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August 1, 2013

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

Re: NSTAR Gas, D.P.U. 13-**XX**
2012 Energy Efficiency Annual Report

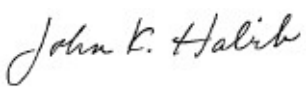
Dear Secretary Marini:

On behalf of NSTAR Gas (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).

Confidential information associated with the Company's 2012 Energy Efficiency Annual Report is being submitted to the Hearing Officer and the Office of the Attorney General only, under seal. A Motion for Protective Treatment is also attached.

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

Enclosures

cc: Jonathan Goldberg, 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)

COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF PUBLIC UTILITIES

NSTAR Gas Company	)	D.P.U. 13-XX

MOTION OF NSTAR GAS COMPANY
FOR PROTECTIVE TREATMENT OF CONFIDENTIAL INFORMATION

NSTAR Gas Company (the "Company" or "NSTAR Gas") hereby requests that the Department of Public Utilities (the "Department") grant, pursuant to G.L. c. 25, § 5D, protection from public disclosure of certain confidential, competitively sensitive and proprietary information submitted as part of the Department's review of the NSTAR Gas's 2012 Energy Efficiency Annual Report (the "Annual Report"). Specifically, the Company requests that the Department protect from public disclosure audit information provided in Section VI and Appendix E, Section 3 of the Annual Report, which contain competitively sensitive information regarding internal audits performed by the Company to evaluate its operations.

I. LEGAL STANDARD

Confidential information may be protected from public disclosure in accordance with G.L. c. 25, § 5D, which states in part that:

> The [D]epartment may protect from public disclosure, trade secrets, confidential, competitively sensitive or other proprietary information provided in the course of proceedings conducted pursuant to this chapter. There shall be a presumption that the information for which such protection is sought is public information and the burden shall be on the proponent of such protection to prove the need for such protection. Where the need has been found to exist, the [D]epartment shall protect only so much of the information as is necessary to meet such need.

In interpreting the statute, the Department has held that:

> . . . [T]he burden on the company is to establish the need for protection of the information cited by the company. In determining the existence and extent of such need, the Department must consider the presumption in favor of disclosure and the specific reasons why disclosure of the disputed information benefits the public interest.

The Berkshire Electric Company et al., D.P.U. 93-187/188/189/190, at 16 (1994) as cited in Hearing Officers Ruling On the Motion of Boston Electric Company for Confidentiality, D.P.U. 96-50, at 4 (1996).

Thus, a Company must prove that: (1) the information for which protection is sought constitutes trade secrets, confidential, competitively sensitive or other proprietary information; and (2) there is a need to ensure nondisclosure of the information. The Berkshire Gas Company, D.T.E. 01-41, at 16 (2001). Where a party proves such a need, the Department may limit the length of time that such protection is in effect. Id.

II. BASIS FOR CONFIDENTIALITY

By this Motion, the Company seeks protection from public disclosure Section VI and Appendix E, Section 3 of the Company's Annual Report. Section VI and Appendix E, Section 3 provide the following information required by the Department to be included in the Company's Annual Report:

> List all audits (internal and external) conducted during the program year, as well as within the last five years, that relate to the Program Administrator's energy efficiency activities. For each audit:
>
> - describe its purpose/scope
> - identify the entity that conducted the audit
> - describe how the audit was conducted
> - provide the date on which the audit was completed
> - identify the recommendations, if any, included in the final audit,
>
> and

- describe the Program Administrator-process for determining whether a recommendation is implemented or rejected; what recommendations were implemented and the impact on the energy efficiency programs; and for those recommendations that were rejected, the reasoning behind the rejection.

In response to this requirement, the Company is providing an audit conducted by its Internal Audit Department during 2012 addressing controls governing the Company's energy efficiency processes, costs and reporting. This audit was performed in the regular course of business pursuant to the Company's comprehensive audit plan and was not spurred by, or related to, any particular incident or circumstances relating to the Company's energy efficiency processes calling for audit or other review.

The Company requests that its internal audits be protected from public disclosure because of the critical importance of encouraging employees to participate in audits and provide all of the information necessary for the audit to be successful. To ensure the integrity of the audit process, employees are given assurances that their answers will not be made available to the public. Such assurances serve an important role in the Company's ability to obtain and detect information that would otherwise be difficult or impossible to gather. The chilling effect that would be created as a result of public disclosure of the information obtained during an audit would substantially reduce the value of the audit process. That is, confidentiality is critical to the process of all internal Company audits in order to obtain the highest quality information.

With that in mind, the Company believes that an effective Internal Audit function is critical to management identifying issues and achieving meaningful solutions to enhance its operations. The effectiveness of the Internal Audit function is directly related

to the Company's ability to have access to a free and candid flow of information. The Company believes that, in general, disclosure of audit findings may have a chilling effect on that flow of information, and may therefore negatively impact management's ability to continually improve operations. Accordingly, consistent with past Department practice, the Company's internal audit should be granted confidential status by the Department.

In the past, the Department has granted protective treatment for utility self-assessments because disclosure may affect the willingness of employees to reveal information fully and completely. NSTAR Electric Company, D.P.U. 09-64, March 19, 2010 Stamp Approval of Company Motion for Protective Treatment of 2005 Audit Information); see also New England Gas Company, D.P.U. 07-46, Hearing Officer Ruling at 5-6 (August 23, 2007) (Department grants protected status for internal audits conducted to evaluate its operations); and Boston Gas Company d/b/a KeySpan Energy Delivery New England, D.T.E. 03-40, Hearing Officer Ruling (October 9, 2003) (Department grants protected status for internal audits conducted to evaluate its operations). Thus, consistent with the Department's precedent, the Company seeks protection from public disclosure of the audit information provided in Section VI and Appendix E, Section 3 of its Annual Report.

III. CONCLUSION

By this Motion, the Company requests that the Department protect from public disclosure Section VI and Appendix E, Section 3 of its Annual Report, which includes confidential information regarding internal audits performed by the Company to evaluate its energy efficiency activities. The Department has previously held that such documents should be protected from public disclosure on public policy grounds. The information

provided to the Department under this motion and will also be available to the Attorney General for her inspection pursuant to the terms of the non-disclosure agreement signed between her and the Company. Therefore, the public interest will not be affected adversely by protecting the information from public disclosure.

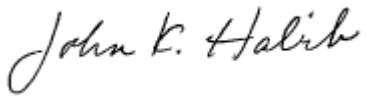
Accordingly, the audit information provided in Section VI and Appendix E, Section 3 to the Annual Report should be granted confidential treatment by the Department. Consistent with Department practice with regard to the confidential treatment of internal audit materials, the Company requests that the Department grant such confidential treatment for a period of two years from the date of the Department's final order in this proceeding. Consistent with Department precedent, prior to expiration, the Company seeks approval to renew its request for confidential treatment, accompanied by proof of the need for such protection. See New England Gas Company, D.P.U. 07-46, Hearing Officer Ruling at 6 (August 23, 2007).

WHEREFORE, the Company respectfully requests that the Department grant its Motion for Protective Treatment as stated herein.

