (including Information or other work product related to the Work) for which Owner has made payment, and Consultant shall execute and deliver such documents and take all such actions as Owner may require for the purpose of vesting in Owner such ownership, rights and benefits of Consultant with respect to the Work.

15.3 In the event of a termination under this Article 15, except as otherwise expressly agreed to in writing by the parties, Owner shall pay for the Work completed in compliance with the Contract through the effective date of termination.

16. OWNER'S REPRESENTATIVE STATUS.

Owner's Representative will perform inspection of the Work and has the authority to stop the Work whenever such stoppage may be necessary to insure the proper execution of the Contract. He/she also has authority to reject any and all Work that does not conform to the Contract and to decide questions that arise in the execution of the Work. Owner's Representative will make decisions in writing within a reasonable time on all claims of Consultant and on all other matters relating to the execution and progress of the Work or interpretation of the Contract documents.

17. CONSULTANT'S SUPERVISORY DUTIES.

17.1 Prior to commencing any Work, Consultant shall identify to Owner a Consultant's Representative authorized to receive all communications from Owner, provide all approvals or authorizations required from Consultant and act on behalf of Consultant in all matters concerning the Work. Owner reserves

the right to require the removal and replacement of Consultant's Representative for any reason.

17.2 Consultant shall efficiently and continuously supervise Consultant Resources required to complete the Work. Consultant shall be fully liable for the acts and omissions of Consultant Resources. Consultant shall provide an adequate and competent supervisory staff throughout the course of the Work.

17.3 Consultant shall at all times enforce strict discipline and good order among Consultant Resources, and shall not employ any unfit person or anyone not skilled in the tasks assigned under the Contract. Owner shall have the right to request Consultant to remove any person determined by Owner to be unqualified or unfit to perform the Work.

17.4 In the event Consultant Resources employees are given access to any of Owner's computer systems and equipment or Owner Information including without limitation Owner's Confidential Information, Consultant agrees not to use Owner's systems or equipment or such Owner Information for any purposes other than that contemplated in the Contract. Consultant further agrees to keep confidential any Information it obtains in the course of performing Work under this Contract and to utilize data security systems approved by Owner and compliant with Owner's IT Security Requirements and applicable law. Consultant agrees to cause its Consultant Resources to comply with applicable provisions of Owner's IT Security Requirements and policies and applicable laws and regulation.

17.5 For any Services to be performed on any Site, within five (5) Business Days of Owner's request, Consultant shall provide to Owner, the names, classifications and job locations of Consultant Resources. Owner shall have the right to request that Consultant remove and replace (at no cost to Owner) any person determined by Owner in its discretion to be unqualified or unfit to perform the Work, in which case Consultant shall do so (including reassignment to work other than for Owner and/or Owner affiliates to the extent allowable under Consultant's labor agreement(s) and Law). Owner's requests and/or reviews concerning any Consultant Resources shall not be construed in any manner as creating any employment, contractual or other relationship between Owner and such person, or otherwise granting Owner control over such person and/or the performance of the related Work.

17.6 Consultant shall, subject to Owner approval, designate certain Consultant Resources as key personnel with respect to the Work. Consultant shall not remove, replace, or reassign such designated key personnel without the prior written consent of Owner, which shall not be unreasonably withheld.

17.7 **THIS SECTION IS APPLICABLE ONLY TO DISTRIBUTION OR TRANSMISSION SERVICES ON SITES**. In addition to the requirements of Section 17.5, Consultant shall provide to Owner, the names, classifications and job locations of Consultant Resources that were former employees of Owner or any of its affiliates, that Consultant desires to assign to provide Services on behalf of Consultant and/or any Subcontractor at least three (3) business days prior to those Consultant Resources performing any such Services.

18. INDEPENDENT CONTRACTOR.

Consultant Resources shall perform all Work as independent contractors, and shall not be deemed to be the employees or agents of Owner for any purpose whatsoever.

19. SUBCONTRACTING.

19.1 Consultant shall provide Owner with notice of any Work that it desires to subcontract along with a list of proposed Subcontractors. Owner shall have the right to refuse any proposed Subcontractor and Consultant shall not enter into any such subcontract with any such Subcontractor as to which Owner has made an objection. Consultant shall not make any substitution of proposed

Subcontractors prior to or during the term of this Contract without prior written approval from Owner. Neither Consultant nor any Subcontractor shall assign any Work under this Contract without the written consent of Owner.

19.2 Irrespective of Owner's consent or the terms of any agreement between Consultant and any Subcontractor, Consultant shall (a) be fully responsible to Owner for acts and omissions of Consultant Resources; (b) remain fully responsible for the full and faithful performance of the Contract; (c) direct and control the activities of all Consultant Resources; (d) remain fully bound by all terms and conditions of the Contract including but not limited to all requirements for indemnity and warranty. Consultant shall include all Contract provisions related to any subcontracted Work in the written agreement between Consultant and such Subcontractor for such Work, including without limitation, warranty, insurance, audit and indemnity provisions.

19.3 Owner shall have the right to request that Consultant terminate any subcontract and remove any Consultant Resources determined by Owner, in its sole discretion, to be unqualified or unfit to perform the Work or any portion thereof.

19.4 Nothing contained in the Contract documents shall create any direct contractual relation between any Subcontractor and Owner.

19.5 Consultant shall not allow access to the Site(s) or any portion thereof under the control of the Consultant by any person not acting under the direction and control of Consultant, other than Owner, the Owner's Representative, other authorized representatives of Owner, other contractors engaged by Owner and governmental authorities

19.6 RESERVED

20. COMPLIANCE.

20.1 Contractor and Contractor Resources shall comply with all laws, regulations and requirements applicable to the Work,,including, without limitation, international, federal, state and local laws, and the laws applicable to any location where any Work is to be performed, constructed, manufactured, stored or delivered. Such compliance shall include, without limitation, environmental, human rights, labor, employment, non-discrimination and anti-corruption laws (including the Foreign Corrupt Practices Act), and all applicable maritime, customs, export, and import laws, requirements, rules and regulations, and the applicable laws, requirements, rules and regulations of the country of origin or destination, any intermediate country, and the United States in the performance of the Work. The country of any location where Work is to be performed, whether it is the country of origin or destination or any intermediate country, must be a member of the International Labour Organization (ILO). The costs of such compliance with the foregoing requirements shall be borne exclusively by Contractor and Contractor shall defend, indemnify, and hold Owner harmless from any liabilities, damages, fines, penalties and costs arising from Contractor's noncompliance with this Article 20.