Respectfully Submitted,

NSTAR GAS COMPANY

By its attorney,



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Dated: August 1, 2013

2012

Energy Efficiency Annual Report

VOLUME 1

August 1, 2013

NSTAR Gas 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. 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.

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

[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.

"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

NSTAR Gas 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[2] 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.

[2] 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[3] 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	$	26,206,578			23,969,094		-9%
Performance Incentive	$	1,177,456			1,095,129		-7%
Savings & Benefits							
Gas							
Lifetime	therms	79,582,407	67,043,040	-16%	61,850,135	-8%	-22%
Annual	therms	5,104,848	4,460,446	-13%	4,179,066	-6%	-18%
Electric							
Annual Energy	kWh	144,633	254,597	76%	258,030	1%	78%
Annual Demand							
Summer	kW	36	34	-5%	125	267%	251%
Winter	kW	75	94	26%	76	-20%	1%
Non-Gas Non-Electric Resources (Lifetime)	$	14,288,219	20,051,314	40%	20,206,405	1%	41%
Cost-Effectiveness							
TRC Benefits	$	78,805,093			71,249,538		-10%
TRC Costs	$	40,390,171			35,711,514		-12%
Net Benefits	$	38,414,922			35,538,024		-7%
BCR	n/a	1.95			2.00		2%

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 in NSTAR Gas Company, D.P.U. 11-107.

As shown in Table 1.A above, a significant variance exists at the portfolio level for lifetime gas savings between the planned and evaluated values. The C&I sector is the driving factor accounting for this variance.

Significant variances also exist at the portfolio level for electric energy and demand between the planned and preliminary year-end and evaluated values. Changes in load shape of measures, coupled with differences between planned and actual participation and measure mix in the Residential New Construction and Major Renovation program, account for these variances.

Non-gas non-electric resources were positively affected by the application of the *Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts ("NEI")* Study in the C&I sector.

[3] 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.

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.

Table I.B: Customer Sector Summary

Sector	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Residential				
TRC Benefits	$	32,905,105	31,555,835	-4%
TRC Costs	$	18,928,843	21,364,960	13%
Net Benefits	$	13,976,262	10,190,875	-27%
BCR	n/a	1.74	1.48	-15%
Low-Income				
TRC Benefits	$	8,090,691	11,216,970	39%
TRC Costs	$	5,695,313	5,672,630	0%
Net Benefits	$	2,395,378	5,544,340	131%
BCR	n/a	1.42	1.98	39%
C&I				
TRC Benefits	$	37,809,297	28,476,733	-25%
TRC Costs	$	15,766,015	8,673,924	-45%
Net Benefits	$	22,043,283	19,802,809	-10%
BCR	n/a	2.40	3.28	37%
TOTAL				
TRC Benefits	$	78,805,093	71,249,539	-10%
TRC Costs	$	40,390,171	35,711,514	-12%
Net Benefits	$	38,414,922	35,538,025	-7%
BCR	n/a	1.95	2.00	2%

As shown in Table 1.B above, significant variances exist at the sector level between planned and evaluated values for the following metrics: residential net benefits; low-income TRC benefits, net benefits and BCR; and C&I TRC benefits, TRC costs and BCR.

- Within the residential sector, the Residential New Construction and Major Renovation and the Residential Heating and Water Heating programs primarily contributed to the variance between planned and evaluated values. 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, the Low-Income Retrofit program caused the variance between planned and evaluated values. Please refer to section II.B.2 for a more detailed discussion of the cause of the variances by program within this sector.

- Within the C&I sector, the C&I New Construction and Major Renovation and C&I Retrofit programs contributed to the variance between planned and evaluated values. 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 Heating and Water Heating
- Residential Mass Save/Weatherization
- Residential Multi-Family Retrofit

Residential Pilots

- Deep Energy Retrofit
- Community Based

Tables II.A.1 and II.A.3 provide summary information on the performance of the residential programs at the sector and program levels, respectively. Please note the gas Program Administrators do not track data by end-use, and, therefore, are not required to provide the information in Table II.A.2.

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	$	13,234,051			14,057,579		6%
Performance Incentive	$	461,603			429,190		-7%
Savings & Benefits							
Gas							
Lifetime	therms	26,670,705	30,138,794	13%	25,982,188	-14%	-3%
Annual	therms	1,347,608	1,593,848	18%	1,429,779	-10%	6%
Electric							
Annual Energy	kWh	144,633	173,733	20%	103,058	-41%	-29%
Annual Demand							
Summer	kW	36	21	-42%	12	-41%	-66%
Winter	kW	75	80	7%	27	-66%	-64%
Non-Gas Non-Electric Resources (Lifetime)	$	10,411,412	14,640,720	41%	9,792,766	-33%	-6%
Cost-Effectiveness							
TRC Benefits	$	32,905,105			31,555,835		-4%
TRC Costs	$	18,928,843			21,364,960		13%
Net Benefits	$	13,976,262			10,190,875		-27%
BCR	n/a	1.74			1.48		-15%

As shown in Table II.A.1 above, significant variances exist at the residential sector level between planned, preliminary year-end, and evaluated values in the electric energy and demand and the non-gas non-electric resources categories. The reasons for such variances are described below.

- Significant variances in the electric energy and demand values between the planned and preliminary year-end values and the planned and evaluated values are related to the Residential New Construction and Major Renovation program. Differences in summer and winter demand between the planned and evaluated values are due to the inclusion of the Cadmus Demand Impact Model which provided new load shapes for many measures. Additionally, differences in anticipated participation and measure mix in the Residential New Construction and Major Renovation program contributed to the discrepancies.
- Non-gas non-electric resources showed a 41 percent increase between planned and preliminary year-end values due to the inclusion of new measures with high non-gas non-electric benefits and a difference in anticipated measure mix. The 33 percent decrease in non-gas non-electric resources from preliminary year-end to evaluated results were primarily driven by the exclusion of certain NEIs as detailed in the *2012 Residential Heating, Water Heating and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing* study.
- The changes in net benefits are a mathematical result of the changes in the TRC benefits and TRC costs.

Table II.A.3: Residential Program Summary				
Program / Performance Category	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Residential New Construction & Major Renovation				
TRC Benefits	$	4,835,430	3,644,939	-25%
TRC Costs	$	2,697,548	2,079,948	-23%
Net Benefits	$	2,137,882	1,564,991	-27%
BCR	n/a	1.79	1.75	-2%
Residential Heating and Water Heating				
TRC Benefits	$	10,492,691	9,672,391	-8%
TRC Costs	$	5,105,068	6,731,200	32%
Net Benefits	$	5,387,622	2,941,191	-45%
BCR	n/a	2.06	1.44	-30%
MassSAVE				
TRC Benefits	$	0	0	0%
TRC Costs	$	1,729,406	1,844,457	7%
Net Benefits	$	-1,729,406	-1,844,457	7%
BCR	n/a			
Weatherization Program				
TRC Benefits	$	15,283,118	16,260,002	6%
TRC Costs	$	7,549,131	9,397,813	24%
Net Benefits	$	7,733,987	6,862,189	-11%
BCR	n/a	2.02	1.73	-15%
Multi-Family Retrofit				
TRC Benefits	$	2,293,866	1,978,503	-14%
TRC Costs	$	1,318,566	1,093,501	-17%
Net Benefits	$	975,300	885,002	-9%
BCR	n/a	1.74	1.81	4%
Deep Energy Retrofit				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	31,032	8,259	-73%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
Community Based Pilot				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	57,000	14,350	-75%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
Hard-to-Measure Initiatives				
TRC Costs	$	498,092	209,782	-58%
TOTAL				
TRC Benefits	$	32,905,105	31,555,835	-4%
TRC Costs	$	18,897,811	21,356,701	13%
Net Benefits	$	14,007,294	10,199,134	-27%
BCR	n/a	1.74	1.48	-15%