20.2 Contractor and Contractor Resources shall comply with Owner's requirements, procedures, policies (available to Contractor upon request), including, without limitation, Owner's Supplier Code of Conduct, any applicable Northeast Utilities Contractor Work Rules/Addendums, any applicable training, and any items specifically incorporated by reference in the Contract and/or issued in connection with the Work.

20.3 **THIS SECTION IS APPLICABLE TO WORK PERFORMED PURSUANT TO A FEDERAL GOVERNMENT CONTRACT:** In connection with its performance of Work pursuant to a federal

government contract, in addition to all other legal compliance obligations, Contractor shall comply with all laws and regulations specific to and applicable to federal government contracts, including, without limitation, regulations and laws regarding employment and non-discrimination and Executive Order 13496 and Executive Order 11246 and the regulations issued pursuant thereto (generally Part 60-1 of Title 41 of the Code of Federal Regulations), unless exempted by said regulations, particularly the provisions of the Equal Opportunity Clause (41 CFR Section 60-1.4(a)), which are incorporated herein by reference; the provisions and regulations pertaining to nondiscrimination and affirmative action in employment (41 CFR Sections 60-1.4, 1.40, 1.41 and 1.42), and the filing of Standard Form 100 (EEO-1). Contractor certifies, in accordance with the requirements of 41 CFR Section 60-1.8), that its facilities for employees are not segregated. In addition, Contractor shall comply with the provisions of the Affirmative Action Clause for Workers with Disabilities (41 CFR Section 60-741.5), and for Covered Veterans (41 CFR Section 60-250.5 and Section 60-300.5), which are also incorporated herein by reference.

21. SITE REQUIREMENTS.

21.1 For all Work to be performed at a Site, Consultant Resources shall comply with Owner's requirements, procedures, and policies and training requirements, including among others those relating to safety, security, environmental practices and access authorization, currently in effect, copies of which are available upon request.

21.2 Owner shall have the right to place its forces or any other contractor's forces at the Site to perform work not included in the Contract. All Work performed by Consultant shall be undertaken in full cooperation with Owner's personnel or the personnel of other contractors at the Site, in order to achieve the least possible interference with the continuity and efficiency of all Owner's interests or activities at the Site. Consultant's forces shall work in harmony with all such other forces, and in accordance with Owner's schedules.

21.3 Consultant represents that prior to commencing Work it has advised its forces of Owner's requirements, procedures and policies; satisfied the applicable training requirements; and conducted such inspections and made such inquiries as it deems necessary concerning the conditions at each Site which might affect Consultant's execution and completion of the Work. Consultant agrees and acknowledges that Information provided by Owner concerning Site conditions has been used for reference only and shall not be claimed to relieve Consultant from its obligation to independently assess the requirements of the Work.

22. INCIDENTAL MATERIALS AND CONSUMABLES.

Consultant, at its sole expense and prior to delivering consumables or materials incidental to performance of Work at the Site, shall inspect or test such consumables or materials to ensure compliance with the Contract, including the Specifications.

23. HAZARDOUS MATERIALS.

23.1 Consultant shall provide to Owner's Representative or designee a written description of and purpose for the use of any products or processes in the Work that are Hazardous Materials or may result in the generation of Hazardous Materials at a Site. Such written submission must identify, prior to the start of the Work and to the satisfaction of Owner's Representative or designee, the practices used to minimize such generation and demonstrate that it has taken all possible steps to eliminate or reduce to the maximum extent possible such generation.

23.2 Consultant shall ensure the environmentally responsible management of any Hazardous Materials included in or resulting from the Work. In performing the Work, Consultant shall comply fully with all Environmental Laws. Consultant is solely responsible for the proper identification and labeling, documentation, handling, storage, minimization, processing and recycling of any and all such Hazardous Materials. Unless otherwise indicated, Consultant shall be responsible for manifesting,

transporting and removing from Site any and all Hazardous Materials. Consultant shall be liable for any and all costs incurred by Owner, at Owner's sole discretion, for the storage, handling, processing, removal and disposal thereof.

23.3 Consultant shall defend and indemnify Owner, its parent, affiliates and its and their employees, agents, officers and directors and hold it and them harmless from any and all damages, claims, demands, or suits of any kind for injury to persons, including death, and damage to property suffered by any person (including Consultant Resources) or by any firm or corporation arising out of, or claimed to have arisen out of, any acts or omissions of Consultant, and Consultant Resources related to or involving Hazardous Materials generated during the course of the Work or brought to the Site by the Consultant or Consultant Resources. This indemnification shall include any liability or claims related to the storage, handling, processing, release, or removal from Site of any such Hazardous Materials by Consultant, Consultant Resources, transporters, recyclers, or any treatment, storage or disposal facility used by Consultant or such other persons. Further, this indemnification shall include liability for any and all costs or penalties (including legal, attorney, administrative, or regulatory fees and expenses) incurred or imposed as a result of actions pursued by federal, state or local governments or agencies related, in any way whatsoever, to the management of such Hazardous Materials.

23.4 Consultant agrees to use the EPA identification number assigned to the Site at which Consultant is working. The use of such EPA number shall not constitute assumption of environmental liability by Owner. In the event Owner has no EPA number for the Site in question, Consultant shall apply for a temporary number.

23.5 No chemical consumable product may be delivered to any Site without prior written approval by the Owner's Representative or designee in the manner provided in the first paragraph of this Article 23. As a condition precedent to such pre-approval, Consultant shall identify to Owner's Representative any and all chemical consumable products that will be used in performing the Work or are listed on the Site's approved Chemical Consumables Products List. Such identification shall include a copy of the product's Material Safety Data Sheet (MSDS), the specific use and location of use, and the expected quantity that will be required to perform the Work. Owner's consideration of Consultant's request shall involve the products' health and safety hazards, environmental and fire hazards, potential for degrading Owner's systems or components, potential for creating Hazardous Materials, and availability of suitable alternatives. A substitute product may only be used following the receipt of express written permission by the Owner's Representative. Consultant is solely responsible for any costs or expenses incurred by Owner as a result of Consultant's use of a product that has not been specifically authorized.

23.6 Following completion of the Work, Consultant shall identify to Owner's Representative all materials or waste that it reasonably believes constitute Hazardous Materials. Final classification of such waste shall be at the sole discretion of Owner's Representative. Unless directed otherwise by Owner, Consultant shall promptly remove any and all equipment and consumables from the Site. In the event that Consultant fails to complete such removal in a timely fashion following completion of the Work, Owner may, at its sole discretion, retain any such material as property of Owner or arrange for its removal at the sole expense of Consultant. Such expenses to be borne by Consultant include, without limitation, the costs of laboratory testing, storage fees, processing, treatment, transportation, recycling, and disposal. The manifesting, transportation and removing from Site of any and all Hazardous Materials shall be effected by Consultant, at Consultant's sole cost and expense.

24. RESERVED.

25. SAFETY PRACTICES, SECURITY, PROTECTION OF THE PUBLIC, WORK AND PROPERTY.

25.1 Consultant and Consultant Resources shall be instructed, familiar with and required to follow safety rules and regulations applicable to the Work being performed, and comply with (1) all Owner policies

and procedures (available upon request) applicable to the Work, and any revisions or updates thereto, including, without limitation, Northeast Utilities Contractor Work Rules and any applicable Contractor Work Rule Addenda; (2) those policies and procedures referenced in the Contract or Purchase Order. Consultant shall coordinate site specific Personal Protective Equipment (PPE), arc flash protection and FR clothing requirements with the Owner. Consultant shall have the sole responsibility to see that such persons are so informed, properly trained and that safety practices are followed.

25.2 Consultant shall establish and maintain safeguards, controls, work rules, or other measures to protect the Owner's property that is placed under Consultant's control, from damage, harm, or sabotage for the entire time during the performance of the Work until Final Acceptance. Consultant shall fully comply with any applicable Owner Site rules. For all Work to be performed at a Site, Consultant's Resources shall comply with Owner's requirements, standards, procedures, and policies and training requirements, including among others those relating to safety, security, environmental practices and access authorization, currently in effect, copies of which are available upon request or may be available electronically, through an Owner web-site. Consultant shall conduct safety briefings and job hazard assessments. Upon Owner's request, Consultant shall provide documentation, confirming Consultant's compliance with this Article 25, including without limitation OSHA logs, qualification requirements and training certifications, licenses and detailed job safety and hazard assessment job plans, and reports of accidents involving Consultant Resources during the performance of the Work on Owner's Site.

25.3 While performing all Work, Consultant shall, and shall ensure that Consultant Resources strictly observe and fully comply with all federal, state, and local safety laws, rules and regulations applicable to the Work and/or the Site Consultant. Consultant shall provide and maintain all necessary precautions for the protection and safety of the public. It shall continuously take all necessary precautions to protect Owner's property from injury or loss arising in connection with the Contract. In addition, when performing Work in close proximity to Owner's employees, Owner's safety rules shall be applicable.

25.4 Consultant shall train all Consultant Resources who carry out Work in the vicinity of energized conductors and equipment, in approved methods of artificial resuscitation, before such persons begin any Work.

25.5 Except with respect to Hazardous Materials, for which the provision of MSDS is required, pursuant to Article 23 "HAZARDOUS MATERIALS", upon Owner request, Consultant shall furnish to Owner's Representative Material Safety Data Sheets (MSDS) for any other product intended for use with the Work and make copies of such MSDS available to Owner at the Site or other mutually agreed upon location. No product for which an MSDS submittal has been requested shall be used until the MSDS has been reviewed by Owner.

25.6 For any Work that takes place at Owner facilities, Consultant shall comply with Owner's security requirements then in effect. Consultant Resources shall strictly adhere to the security regulations and obey the directions of Owner's security personnel. Consultant shall develop and, after review and approval by Owner, implement a security program to account for and protect all tools and equipment under its sole and exclusive care, custody and control in the performance of the Work. Owner shall not be liable to Consultant for loss of or damage to such tools or equipment.

25.7 Owner may immediately suspend or terminate all or any portion of the Work, without any added cost to Owner, and with no adjustments made to the schedule for the Work, if Owner determines that any safety or environmental violations have occurred, including conditions that could result in injury to any individual or damage to property or to the environment.

25.8 RESERVED.

25.9 RESERVED.

26. DELIVERY, TITLE AND RISK OF LOSS TO EQUIPMENT AND MATERIALS.

26.1 Whenever Consultant provides Work that will not be subject to further work by Consultant, title shall pass to Owner upon the performance and delivery of the Work as set forth in the Contract documents and Acceptance.

26.2 RESERVED.

26.3 RESERVED.

26.4 RESERVED.

26.5 Consultant shall deliver the Work materials purchased by Owner to the location stated in the Contract in accordance with the delivery dates and any schedule of performance provided in the Contract, time being of the essence for each such delivery for which a date or a length of time is fixed for delivery.

27. CLEANUP.

For Work performed at any Site, Consultant shall at all times keep the Site free from accumulations of waste material or rubbish. Consultant shall remove at its sole cost and expense from the Site and from all public and private property all temporary structures, rubbish and waste materials resulting from its operations.

28. RESERVED.

29. RESERVED.

30. REMOVAL OF EQUIPMENT.

Except as required to comply with the directions of Owner, Consultant shall promptly remove all Consultant provided materials and supplies from the Site upon completion or termination of the Contract subject to requirements set forth in Article 27 “CLEANUP”. If Consultant fails to complete such removal within fifteen (15) days after notice from Owner, Owner may elect (i) to retain all or any portion of such remaining materials and supplies as its property, or (ii) to remove and dispose of all or any portion of such items at the expense of Consultant.

31. INSURANCE BY CONSULTANT.

As a condition to undertaking the Work, Consultant shall acquire, at its sole cost and expense, the following insurance coverage (or equivalent) from insurers with an A.M. Best rating of A- or better, with the indicated amounts and shall maintain such required insurance coverages during all Work and until the date of final payment under the Contract or Acceptance of all Work under the Contract, unless a longer period is specified below:

31.1 Workers' Compensation in the amounts mandated by law (statutory coverage) and Employers Liability Insurance with limits of not less than $500,000.