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

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[4] – 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. 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 codes. 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*. This 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 Heating and Water Heating - In 2012, the PAs collectively achieved over 100 percent of their annual savings goals within budget due to attractive customer incentives. Through the program, the Program Administrators reached out to 300 supply houses and over 1,000 contractors throughout Massachusetts and New England. The PAs continued to successfully utilize extensive contractor outreach via supply houses and big box retailers, which contributed to increased participation levels in this program. PAs sponsored and participated in 25 training events in 2012. On September 20, 2012, the PAs sponsored their 12th Annual GasNetworks®/Mass Save Fall Conference and Trade Show in Randolph, MA. Attendees included over 400 HVAC contractors, trainers, and inspectors from the across the Commonwealth, as well as 32 exhibitors. The Program Administrators coordinated a full-day agenda of training sessions and seminars on the latest high efficiency natural gas HVAC technologies and installation and maintenance practices. Participants also learned about opportunities to save energy and participate in PA programs. The Program Administrators also continued their integration efforts with the electric Residential Cooling and Heating Equipment ("Cool Smart℠") program and incorporated breakout sessions to include such topics as electronically commutated motors, brushless fan

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

motor technology, hydronic heating, on-demand water heating, condensing and modulating boilers, near boiler piping, system sizing, renewables and codes and standards updates.

- Mass Save/Weatherization – 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 vendors.

  The Contractor 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. 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.

- 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.

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, 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 gas 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:

- Heating
- Air Duct
- Hot Water
- Envelope

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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 135-144 (bates numbering 00136-00145). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

Table II.A.4[5] 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	$	1,623,402			1,263,368		-22%
Performance Incentive	$	57,771			51,757		-10%
Participants	unique accts	700			488		-30%
Program Cost / Participant	$	2,319			2,589		12%
Savings & Benefits							
Gas							
Lifetime	therms	3,685,992	1,874,715	-49%	1,764,707	-6%	-52%
Annual	therms	155,818	81,538	-48%	75,505	-7%	-52%
Average Measure Life	yrs	23.7	23.0	-3%	23.4	2%	-1%
Electric							
Annual Energy	kWh	144,899	174,797	21%	104,122	-40%	-28%
Annual Demand							
Summer	kW	36	21	-42%	12	-40%	-65%
Winter	kW	75	81	7%	27	-66%	-64%
Non-Gas Non-Electric Resources (Lifetime)	$	1,479,433	1,998,101	35%	1,997,781	0%	35%
Cost-Effectiveness							
TRC Benefits	$	4,835,430			3,644,939		-25%
TRC Costs	$	2,697,548			2,079,948		-23%
Net Benefits	$	2,137,882			1,564,991		-27%
BCR	n/a	1.79			1.75		-2%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

Expenses – The variance between the planned and evaluated total program costs was due to lower than expected expenditures on participant incentives. Due to economic conditions, and the carry over of numerous projects into 2013, there were 30 percent fewer participants than expected in this program in 2012. The fact that fewer overall participants were involved in this program explains the lower than expected spend on participant incentives.

Savings and Benefits – The decrease in lifetime and annual gas savings between planned values and preliminary year-end and evaluated values was due to fewer participants in the program.

There were several variances in the electric energy and demand savings because electric savings are not a major focus of this gas program. Most of the large variances were caused by a small number of electric measures that are not a significant portion of the program savings. A revision in the kWh savings assumption associated with heating equipment and variations in participation in

[5] 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.

the Residential New Construction and Major Renovation program explains the variances in annual energy saving between planned, preliminary year-end, and evaluated values. Differences in summer and winter demand between the planned, preliminary year-end, and evaluated values are due to the inclusion of new load shapes from the Cadmus Demand Impact Model for many measures. Additionally, differences in anticipated participation and measure mix in the Residential New Construction and Major Renovation program contributed to the discrepancies.

For non-gas non-electric resources, the increase from planned values to preliminary year-end and evaluated values was due to the reclassification of certain NEIs from one-time values to annual values.

Cost-Effectiveness – Evaluated TRC benefits are 25 percent lower than planned values due to lower gas savings from lower participation than expected and lower NTG ratios as reported in the *Massachusetts 2011 Baseline Study of Single-family Residential New Construction*. The referenced study was filed with the Company's 2013-2015 Three-Year Energy Efficiency Plan. See NSTAR Gas, D.P.U. 12-105. 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 1.75.

b. Residential Heating and Water Heating

Purpose/Goal: The purpose of the Residential Heating and Water Heating program was to overcome market barriers to the installation of energy efficient heating/hot water equipment and to increase program awareness among consumers, plumbing/heating contractors, and home builders/developers, by means of rebates, marketing, and training courses.

Targeted Customers: The program targeted residential home owners with natural gas heating/hot water heating equipment (both new construction and existing homes), home designers/architects, engineers, plumbing and HVAC contractors and technicians, high efficiency heating equipment and related parts/accessory suppliers, manufacturers, and distributors, and new home building and remodeling contractors.

Definition of Program Participant: A participant is defined as the number of measures installed.

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 end-uses targeted by this program were space and water heating fueled by natural gas.

Delivery Mechanism: The program was administered by each Program Administrator in its service territory and coordinated regionally through the GasNetworks collaborative. GasNetworks utilized a third-party contractor secured through a competitive bidding process to administer rebate processing. This vendor was also responsible for tracking and reporting program activity to the Program Administrators. The program also has a second third-party contractor who provided trade ally outreach and program participant training to supply houses and manufacturers of natural gas high efficiency heating and water heating equipment.

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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 108-116 (bates numbering 00109-00117). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

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

Table II.A.5: Residential Heating and Water Heating							
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	$	3,157,587			3,614,469		14%
Performance Incentive	$	132,028			119,675		-9%
Participants	# of measures	6,332			5,175		-18%
Program Cost / Participant	$	499			698		40%
Savings & Benefits							
Gas							
Lifetime	therms	7,306,931	8,804,943	21%	9,361,894	6%	28%
Annual	therms	406,960	471,783	16%	523,272	11%	29%
Average Measure Life	yrs	18.0	18.7	4%	17.9	-4%	0%
Electric							
Annual Energy	kWh	-266	-1,064	300%	-1,064	0%	300%
Annual Demand							
Summer	kW	0	-0.1	300%	-0.1	0%	300%
Winter	kW	0	-1	300%	-0.3	-46%	114%
Non-Gas Non-Electric Resources (Lifetime)	$	4,498,610	6,113,392	36%	1,994,697	-67%	-56%
Cost-Effectiveness							
TRC Benefits	$	10,492,691			9,672,391		-8%
TRC Costs	$	5,105,068			6,731,200		32%
Net Benefits	$	5,387,622			2,941,191		-45%
BCR	n/a	2.06			1.44		-30%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

Expenses – The increase in program cost per participant from planned to evaluated is due to high demand for the higher efficiency heating and water heating products that are offered within the program. This resulted in a shift in forecasted production of equipment type and efficiency levels as a result of consumers purchasing more of the super high efficiency models than originally forecasted. There were fewer participants than expected but due to customers predominantly purchasing the higher efficiency equipment with a corresponding higher cost, there was a 40 percent increase in cost per participant.

Savings and Benefits – The increase in annual and lifetime gas savings between the planned values and preliminary year-end and evaluated values is due to the inclusion of new measures such as the condensing gas water heater and higher than planned purchases of equipment with the highest savings values. 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 non-gas non-electric 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. The increase in non-gas non-electric resources from

planned values to preliminary year-end values is due to the higher number of high-saving measures referenced above.

Variances in energy and demand are due to a negative electric value associated with heat recovery ventilators. The variances between planned values and preliminary year-end and evaluated values are due to more heat recovery ventilators being installed than anticipated. The variance from preliminary year-end to evaluated vales was due to a new load shape for the measure derived from the Cadmus Demand Impact model.

Cost-Effectiveness – The variance in TRC costs is due to higher participant costs. As mentioned above, customers mostly took advantage of higher cost but higher 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 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 Heating and Water Heating program is cost effective with a BCR of 1.44.

c. Residential Mass Save/Weatherization

Purpose/Goal: The purpose of the Mass Save/Weatherization program (also known as the Home Energy Services ("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 upgrades.

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.

Definition of Program Participant: A participant is defined as the number of insulation and blower door air sealing jobs completed for Weatherization. A participant in Mass Save is defined as the number of audits completed.

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:

- Building Envelope (Deeper Retrofit Measures)
- HVAC/mechanical systems
- Hot Water

Delivery Mechanism: The Mass Save and Gas Weatherization programs were fully integrated in 2011 and were implemented by each PA's competitively procured lead vendor. The PAs incorporated both HPCs (to provide audits and weatherization work) and IICs (to implement weatherization work) into the program.

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 include:

- Consistent statewide training
- Data reporting
- Achieving aggressive savings
- Customer satisfaction
- Quality control standards
- Scheduling requirements
- Technical assistance
- Maintain and report 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 Gas Energy Efficiency Plan, filed October 30, 2009 and the Company's 2012 RCS Budget Petition, filed November 1, 2011. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 117-128 (bates numbering 00118-00129) and NSTAR Gas Company, D.P.U. 11-RCS-11, respectively. The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126 and on December 27, 2011 in NSTAR Gas Company, D.P.U. 11-RCS-11, respectively.

Table II.A.6 provides information on the performance of the residential Mass Save program and Table II.A.7 provides information on the performance of the Weatherization program.

Table II.A.6: 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	$	1,729,406			1,844,457		7%
Performance Incentive	$	0			0		0%
Participants	# of audits	6,000			7,669		28%
Program Cost / Participant	$	288			241		-17%
Savings & Benefits							
Gas							
Lifetime	therms	0	0	0%	0	0%	0%
Annual	therms	0	0	0%	0	0%	0%
Average Measure Life	yrs	n/a	n/a	n/a	n/a	n/a	n/a
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	0	0	0%	0	0%	0%
Cost-Effectiveness							
TRC Benefits	$	0			0		0%
TRC Costs	$	1,729,406			1,844,457		7%
Net Benefits	$						
BCR	n/a						

The variance between planned and evaluated participants for the Mass Save program was the result of a higher than expected number of audits, which was due to increased operational efficiencies as the program matured and increased awareness of the Mass Save program. Additionally, as the number of gas customers increases in the state, it is not surprising that the number of audits increased as well.

Table II.A.7: Weatherization Program							
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	$	4,899,121			5,972,920		22%
Performance Incentive	$	244,745			229,147		-6%
Participants	# of air sealing/ insulation jobs	3,300			3,758		14%
Program Cost / Participant	$	1,485			1,589		7%
Savings & Benefits							
Gas							
Lifetime	therms	13,854,173	17,452,780	26%	13,103,834	-25%	-5%
Annual	therms	635,804	884,381	39%	676,052	-24%	6%
Average Measure Life	yrs	21.8	19.7	-9%	19.4	-2%	-11%
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	3,591,835	5,997,038	67%	5,209,545	-13%	45%
Cost-Effectiveness							
TRC Benefits	$	15,283,118			16,260,002		6%
TRC Costs	$	7,549,131			9,397,813		24%
Net Benefits	$	7,733,987			6,862,189		-11%
BCR	n/a	2.02			1.73		-15%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values in the Weatherization program are as follows:

Expenses – The variance in total program costs was due to higher than anticipated participation in the program, leading to a higher expenditure on participant incentives. Additionally, new measures with higher costs and higher savings were introduced into the program such as early boiler replacements.

Savings and Benefits – The higher lifetime and annual gas savings between planned and preliminary year-end results were due to the inclusion of the early boiler replacement measure, which offered high savings values and had high participation. There are significant non-gas non-electric resources associated with the early replacement boiler measure and the inclusion of this measure is the primary cause of the variance seen between the planned values and preliminary year-end and evaluated values. The variance in lifetime and annual gas savings values from preliminary year-end and evaluated results was due to application of a realization rate that was necessitated by a change in the implementation vendor's software. Detailed results from that study can be found in the *HES Realization Rate Results Memo*.

Cost-Effectiveness – TRC costs show a variance of 24 percent due to high participation in the early boiler replacement measure.

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

- *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 Weatherization program is cost effective with a BCR of 1.73.

d. 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 the number of measures installed 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:

- Heating, Ventilation, and Air Conditioning
- 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 throughout 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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 145-160 (bates numbering 00146-00161). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

Table II.A.8 provides information on the performance of the Residential Multi-Family program.

Table II.A.8: 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	$	1,295,411			1,144,324		-12%
Performance Incentive	$	27,059			27,059		0%
Participants	# of measures	5,810			4,690		-19%
Program Cost / Participant	$	223			244		9%
Savings & Benefits							
Gas							
Lifetime	therms	1,823,609	2,006,356	10%	1,751,752	-13%	-4%
Annual	therms	149,026	156,146	5%	154,950	-1%	4%
Average Measure Life	yrs	12.2	12.8	5%	11.3	-12%	-8%
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	841,534	587,307	-30%	667,274	14%	-21%
Cost-Effectiveness							
TRC Benefits	$	2,293,866			2,055,034		-10%
TRC Costs	$	1,318,566			1,091,950		-17%
Net Benefits	$	975,300			963,084		-1%
BCR	n/a	1.74			1.88		8%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

> Savings and Benefits – Non-gas non-electric resources were negatively affected by lower than anticipated participation. Since non-gas non-electric resources are calculated on a per measure basis in this program, lower participation leads to lower values.

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 Multi-Family Retrofit program is cost effective with a BCR of 1.88.