31.2 Comprehensive or Commercial General Liability Coverage on standard bureau form excluding Professional Liability but including, without limitation, Operations, Products and Completed Operations, Contractual Liability and Broad Form Property Damage Liability written in one or more layers with a combined single limit for Bodily Injury and Property Damage of not less than $2,000,000 per occurrence and annual aggregate. Products and Completed Operations coverage shall remain in effect for a minimum of three (3) years from the date of final payment under the Contract or Acceptance of all Work under the Contract, whichever is later, unless the Work is to be performed

solely in CT, in which case the required coverage should be in force for two (2) years from such date.

31.3 Comprehensive Automobile Liability Coverage, including, without limitation, all owned, non-owned, and hired vehicles, written in one or more layers with a combined single limit for Bodily Injury and Property Damage of not less than $2,000,000 per accident.

31.4 If applicable, Errors and Omissions coverage for professional Services and products provided by Consultant with limit of not less than $2,000,000 per occurrence and annual aggregate, which coverage Consultant shall maintain in effect for a period of at least seven (7) years following the final payment under the Contract or Acceptance of all Work Under the Contract, whichever is later.

31.5 All policies contemplated in this Article 31 other than Workers' Compensation and Errors and Omissions shall be endorsed to include, without limitation, Owner, its affiliates and their respective directors, officers, employees and agents (including, without limitation, the Owner's Representative), as additional insureds as respects any and all personal and/or bodily injury and/or property damage claims arising out of Consultant's operations hereunder. The limits required under this Article 31 may be satisfied by a combination of primary and excess (umbrella) coverage layers. The foregoing insurance policies shall include a waiver of any right of subrogation of the insurers thereunder against the additional insureds hereunder, and of any right of the insurers to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such person insured under such policy. Should any of the above described policies be cancelled before the expiration date thereof, notice will be delivered in accordance with policy provisions.

31. 6 Consultant shall provide certificates of insurance to Owner to evidence Consultant’s insurance policies within thirty (30) days of the award of any Contract but in no event later than prior to the commencement of any Work. Consultant shall ensure that its broker shall provide Owner with replacement certificates evidencing required insurance coverage prior to the expiration of prior certificates. Failure to provide such certificates shall be grounds for withholding payment and/or termination of the Contract.

31.7 Such insurance coverage shall be primary to any other coverage available to Owner or its affiliates, and shall not be deemed to limit Consultant's liability under the Contract.

31.8 Consultant shall have and maintain in effect the insurances required by this Article 31 for the duration of the Contract and thereafter for any period of continuing contractual obligations, including without limitation, Consultant's warranty obligations. In addition, Consultant and any Subcontractor whose scope of work may include professional services shall procure tail coverage through the applicable warranty period on each errors and omissions policy maintained in accordance herewith upon the expiration and/or non-renewal thereof, unless Consultant's replacement errors and omissions policy provides continuing coverage for the Work through the applicable warranty period.

31.9 Consultant shall be solely responsible for payment of any and all deductible amounts relating to any and all of the policies of insurance required by this Article 31.

31.10 For any Services to be provided by any Subcontractor, Consultant shall require such Subcontractor to provide the foregoing insurance coverages and amounts and comply with the requirements set forth in this Article 31.

32. INDEMNIFICATION BY CONSULTANT.

To the fullest extent permitted by Law, Consultant shall be responsible for and shall indemnify, and shall defend and save Owner, its affiliates and their respective employees, trustees, shareholders, officers, and directors, as well as their respective agents and consultants (each, an

"*Indemnified Person*") harmless from and against any and all costs and expenses (including all costs and expenses of litigation, as well as related attorneys' fees), losses, liabilities, fines, penalties, damages, claims, demands, judgments, awards, obligations, actions, or proceedings whatsoever related to the Work or Consultant's obligations under the Contract Documents. Consultant further agrees to obtain, and maintain at its expense, such insurance as will insure the provisions of all indemnity obligations in the Contract. Nothing in this Article shall derogate or reduce Consultant's obligations under Article 31 hereof.

33. INFRINGEMENT OF PROPRIETARY RIGHTS.

33.1 Consultant shall indemnify, defend and hold harmless Owner, its parent, affiliates and its and their employees, agents, officers, and directors from any and all liabilities, penalties, damages, claims, actions or proceedings based upon any allegation that (i) any portion or all of the Work furnished under the Contract, or any use thereof for purposes intended by the Contract constitutes an infringement of any patent, copyright, trademark or other proprietary interest or (ii) Consultant has, other than solely for Owner's benefit in connection with the Work, made use of Information in which a third party claims a proprietary interest which Information was obtained by Owner from third parties under agreements for confidentiality.

33.2 If Owner provides Consultant notice of a claim of infringement with respect to any material, or Information used in connection with the Work (collectively, the "Product") or Owner's use of all or any portion of the Product is enjoined due to a claim of infringement, Consultant shall promptly and at its sole expense either (i) procure for Owner the right to continue using the Product or (ii) replace the Product with non-infringing and functionally equivalent Product, (iii) modify the Product so that it becomes non-infringing and functionally equivalent, or (iv) take such other action as is necessary to assure Owner's uninterrupted use of the Product.

34. CONFIDENTIAL INFORMATION.

34.1 Each party acknowledges that it may be necessary to disclose Confidential Information to the other. Except to the extent set forth in this Article 34,, or as otherwise agreed to in writing by the parties, each party agrees not to disclose to third parties or to publish any Confidential Information of the other party that is disclosed. However, if Owner, within one hundred eighty (180) days of receipt of Consultant's Confidential Information, disputes the proprietary nature of such Information by written notice to Consultant, the parties shall consult to resolve such dispute. Each party shall advise its employees, Subcontractors, consultants, agents and those under its and/or their respective control of these requirements for confidentiality with regard to Confidential Information.

34.2 Owner shall have the right, without Consultant's approval, to disclose Consultant's Confidential Information to the limited extent required (i) for financing, acquisition or conveyance of ownership share, licensing, construction, startup, commissioning operation, maintenance or repair of the facility at which the Work is performed, and (ii) to comply with any request or order of a governmental agency or court. If Owner discloses Consultant's Confidential Information to any governmental agency or court, Owner shall, to the extent it does not violate or fail to comply with any such request or order, advise Consultant prior to disclosure and, at Consultant's sole cost and expense, cooperate in any effort by Consultant to minimize the amount of Confidential Information disclosed, secure confidential treatment of such Confidential Information, or seek permission from such governmental agency or court to revise the Confidential Information in a manner consistent with Consultant's interests, the interests of Owner, and in a manner that meets the requirements of the governmental authority or court.