3. Residential Pilots

a. Deep Energy Retrofit

Description of Pilot/Specific Activities Intended to Study: The Deep Energy Retrofit ("DER") 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 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 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 gas 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:

- Heating (deeper energy retrofit measures)
- Hot Water
- Envelope (deeper energy retrofit measures)
- End Use Behavior

Delivery Mechanism: Project design details and assistance were provided to Deep Energy Retrofit contractors performing the work. The projects were handled through technical specialist contractors, program managers and organizations under contract and/or utilizing DOE 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, NSTAR Gas 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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 129-134 (bates numbering 00130-00135). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

Table II.A.9 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.9: 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	$	31,032			8,259		-73%
Participants	unique accts	n/a			n/a		n/a
Program Cost / Participant	$	n/a			n/a		n/a
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annual	therms	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
Electric							
Annual Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annual Demand							
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
Non-Gas Non-Electric Resources (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	$	31,032			8,259		-73%
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. Community-Based Pilots

Description of Pilot/Specific Activities Intended to Study: The term "Community-Based Pilots" encompassed a number of unique partnerships in 2012 between the Program Administrators and local communities designed to harness the power of community-based outreach to achieve broader participation in the Commonwealth's energy efficiency programs. NSTAR Gas participated in a number of successful community initiatives in its service territory in 2012 including those in New Bedford, Cambridge, Somerville, Needham, and Dartmouth.

Why Implemented on Pilot Basis rather than as a Full Program: The community-based initiatives were offered as pilots to assess the effectiveness of each partnership and determine their potential for replication.

Targeted Customers: The Program Administrators and interested stakeholders selected communities with the greatest opportunities for success, based on an assessment of the proposal submitted. Targeted customers varied by pilot, but in general included residential customers with incomes between 61 and 120 percent of median household income in their community.

Definition of Program Participant: Participants in this pilot are counted as participants in other programs such as Mass Save.

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 end-uses targeted by the community based pilots included the same end-uses addressed under the Company's existing audit and weatherization programs.

Delivery Mechanism: Program outreach was conducted by local community groups. Measures were installed through the Company's existing lead vendors.

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

How Achievement of the Pilot's Stated Goal was Measured: A multi-year evaluation of community based pilots was conducted by Opinion Dynamics Corporation to assess the effectiveness of these pilots and determine their potential for replication. This process evaluation was submitted with each Program Administrator's 2011 Energy Efficiency Annual Report.

Docket/Exhibit where the Program is Discussed and Approved: The pilot is discussed in detail in the Company's 2010-2012 Three-Year Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 101-104 (bates numbering 00102-00105). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

Table II.A.10 provides information on the performance of the Community Based pilots. 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.10: Community Based Pilot

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	$	57,000			14,350		-75%
Participants	see Mass Save/ Weatherization	n/a			n/a		n/a
Program Cost / Participant	$	n/a			n/a		n/a
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annual	therms	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
Electric							
Annual Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annual Demand							
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
Non-Gas Non-Electric Resources (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	$	57,000			14,350		-75%
Net Benefits	$	n/a			n/a		n/a
BCR	n/a	n/a			n/a		n/a

There are no EM&V studies included in the Company's 2012 Annual Report that apply to this pilot.

As stated above, NSTAR Gas Company participated in a number of community initiatives in its service territory in 2012 including those in Cambridge, Dartmouth, and Needham. The Company also participated in a community based partnership in New Bedford. Community organizations performed outreach to local residents to increase participation levels in the Mass Save 1-4 family and multi-family programs.

The Company remains committed to working with various community organizations. As described in its 2013-2015 three-year plan, the Company anticipates community based outreach initiatives to become an extension of its overall program level marketing and outreach strategies.

B. Low-Income Sector Programs

1. Summary

In 2012, the Company implemented the Low-Income Retrofit program which consisted of two initiatives: the Low-Income Single-Family Retrofit initiative and the Low-Income Multi-Family initiative.[6] The Company did not offer any pilots in the low-income sector during 2012.

Tables II.B.1 and II.B.3 provide summary information on the performance of the low-income program at the sector and program/initiative levels, respectively. Please note the gas Program Administrators do not track data by end use, and, therefore, are not required to provide the information in Table II.B.2.

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	$	5,556,026			5,467,941		-2%
Performance Incentive	$	139,288			204,689		47%
Savings & Benefits							
Gas							
Lifetime	therms	5,111,100	6,191,955	21%	5,975,806	-3%	17%
Annual	therms	269,970	300,715	11%	289,044	-4%	7%
Electric							
Annual Energy	kWh	0	0	0%	154,972	0%	0%
Annual Demand							
Summer	kW	0	0	0%	113	0%	0%
Winter	kW	0	0	0%	49	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	3,780,431	5,410,594	43%	5,533,398	2%	46%
Cost-Effectiveness							
TRC Benefits	$	8,090,691			11,216,970		39%
TRC Costs	$	5,695,313			5,672,630		0%
Net Benefits	$	2,395,378			5,544,340		131%
BCR	n/a	1.42			1.98		39%

6 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.

As shown in Table II.B.1, significant variances exist at the low-income sector level in the Expenses, Savings & Benefits and Cost-Effectiveness categories. The reasons for the variances between planned, preliminary year-end, and evaluated values in the Savings & Benefits category were due to higher insulation and weatherization savings than planned and higher than expected participation in the Low-Income Multi-Family initiative.

Table II.B.3: Low-Income Retrofit Program Summary

Program / Performance Category	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Low-Income Retrofit				
TRC Benefits	$	8,090,691	11,216,970	39%
TRC Costs	$	5,531,845	5,608,569	1%
Net Benefits	$	2,558,846	5,608,401	119%
BCR	n/a	1.46	2.00	37%
Hard-to-Measure Initiatives				
TRC Costs	$	163,468	64,061	-61%
TOTAL				
TRC Benefits	$	8,090,691	11,216,970	39%
TRC Costs	$	5,695,313	5,672,630	0%
Net Benefits	$	2,395,378	5,544,340	131%
BCR	n/a	1.42	1.98	39%

TRC benefits were higher than planned, as shown in Table II.B.3, due to the higher gas savings and non-gas non-electric resources discussed further in Section II.B.2 below. TRC costs in the Hard-to-Measure Initiatives were lower than expected due to lower than planned expenditures on statewide marketing and education, LEAN funding, and DOER assessment. The changes in net benefits and BCR are a mathematical result of the changes in the TRC benefits and TRC costs.

Section II.B.2 provides detailed information on the performance of the low-income program.

Low-Income Sector Performance Highlights

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 Housing and 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 the above program follows.

2. Low-Income Retrofit Program

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

The purpose of the LISF Retrofit initiative was to increase energy efficiency and reduce the energy cost burden for income-eligible customers through the installation of gas 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 initiative 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 LISF Retrofit initiative targeted residential gas 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-discounted rates. 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 the number of measures installed.

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:

- Heating
- 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") as well as the Multi-Family Advisory Committee comprised of LEAN, Community Development Corporations, Public Housing Authorities and other nonprofit owners of low-income non-institutional multi-family housing. 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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 161-168 (bates numbering 00162-00169) and pages 177-190 (bates numbering 00178-00191). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

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

Table II.B.4: 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	$	5,392,558			5,403,880		0%
Performance Incentive	$	139,288			204,689		47%
Participants	# of measures	1,408			1,548		10%
Program Cost / Participant	$	3,830			3,491		-9%
Savings & Benefits							
Gas							
Lifetime	therms	5,111,100	6,191,955	21%	5,975,806	-3%	17%
Annual	therms	269,970	300,715	11%	289,044	-4%	7%
Average Measure Life	yrs	18.9	20.6	9%	20.7	0%	9%
Electric							
Annual Energy	kWh	0	0	0%	154,972	0%	0%
Annual Demand							
Summer	kW	0	0	0%	113	0%	0%
Winter	kW	0	0	0%	49	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	3,780,431	5,410,594	43%	5,533,398	2%	46%
Cost-Effectiveness							
TRC Benefits	$	8,090,691			11,216,970		39%
TRC Costs	$	5,531,845			5,608,569		1%
Net Benefits	$	2,558,846			5,608,401		119%
BCR	n/a	1.46			2.00		37%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

> Expenses – 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 gas savings were higher than planned lifetime savings as a result of higher insulation and weatherization savings. Planned numbers are based on the best available information while preliminary year-end and evaluated results are actual numbers supplied by the implementation vendor, and in this case the implementation vendor was able to produce higher than expected savings.

Preliminary year-end and evaluated non-gas non-electric resources values showed a significant increase over the planned values due to higher than expected participation in the Low-Income Multi-Family initiative. NEIs in this initiative are based on the number of measures installed. As the number of installed measures was higher than expected, there was a corresponding higher than expected level of non-gas non-electric resources.

Cost-Effectiveness – TRC benefits were higher than planned due to the higher gas savings and non-gas non-electric resources discussed 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 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 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, Study 11.

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 Single-Family Retrofit program is cost effective with a BCR of 2.00.

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 Retrofit
- C&I Direct Install

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

Tables II.C.1 and II.C.3 provide summary information on the performance of the C&I programs at the sector and program levels, respectively. Please note the gas Program Administrators do not have end-use data available, and, therefore, are not required to provide the information in Table II.C.2

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	$	7,416,502			4,443,574		-40%
Performance Incentive	$	576,565			461,250		-20%
Savings & Benefits							
Gas							
Lifetime	therms	47,800,602	30,712,291	-36%	29,892,141	-3%	-37%
Annual	therms	3,487,270	2,565,883	-26%	2,460,243	-4%	-29%
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	96,377	5,410,594	5514%	4,880,242	-10%	4964%
Cost-Effectiveness							
TRC Benefits	$	37,809,297			28,476,733		-25%
TRC Costs	$	15,766,015			8,673,924		-45%
Net Benefits	$	22,043,283			19,802,809		-10%
BCR	n/a	2.40			3.28		37%

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

- Total program costs were lower than anticipated due to lower than expected participation in the C&I Retrofit and C&I New Construction and Major Renovation programs.

- 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.

- Lower lifetime and annual gas savings from planned to both preliminary year-end and evaluated results were due to lower than anticipated participation in both the C&I New Construction and Major Renovation and the C&I Retrofit programs. Additionally, lower net to gross ratios for custom projects and a shorter measure life contributed to the lower lifetime numbers.

- The increase in non-gas non-electric resources is due to the inclusion of NEIs from the *Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts* study filed with the Company's 2013-2015 Three-Year Energy Efficiency Plan. See NSTAR Gas, D.P.U. 12-105.

- The significant difference in TRC benefits is due to lower gas savings, as outlined above. TRC costs were lower than expected due to lower than anticipated participation in the C&I New Construction and Major Renovation program and lower than expected Sales, Technical Assistance, and Training expenses in the C&I Retrofit program. The net benefits number is a calculated number and has changed due to the change in TRC benefits and costs.

Table II.C.3: C&I Program Summary				
Program / Performance Category	**Units**	**Planned Value**	**Evaluated Results**	
			Value	% Change from Planned
C&I New Construction and Major Renovation				
TRC Benefits	$	15,175,842	10,139,194	-33%
TRC Costs	$	3,730,837	2,856,033	-23%
Net Benefits	$	11,445,005	7,283,161	-36%
BCR	n/a	4.07	3.55	-13%
C&I Retrofit				
TRC Benefits	$	22,138,637	16,634,251	-25%
TRC Costs	$	11,781,248	5,503,615	-53%
Net Benefits	$	10,357,390	11,130,636	7%
BCR	n/a	1.88	3.02	61%
C&I Direct Install				
TRC Benefits	$	494,818	1,703,288	244%
TRC Costs	$	95,004	245,791	159%
Net Benefits	$	399,815	1,457,497	265%
BCR	n/a	5.21	6.93	33%
Hard-to-Measure Initiatives				
TRC Costs	$	158,927	68,485	-57%
TOTAL				
TRC Benefits	$	37,809,297	28,476,733	-25%
TRC Costs	$	15,766,015	8,673,924	-45%
Net Benefits	$	22,043,283	19,802,809	-10%
BCR	n/a	2.40	3.28	37%

Section II.C.2 provides detailed information on the performance of each C&I program.

C&I Sector Performance Highlights

During 2012, the Program Administrators built upon existing C&I gas energy efficiency programs and significantly expanded initiatives to increase participation in all C&I programs. In order to provide appropriate customer incentives, the gas and electric Program Administrators continued to collaborate on projects in overlapping service territories by sharing both the costs and the results of technical assistance studies. The Program Administrators also held a *Gas Strategy Summit* to identify barriers to customer participation and any other program issues. PA efforts continued in 2012 to transform the workforce, including holding regional and local training events for plumbers, contractors, homeowners and business owners through the Program Administrators' GasNetworks®/Mass Save event schedule. The Program Administrators collectively evaluated emerging technologies through a series of shared seminars and discussions. Additional, more formal channels of testing and evaluation are being performed by individual Program Administrators, with resultant information being shared amongst the PAs. GasNetworks/Mass Save and the Massachusetts Technical Assessment Committee collaborated

on a more formal process for emerging gas technologies. The following highlights the Program Administrators' efforts in the C&I gas energy efficiency arena during the 2012 program year:

- Annual Training - On September 20, 2012, the PAs sponsored their 12th Annual GasNetworks®/Mass Save Fall Conference and Trade Show in Randolph, MA. Attendees included over 400 HVAC contractors, trainers, and inspectors from the across the Commonwealth, as well as 32 exhibitors. The Program Administrators coordinated a full-day agenda of training sessions and seminars on the latest high efficiency natural gas HVAC technologies and installation and maintenance practices. Participants also learned about opportunities to save energy and participate in PA programs.

- Commercial Food Equipment Market - The PAs participated in various food equipment shows throughout the Commonwealth. In 2012, the gas PAs contacted commercial food service equipment dealers, distributors and manufacturers in Massachusetts on over 600 different occasions, including contacts with more than 50 trade partners, to build support and participation in the GasNetworks/ Mass Save program. Approximately 2,580 pieces of program collateral and rebate forms were distributed to partners and end users resulting in 200 rebates being processed through the program. PAs also staffed a number of special events in 2012 to help build awareness and participation in the program. These events included the New England Food Service Expo and the College Sustainability Conference, both in Boston, MA, and the Perkins Trade Show in Foxboro, MA. The PAs also engaged trade partners in promoting the program through their existing marketing vehicles. As a result, the GasNetworks/ Mass Save Program was featured in partner newsletters on four different occasions in 2012. Qualified equipment lists were also maintained and updated on a quarterly basis based on changes to the ENERGY STAR® and Food Service Technology Center websites. The PAs continue to research and analyze the market for efficient food service equipment, monitor developments in the industry and emerging technologies, and collect data to help evaluate the program's impact.