34.3 Any Information transmitted to either party will not be deemed Confidential Information if that Information is: (a) in the receiving party's possession without restriction on disclosure prior to disclosure hereunder; (b) at the time of disclosure, generally available to the public without restriction on disclosure; (c) after disclosure, generally available to the public without restriction on disclosure, by

publication or otherwise, through no fault of the receiving party; or (d) after the time of disclosure, received from a third party who imposes no obligation of confidentiality and who, insofar as the receiving party can reasonably determine, did not acquire any such Confidential Information directly or indirectly from the other party subject to requirements of confidentiality.

34.4 Consultant shall notify Owner as soon as possible in writing if any Confidential Information provided to Owner has been changed to a non-proprietary status.

34.5 The provisions of this Article 34 shall also apply to Information that a party identifies and establishes in writing to the others as having been obtained from third parties under agreements for confidentiality.

34.6 Owner may demand the return and/or disposal of its Confidential Information at any time upon giving of written notice to Consultant. Within fifteen (15) days of receipt of such notice, Consultant shall return all of the original Confidential Information and shall dispose of all copies, reproductions or extracts (both written and electronic) in its possession and in the possession of any representatives to whom it was disclosed using methods authorized by the National Association for Information Destruction for the media on which the Confidential Information is stored. Except as may otherwise be agreed upon by the parties in writing, Consultant shall provide Owner with written certification of the return and/or disposal of such Confidential Information promptly following the return or disposal of such Confidential Information.

34.7 In the event any Confidential Information of Owner is disclosed to Consultant by Owner under this Article 34, Consultant shall not make use of such Confidential Information, other than for Owner's sole benefit and for the sole purpose related to the Work for which the Confidential Information has been disclosed.

34.8 The provisions of this Article shall survive the termination of the Contract and shall bind the parties and their successors and assigns.

34.9 **THIS SECTION IS APPLICABLE ONLY TO GENERATION, TRANSMISSION AND DISTRIBUTION WORK:** In addition to the foregoing confidentiality obligations, to the extent that Consultant obtains or generates any critical energy infrastructure information ("CEII"), as defined by Federal Energy Regulatory Commission ("FERC"), pursuant to 18 C.F.R. §388.13, in its performance of the Work, Consultant shall keep confidential any CEII applicable to Owner and the Work. To the extent any such Work involves critical cyber assets, Consultant agrees to be bound by and comply with the North American Electric Reliability Council ("NERC") Critical Infrastructure Protection ("CIP") standards (CIP-002 through CIP-009). Consultant shall indemnify Owner for any liabilities or penalties arising from any failure to comply with the requirements of this Section 34.9 by Consultant, or its subcontractors, at any tier. In addition, upon request by Owner, Consultant shall execute an agreement confirming such compliance with the foregoing obligations.

34.10 **THIS SECTION IS APPLICABLE TO PERSONAL INFORMATION:** Personal Confidential Information shall be kept confidential by Consultant and its agents, employees, and representatives in compliance with all applicable federal and state laws, including, without limitation, Connecticut, New Hampshire and Massachusetts (M.G.L. c. 93H) personal information laws and laws and regulations applicable to persons who own, license, store or maintain personal information about residents of Connecticut and New Hampshire and the Commonwealth of Massachusetts, and Consultant shall take appropriate measures to protect Customer Confidential Information in compliance with Section 17.4 and industry best practices. Consultant shall encrypt all personal information containing financial account or credit or debit account numbers, driver's license numbers, state issued identification numbers or Social Security numbers when such

personal information is stored on laptops or other portable devices, or transmitted across public networks or wirelessly.

35. WARRANTY.

35.1 Services Warranty

35.1.1 Consultant warrants that any Services performed or provided by, through, or on behalf of Consultant as part of or in connection with the Contract shall (i) be performed by Consultant Resources who are fully qualified and competent and whose recommendations, guidance and performance reflect professional knowledge, judgment, and performance in accordance with the highest professional standards applicable to the utility industry and the industry applicable to such Services; and (ii) comply with and conform to all provisions and requirements of the Contract and to any and all provisions of any and all applicable laws.

35.1.2 Within the period of two (2) years after Final Acceptance of all Work under the Contract, if Owner determines that any portion of the Services performed by, through, and/or on behalf of Consultant fails to comply with the warranties set forth above, or if a defect or error is discovered in any Information supplied with such Services, Consultant shall, at its sole cost and at Owner's option, (i) correctly re-perform such Services or correct the defect or error in the Information, or (ii) return to Owner the charges paid by Owner and attributable to such Services or defective or erroneous Information supplied. Owner shall have the right to set-off against other amounts due Consultant hereunder or otherwise any amount owed by Consultant to Owner under this Article 35.

35.1.3 RESERVED

35.2 Supplier Warranties

Consultant shall take all reasonable steps to transfer for the benefit of Owner all warranties or guarantees available from the suppliers of any portion of the Work.

35.3 Information Warranty

Consultant warrants that it has the full legal right, title and ownership of the Information furnished pursuant to the Contract.

35.4 RESERVED

35.5 Completion Warranty

Consultant warrants that it shall complete the Work in accordance with the Work schedule. If the Work falls behind schedule due to causes attributable to Consultant or Consultant Resources, Consultant shall, at its sole cost and expense, use its best efforts to restore the Work to schedule, including but not limited to the following measures: placing Consultant Resources on extended working hours; assigning additional personnel to the Work, and prioritizing Consultant's resources and obligations to ensure that the Work is completed on schedule.

35.6 Conditions of Warranties

The foregoing warranties are subject to the following conditions:

35.6.1 Consultant shall not be responsible for unauthorized changes or corrections made to the Work by persons other than Consultant Resources or any other person at the direction of Consultant Resources;

35.6.2 Owner shall notify Consultant in writing of any breach of warranty.

35.6.3 RESERVED

35.6.4 RESERVED.

35.6.5 Corrective Work performed by Consultant shall be subject to the applicable warranty provisions of this Article. The warranty period for such corrective Work shall be the remainder of the original warranty period plus an additional two years.