- Statewide Training on Steam Systems - GasNetworks/Mass Save was represented at several contractor training days, refrigerant system training days, and supply house vendor and product shows. Information on contractor and other training, as well as the annual fall event to kick off the heating season, can be found throughout the year on masssave.com and gasnetworks.com. The PAs are proud to endorse renowned hydronic and steam heating expert Dan Holohan who has been a lead GasNetworks/Mass Save trainer and ally for several years.

- Commercial Custom Steam Program - The PAs completed a survey of each PA's steam trap program. Using these survey results, the PAs aligned the implementation of their programs for consistency throughout the Commonwealth. This has increased participation in some service territories.

- Statewide Forms Review for 2013 - The gas Program Administrators worked collectively to make changes to prescriptive offerings necessitated by market changes and efficiency standards testing issues. GasNetworks/Mass Save offered support to the vendor community with respect to information flow for the Northeast Furnace Standards Rule and the suspension, due to a flaw in the test procedure, of the Air-Conditioning, Heating and Refrigeration Institute and ENERGY STAR listings of modulating condensing boilers.

- C&I Gas Summit - GasNetworks/Mass Save hosted a C&I Gas Summit on July 26, 2012, which included participation from all Program Administrators and key stakeholders. Improved methods of administering programs and emerging technologies were identified. Specifically, improved collaboration between gas and electric PAs whose territories overlap was identified as a requirement to more effectively and efficiently deliver savings to customers. A matrix was developed that categorized the results of the Summit into the four guiding principles including: Emerging Technologies, Behavioral Motivators, Forms and Process Improvements, and Collaboration. The results were shared amongst the PAs to help address barriers that were common to all. The issues and barriers identified fell into three categories: Specific Measures, Collaboration and Trade Allies and Forms and Program Issues.

- Market Characterization and Segmentation - The gas Program Administrators analyzed different market segments including those in service territories shared with electric PAs. Technical teams developed lists of specific measures for different customer segments that will offer the best overall comprehensive efficiency opportunities. They also developed specific groups of measures that will be marketable to different customer segments. The PAs have been using technical assistance vendors to help identify savings for these newer measures, which is costly. For that reason, the PAs have been developing savings estimating tools for all of the PAs to share in order to lower the cost of technical assistance. Examples of these tools include the steam trap custom tool, the dual-fuel screening tool, the rooftop controller tool, and the energy recovery ventilation tool. The Program Administrators are collectively seeking and providing training opportunities for the design communities and strategic vendors to familiarize them with these tools and measures.

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

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 gas 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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 203-214 (bates numbering 00204-00215). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

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	$	2,336,336			1,858,951		-20%
Performance Incentive	$	248,418			166,696		-33%
Participants	# of projects	448			371		-17%
Program Cost / Participant	$	5,215			5,011		-4%
Savings & Benefits							
Gas							
Lifetime	therms	19,016,715	12,226,331	-36%	12,630,618	3%	-34%
Annual	therms	949,545	653,417	-31%	655,303	0%	-31%
Average Measure Life	yrs	20.0	18.7	-7%	19.3	3%	-4%
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	2,522	0	-100%	0	0%	-100%
Cost-Effectiveness							
TRC Benefits	$	15,175,842			10,139,194		-33%
TRC Costs	$	3,730,837			2,856,033		-23%
Net Benefits	$	11,445,005			7,283,161		-36%
BCR	n/a	4.07			3.55		-13%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

Expenses – Participation was lower than expected due to stagnation in the new construction market coupled with decreased customer sensitivity to natural gas as pricing remains low. This resulted in lower levels of participation incentives across the prescriptive measures as well as the high-impact, custom building shell projects, resulting in lower total program costs. Participation in the program is expected to increase as the Massachusetts economy and construction market show signs of improvement in addition to the expansion of commercial gas infrastructure.

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 gas savings were lower than planned values due to significantly lower participation. Lower participation was driven by stagnation in the new construction market coupled with decreased customer sensitivity to natural gas as pricing remains low. This is especially true for custom projects, which represent high savings measures.

Non-gas non-electric resources were lower than expected because planned values included measures with water savings but none of these measures were installed in 2012.

Cost-Effectiveness – The lower TRC benefits were driven by a combination of lower gas and water savings while the lower TRC costs are due to the lower participation outlined above. The change in net benefits is 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:

- *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 by 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.

- *Impact Evaluation of 2011 Prescriptive Gas Measures*
  This report presents the results of the impact evaluation of C&I prescriptive gas measures installed during program year 2011. The evaluation consists of on-site monitoring and verification of the savings for a sample of participants for four of the top five measures installed (based on total savings). The net effect for the Company was to increase energy savings. The study is discussed in more detail in Section III, Study 19.

- *Standard Boiler Research Plan and Interview Results Memo*
  This document summarizes the plan, execution, and the decision to re-scope a planned boiler baseline assessment. The study intended to identify baseline boiler features and operation for both prescriptive and custom boiler measures, followed by measurement and verification of non-program boilers. However, the team was not able to locate any customers with a relatively recently installed standard efficiency boiler that was willing to participate in the study. The study had no impact on savings. The study is discussed in more detail in Section III, Study 20.

- *Impact Evaluation of 2011 Custom Gas Installations*
  This study produced updated realization rates for custom commercial gas measures for NSTAR and PAs that use the statewide custom gas realization rate. The net effect of the study was to decrease savings for the Company. The study is discussed in more detail in Section III, Study 21.

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 New Construction and Major Renovation program is cost effective with a BCR of 3.55.

b. C&I Retrofit

Purpose/Goal: The C&I 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 gas 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

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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 191-202 (bates numbering 00192-00203). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

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

Table II.C.5: C&I 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	$	4,844,352			2,327,164		-52%
Performance Incentive	$	306,843			263,785		-14%
Participants	# of projects	559			461		-18%
Program Cost / Participant	$	8,666			5,048		-42%
Savings & Benefits							
Gas							
Lifetime	therms	28,268,766	17,522,042	-38%	16,072,465	-8%	-43%
Annual	therms	2,486,540	1,788,581	-28%	1,652,120	-8%	-34%
Average Measure Life	yrs	11.4	9.8	-14%	9.7	-1%	-14%
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	0	0	0%	4,080,882	0%	0%
Cost-Effectiveness							
TRC Benefits	$	22,138,637			16,634,251		-25%
TRC Costs	$	11,781,248			5,503,615		-53%
Net Benefits	$	10,357,390			11,130,636		7%
BCR	n/a	1.88			3.02		61%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

> Expenses – Total program expenses were lower than expected due to lower participation, especially in those measures with high savings and high costs. The decline in program cost per participant is a mathematical result of total program costs declining at a higher rate than the number of participants.