35.6.6 The warranties provided for in this Article 35 shall apply regardless of where the Work is performed.

35.6.7 In the case of Work affecting government-owned property, warranties shall also be enforceable directly by the applicable government agency having jurisdiction.

35.7 Subcontractor Warranties

35.7.1 Consultant shall obtain usual and customary warranties from Subcontractors. Such warranties shall be obtained for the benefit of Owner as well as for Consultant. Consultant shall ensure that the benefit of any warranty offered by any Subcontractor at any tier is passed through to Owner, shall provide a copy of the terms of any such Subcontractor warranty to Owner, and shall identify relevant Subcontractor contracts and otherwise actively assist Owner, as required or desired by Owner and without additional charge, in enforcing any such warranty in the event such enforcement should become necessary.

35.7.2 The existence and/or absence of any Subcontractor warranties, including compliance or non-compliance therewith, shall not affect or impair in any manner whatsoever Consultant's obligations to Owner hereunder.

36. LIMITATION OF LIABILITY.

36.1 CONSULTANT'S LIABILITY TO UTILITY UNDER THE CONTRACT WHETHER BASED UPON BREACH OF ANY EXPRESS OR IMPLIED WARRANTY, TORT, CONTRACT, STRICT LIABILITY, OR OTHERWISE SHALL BE THE SUM OF (i) FOR WARRANTY AND INDEMNITY OBLIGATIONS, THE REMEDIES DESCRIBED IN THE CONTRACT, PLUS (ii) FOR DAMAGES CONSULTANT IS REQUIRED TO INSURE AGAINST, ANY RECOVERY AVAILABLE UNDER THE INSURANCE COVERAGES REQUIRED BY THE CONTRACT PLUS (iii) FOR ANY ADDITIONAL DIRECT DAMAGES TO THE UTILITY, AN AMOUNT EQUAL TO THE GREATER OF THE TOTAL OF ALL CHARGES PAID BY UTILITY TO CONSULTANT UNDER THE CONTRACT OR TWO MILLION DOLLARS ($2,000,000). OWNER'S AGGREGATE LIABILITY TO CONSULTANT UNDER THE CONTRACT SHALL NOT EXCEED, UNDER ANY CIRCUMSTANCES WHATSOEVER, THAT PORTION OF THE COMPENSATION DUE UNDER ARTICLE 3 “TERMS OF PAYMENT” THAT HAS NOT YET BEEN PAID BY OWNER WITH RESPECT TO THE WORK.

36.2 EXCEPT TO THE EXTENT ALLOWED UNDER THE INSURANCE, WARRANTY OR INDEMNITY PROVISIONS OF THE CONTRACT, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES.

36.3 CONSULTANT WAIVES ALL CLAIMS AGAINST UTILITY FOR ANY LIABILITY OR LOSS IN CONNECTION WITH: (i) PAYMENT OF ALL FEDERAL, STATE AND LOCAL TAXES OR CONTRIBUTIONS IMPOSED OR REQUIRED UNDER UNEMPLOYMENT INSURANCE, SOCIAL SECURITY AND INCOME TAX LAWS WITH RESPECT TO CONSULTANT'S WORK UNDER THE CONTRACT; (ii) ALL LOSSES IN CONNECTION WITH ANY CLAIMS FOR LOST WAGES, SEVERANCE PAY, PENSIONS OR OTHER BENEFITS WITH RESPECT TO CONSULTANT'S WORK UNDER THE CONTRACT; AND (iii) ALL CLAIMS FOR LIABILITY FOR DAMAGE TO CONSULTANT'S PERSONAL PROPERTY OR INJURY TO CONSULTANT RESOURCES IN

CONNECTION WITH THE CONTRACT.

36.4. The parties understand and agree that the liability of Consultant to Owner under the Contract, at law, and/or in equity shall not be limited by the amount of insurance coverage required or made available pursuant to the provisions of Article 31 “INSURANCE BY CONSULTANT”.

37. RIGHTS AND LIABILITIES OF PRINCIPALS.

All benefits, protections, indemnifications and other rights in favor of Owner under the Contract shall also benefit, protect and indemnify the principals of Owner.

38. RESERVED.

39. DISPUTE RESOLUTION; NEGOTIATION; MEDIATION; ARBITRATION.

39.1 The Parties shall attempt in good faith to resolve any dispute arising out of or relating to this Contract promptly by negotiation between executives with authority to settle the dispute and who are at a higher level of management than the persons with direct responsibility for administration of this Contract. Any party may give the other written notice of any dispute, which notice shall include a summary of that party's position and the name and title of the executive who will be representing that party. Within fifteen (15) days after delivery of the notice, the receiving party shall respond with a summary of that party's position and the name and title of the executive who will represent that party. Within thirty (30) days after the initial notice, the Parties’ executives shall meet at a mutually acceptable time and place to attempt to resolve the dispute. All reasonable requests for information made by one party to the other in support of the negotiation will be honored, and all negotiations pursuant to this Article 39 shall be confidential and treated as compromise and settlement negotiations.

39.2 If the dispute has not been resolved by negotiation within forty-five (45) days after the disputing party's notice, or if the Parties failed to meet within thirty (30) days, the Parties shall proceed to mediation under the then current CPR Mediation Procedure, and, unless otherwise agreed, will select a mediator from the CPR Panels of Distinguished Neutrals.

39.3 Any dispute arising out of or relating to this Contract, including the breach, termination or validity thereof, that has not been resolved by a non-binding procedure as provided herein within ninety (90) days of the initiation of such procedure, shall be finally resolved by arbitration in accordance with the then current CPR Rules for Non-Administered Arbitration by a sole arbitrator, for disputes involving amounts in the aggregate under Three Million Dollars ($3,000,000), or three arbitrators, for disputes involving amounts in the aggregate equal to or greater than Three Million Dollars ($3,000,000), of whom each party shall designate one in accordance with the "screened" appointment procedure provided in CPR Rule 5.4, with the third arbitrator selected pursuant to CPR Rules 5 and 6. The arbitration shall be governed by the Federal Arbitration Act, 9 U.S.C. §§ 1-16, and judgment upon the award rendered by the arbitrator(s) may be entered by any court having jurisdiction thereof. Unless otherwise agreed to by the parties, the place of arbitration shall be Hartford, Connecticut.

39.4 Any award or determination made by the arbitrator(s) shall be subject to the limitations of liability set forth in this Contract. The arbitrator(s) are not empowered to award damages in excess of compensatory damages and each party expressly waives and foregoes any right to punitive, exemplary or similar damages unless a statute requires that compensatory damages be increased in a specified manner. Each Party shall be responsible for its own costs and expenses, including attorney's fees. Unless otherwise directed in writing by Owner and to the extent permitted by law, Consultant shall continue performance of the Work in compliance with the Contract notwithstanding the existence of any Dispute between the Parties. Nothing herein shall prejudice, impair or otherwise prevent Owner from receiving equitable relief pending the conclusion of any mediation and/or arbitration proceeding.

39.5 Each Party will proceed in good faith to conclude the arbitration proceeding as quickly as reasonably possible. If a party refuses to participate in an arbitration proceeding as required by this Contract, the other party may petition any governmental authority having proper jurisdiction for an order directing the refusing Party to participate in the arbitration proceeding. All costs and expenses incurred by the petitioning Party in enforcing such participation will be paid for by the refusing Party. The parties hereby consent to the exclusive jurisdiction of the courts of the State of Connecticut for enforcement of all arbitration procedures pursuant to this Article 39 and any other legal proceedings arising out of or relating to the Contract and the transactions contemplated hereby.

40. ADVERTISING.

Unless authorized in writing by Owner or except as required by applicable law, Consultant shall not engage in any advertising, publicity or other promotional activity which directly or indirectly mentions or refers to the relationship between the parties or the Work furnished under the Contract.

41. BINDING EFFECT; ASSIGNMENT.

The Contract shall be binding upon the parties and their respective successors and permitted assigns. Consultant is not authorized to and shall not directly or indirectly (through an equity sale, merger or other transaction) sell, assign or otherwise transfer the Contract, in whole or in part, or any of the Work to be performed hereunder, without the prior written consent of Owner, which may be granted or withheld in Owner's sole discretion. Without waiving any rights and remedies Owner may have against Consultant, upon discovering that Consultant has purported to sell, assign or otherwise transfer, in whole or in part, the Contract or any of the Work to be performed, without the Owner's prior written consent, Owner may, at its sole option and in its sole discretion, deem such action to be binding and enforceable against such assignee, successor, or transferee, or may deem such action to be null, void, and of no force or effect.

42. WAIVERS.

The waiver by any party of a breach of and/or other non-compliance with any provision of the Contract shall not operate or be construed as a waiver of any subsequent breach or non-compliance.

43. APPLICABLE LAW.

43.1. The Contract and the rights and duties of the parties hereunder shall be governed by and construed, enforced and performed in accordance with the laws of the State of Connecticut, without regard to its principles of conflicts of law *provided* that if the Work is exclusively for Public Service Company of New Hampshire, then the Law of the State of New Hampshire shall apply.

43.2 RESERVED

44. NOTICES; DEMANDS.

All notices required under the Contract shall be in writing and shall be deemed to be given when received upon personal delivery, or if mailed, as of the date indicated on the receipt document provided by the mail carrier, if so delivered or if so mailed (a) with respect to Owner, to the individual set forth on the "Direct Inquiries" line on Owner's Purchase Order at the address set forth thereon; or (b) with respect to each of the Owner's Representative, Consultant or the Consultant's Representative, to the applicable individual set forth in the Special Terms and Conditions, at the address of such individual set forth thereon, unless otherwise indicated in the Contract.

45. RIGHT TO AUDIT.

Owner shall have the right to inspect and audit all of Consultant's and any Subcontractor's books, records, correspondence, receipts, vouchers and memoranda relating to or affecting the Contract. Consultant shall provide for such right to audit by Owner in all contracts with Subcontractors relating to the Contract.

46. DOCUMENT RETENTION.

Except as set forth in Section 6.5 "INFORMATION", Article 34 "CONFIDENTIAL INFORMATION" and below in this Article 46, all Information shall remain the exclusive property of Owner, regardless of where it is stored. Consultant shall preserve Owner's Information in its care, custody or control for a period of six (6) years following Final Acceptance of the Work or return such Information to Owner in a form acceptable to Owner. Consultant shall not destroy any such Owner Information prior to the expiration of such six (6) year period absent Owner's prior written consent. Owner reserves the right to access such Owner Information at any time while such Information is in Consultant's possession and such Information shall be provided to Owner on a timely basis whenever requested, regardless of whether such requests are for audits, regulatory or legal proceedings such as lawsuits or arbitrations. Any Owner Information in Consultant's possession shall be disclosed to third parties only as necessary to comply with applicable laws and government orders or requests so long as Owner receives advance written notice of such disclosure and an opportunity to contest such requests. Consultant agrees to access Information in its possession only for the purposes of performing the Work and to operate or maintain its information systems and will take appropriate and Owner approved measures and precautions to protect against unauthorized access or disclosure. Consultant agrees for itself, and on behalf of any Subcontractor, to (a) access Owner Information in its, or in any Subcontractor's, possession only for the purpose of performing the Work on a Project, and (b) operate, maintain and/or take appropriate and Owner-approved measures and precautions to protect its information systems against unauthorized access or disclosure of Owner Information. Consultant shall be responsible for ensuring that Owner Information is protected from damage and/or loss while in the care, custody or control of Consultant and/or any Subcontractor, including making backups of Information and using disaster recovery best practices for any computer systems used to store Information. Owner reserves the right to audit Consultant to ensure such Information is managed in accordance with this Article 46. The foregoing obligations and restrictions regarding disclosure of Information in this Article 46 shall not apply to Consultant's Confidential Information, which shall be governed by Article 34 "CONFIDENTIAL INFORMATION" The provisions of this Article shall survive the termination of the Contract and shall bind the parties and their successors and assigns.

47. SUPPLIER DIVERSITY AND SUBCONTRACTING PLAN.

47.1. Owner fully supports the government's policies of ensuring that Small Disadvantaged Businesses (SDB), Women-Owned Small Businesses (WOSB), Service-Disabled Veteran-Owned Small Businesses (SDV), Veteran-Owned Small Businesses (VE) and Businesses Located in and qualified as Historically Underutilized Business Zones (HUBZone) have every opportunity to compete for contracts and subcontracts. Owner has and will continue to commit to filing annual subcontracting plans regarding the utilization of SDB, WOSB, SDV, VE and HUBZone as contractors and subcontractors in accordance with Federal Acquisition Regulation (FAR) 52.219.

47.2. FOR ALL CONTRACTS THAT OFFER SUBCONTRACTING OPPORTUNITIES, CONSULTANT WILL BE REQUIRED TO SUBMIT DATA AND/OR SUBCONTRACTING PLANS REGARDING CONSULTANT'S UTILIZATION AND INTENDED UTILIZATION OF SUCH SDB, WOSB, SDV, VE and HUBZone DURING THE TERM OF THE CONTRACT.For all contracts that offer subcontracting opportunities, Consultant will be required to submit data and/or subcontracting plans regarding Consultant's utilization and intended utilization of such SDB, WOSB, SDV, VE and HUBZone during the term of the Contract to the: **Manager of Supplier Relations and Diversity; Northeast Utilities Service Company; Purchasing Department; P.O. Box 270;**

Hartford, CT 06141-0270 or by email at SupplierDiversity@NU.com with "Attention Supplier Diversity" in the subject line. If direct subcontracting opportunities do not exist, Consultant nonetheless may be required to submit data and/or subcontracting plans regarding indirect spend. Consultant shall supply Consultant's subcontracting plan to Owner within a reasonable time after the effective date of this Agreement (but in no event more than sixty (60) days after the effective date) and shall fully comply with such plan in performing the Work.

47.3. The text of FAR 52.219 may be accessed electronically at the following address: https://www.acquisition.gov/far/. To the extent applicable to Work performed pursuant to a federal government contract, this Article 47 incorporates one or more clauses by reference, with the same force and effect as if they were given in full text.

48. PRIORITY OF DOCUMENTS.

In the event of any conflict, inconsistency or ambiguity between or among the Contract documents, the order of priority shall be: as follows, except as otherwise designated in advance and in writing by Owner: (1) Owner's Purchase Order; (2) Special Terms and Conditions (if any); (3) these General Terms and Conditions; (4) Specifications; and (5) any remaining documents referred to in the Contract documents. The provisions of change orders and other changes, amendments, deletions, additions or other alterations to Contract documents shall have the priority of the applicable Contract documents to which they relate. In the absence of written direction from Owner to the contrary, the more/most stringent requirement of the Information included in the Specifications shall be deemed to apply in the event of any inconsistency, conflict, or ambiguity between or among two or more requirements therein. The pre-printed terms on the back of Owner's Purchase Order are hereby deleted and shall not bind either party.

49. SEVERABILITY.

In the event that any provision of the Contract is deemed invalid or unenforceable, it shall be modified to the extent necessary to make it valid and enforceable. The remaining provisions of the Contract shall remain fully enforceable notwithstanding the unenforceability of any individual provision.

50. FINANCIALS.

Upon written request by Owner, Consultant shall furnish the Owner, the Consultant's financial statements, including the accompanying notes thereto, for the immediately preceding quarter or fiscal year, as Owner requests, throughout the term of this Agreement. Such financial statements shall be prepared and certified internally by the chief financial officer of the Consultant and shall be reviewed annually by an independent certified public accountant hired by Consultant. All such financial information shall be considered Consultant's Confidential Information.

51. RESERVED

52. NO GIFTS OR INDUCEMENTS.

Consultant warrants and represents to Owner that neither it nor its Consultant Resources have either provided or offered to provide any gifts, payments, or other inducements to any officer, employee or agent of Owner for any purpose. Consultant shall not provide or offer any gifts, payments, or other inducements to any officer, employee or agent of Owner for any purpose and shall ensure that no employee or agent of Consultant offers any such gifts, payments or inducements. Consultant also represents and warrants to Owner that it and its Consultant Resources has neither provided nor offered to provide any gifts, payments, or other inducements to any government official, employee or agent in violation of any laws or regulations, including the Foreign Corrupt Practices Act.

53. MOONLIGHTING RESTRICTION.

Consultant shall neither employ, nor knowingly permit subcontractors to employ, Owner

employees to perform the Work while the employees are employed by Owner.

54. APPLICABLE TO TRANSMISSION WORK ONLY: NON-HIRING PROVISION.

During the term of this Agreement, and for a period of one (1) year thereafter, Consultant shall not solicit the employment of, employ, or contract with, any of Owner's employees, either directly or through a third party. Such hiring restriction shall not apply to Consultant's employment of any individual after twelve (12) months have elapsed subsequent to the date on which such person's employment with Owner has terminated. Consultant agrees that, should it breach this paragraph, it will be liable to Owner for all resulting damages, and, in addition, to appropriate equitable relief. Owner, in its sole discretion, may waive in writing this entire paragraph or selected provisions thereof.

55. INTERPRETATION.

The parties acknowledge that (a) they are of equal bargaining strength and have jointly participated in the preparation of the Contract; and (b) any rule of construction to the effect that ambiguities are to be resolved against the drafting party shall not apply in the interpretation of the Contract, any portion thereof, or any amendments thereto.

56. CAPTIONS.

The captions for the Sections and Articles contained in the Contract have been inserted for convenience only and form no part of the Contract and shall not be deemed to affect the meaning or construction of any covenants, agreements, conditions or terms of the Contract.

57. SURVIVAL.

All agreements, representations, warranties and covenants made by a party to the Contract and in the certificates or other documents delivered by a party pursuant to the Contract shall be considered to have been relied upon by the other party and shall survive Final Acceptance of the Work hereunder. All requirements, terms, conditions and provisions that by their nature are incapable of being fully performed within the period of performance hereof shall survive cancellation, termination or expiration of the Contract, including, without limitation, all of Consultant's non-disclosure obligations, warranties, and indemnities for the benefit of Owner.

58. COMPLETE AGREEMENT.

The Contract shall constitute the complete agreement between the parties. All prior communications, whether oral or written, shall be superseded by the Contract and shall not bind the parties. No change to the Contract shall be binding upon the parties unless made in writing and signed by both parties.

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APPENDIX F

LOST BASE REVENUE

This section does not apply to the Company, as the Company has decoupled. See Western Massachusetts Electric Company, D.P.U. 10-70.