Savings and Benefits – The variance in lifetime and annual gas savings between preliminary year-end and evaluated values and planned values was due to fewer participants than anticipated, coupled with fewer installations of measures with the highest savings values, such as ozonated laundry systems.

The increase in non-gas non-electric resources is due to the inclusion of *NEIs from the Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts* study filed in the Company's 2013-2015 Three-Year Energy Efficiency Plan. See NSTAR Gas, D.P.U. 12-105.

Cost-Effectiveness – The significant decrease in TRC benefits is due to the lower gas savings described above with the decrease in TRC costs largely attributable to lower participation. The change in BCR is 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:

- *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 by 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.

- *Impact Evaluation of 2011 Prescriptive Gas Measures*
  This report presents the results of the impact evaluation of C&I prescriptive gas measures installed during program year 2011. The evaluation consists of on-site monitoring and verification of the savings for a sample of participants for four of the top five measures installed (based on total savings). The net effect for the Company was to increase energy savings. The study is discussed in more detail in Section III, Study 19.

- *Standard Boiler Research Plan and Interview Results Memo*
  This document summarizes the plan, execution, and the decision to re-scope a planned boiler baseline assessment. The study intended to identify baseline boiler features and operation for both prescriptive and custom boiler measures, followed by measurement and verification of non-program boilers. However, the team was

not able to locate any customers with a relatively recently installed standard efficiency boiler that was willing to participate in the study. The study had no impact on savings. The study is discussed in more detail in Section III, Study 20.

- *Impact Evaluation of 2011 Custom Gas Installations*
  This study produced updated realization rates for custom commercial gas measures for NSTAR and PAs that use the statewide custom gas realization rate. The net effect of the study was to decrease savings for the Company. The study is discussed in more detail in Section III, Study 21.

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 Retrofit program is cost effective with a BCR of 3.02.

c. C&I Direct Install

Purpose/Goal: The primary objective of the C&I Direct Install 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 was direct install retrofit business customers with electric consumption below 300kW.

Definition of Program Participant: A program participant is defined as the number of measures installed.

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 Gas Energy Efficiency Plan, filed October 30, 2009. See NSTAR Gas Company, D.P.U. 09-126, Exhibit NSTAR-1, pages 215-219 (bates numbering 00216-00220). The program was approved by the Department on January 28, 2010 in NSTAR Gas Company, D.P.U. 09-126.

Table II.C.6 provides information on the performance of the C&I Direct Install program.

Table II.C.6: C&I Direct Install

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	$	76,887			188,974		146%
Performance Incentive	$	21,304			30,769		44%
Participants	# of measures	305			574		88%
Program Cost / Participant	$	252			329		31%
Savings & Benefits							
Gas							
Lifetime	therms	515,120	963,918	87%	1,189,057	23%	131%
Annual	therms	51,185	123,885	142%	152,820	23%	199%
Average Measure Life	yrs	10.1	7.8	-23%	7.8	0%	-23%
Electric							
Annual Energy	kWh	0	0	0%	0	0%	0%
Annual Demand							
Summer	kW	0	0	0%	0	0%	0%
Winter	kW	0	0	0%	0	0%	0%
Non-Gas Non-Electric Resources (Lifetime)	$	93,854	266,549	184%	799,360	200%	752%
Cost-Effectiveness							
TRC Benefits	$	494,818			1,703,288		244%
TRC Costs	$	95,004			245,791		159%
Net Benefits	$	399,815			1,457,497		265%
BCR	n/a	5.21			6.93		33%

The reasons for the significant variances between planned, preliminary year-end, and evaluated values are as follows:

> Expenses – The difference in program cost was driven by increased marketing and advertising, and higher than anticipated participant incentives. Higher participation, and corresponding higher participant incentive, aligns with significant increases in the number of units that flowed through the program as a result of focused outreach to the direct install segment meant to derive a higher percentage of their C&I gas savings from this segment. More units were installed

in almost all direct install categories than originally planned, from the highest per unit impact products (boiler controls) to the lowest (duct sealing & insulation). Total program costs increased at a higher percentage than the number of participants, leading to a variance in program cost per participant.

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 – Differences in lifetime and annual gas savings between planned values and preliminary year-end and evaluated results were due to higher overall program participation and the inclusion of new measures within the program such as steam traps. The variance in gas savings between evaluated and preliminary year-end results was due to higher net-to-gross ratios. Variances in lifetime gas savings were due to differences in planned measure life. Planning was done with a high measure life based on the best information available at the time. A greater volume of project information is now available as more projects have come through the program, resulting in a lower measure life based on the new information.

Non-gas non-electric resources show a significant variance because originally the only resource included in the planned value was water. The increase in non-gas non-electric resources is due to the inclusion of *NEIs from the Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts* study filed in the Company's 2013-2015 Three-Year Energy Efficiency Plan. See NSTAR Gas, D.P.U. 12-105.

Cost-Effectiveness – The increase in the TRC benefits is predominantly driven by the significant increases in gas savings and the inclusion of NEIs. TRC costs have increased due to higher participation and participant incentives as detailed above. A ratio analysis can explain the increase in BCR, as TRC benefits increase much more rapidly than associated TRC costs.

The EM&V studies included in the Company's 2011 Annual Report that apply to this program are as follows:

- *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 by 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 Direct Install program is cost-effective with a BCR of 6.93.

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 gas 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
- Impact Evaluation of 2011 Custom Gas Installations study
- Impact Evaluation of 2011 Prescriptive Gas Measures study

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 billing analysis 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 Impact Evaluation of 2011 Custom Gas Installations and the Impact Evaluation of 2011 Prescriptive Gas Measures sought to test the accuracy of estimated savings of installed C&I custom and prescriptive gas measures. Historically, gas impact work generally found the gas savings estimates to be unpredictable. However, these two new studies showed results appear to be stabilizing. While some measure variation remains, the statewide custom realization rate on annual gas therm savings was found to be 82.1 percent of forecasted savings and the overall statewide prescriptive evaluated savings were found to be 102 percent of forecasted savings. These studies are discussed in more detail in Appendix C, Studies 19 and 21.

Table III.A summarizes the EM&V studies that have not been included in previous Annual Reports. Please note: Studies 4, 5, 6, 8, 10, 13, 14, 15 and 16 apply to electric energy efficiency programs only and are 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		
Results of the Massachusetts Onsite Lighting Inventory	App. C, Study 7		
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
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
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
Customer Profile Project	App. C, Study 17		
Mid-Sized Customer Needs Assessment - Interim Results	App. C, Study 18		
Impact Evaluation of 2011 Prescriptive Gas Measures	App. C, Study 19		
Standard Boiler Research Plan and Interview Results Memo	App. C, Study 20		
Impact Evaluation of 2011 Custom Gas Installations	App. C, Study 21		
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 multi-family buildings of three or fewer stories (MF 1-3), and mid- to high-rise multi-family 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 3, 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 3. 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

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

5. Residential Lighting Shelf Survey and Pricing Analysis.

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

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

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

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

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

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

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

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

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

13. Prescriptive VSD Impact Evaluation

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

14. Impact Evaluation of 2010 Prescriptive Lighting Installations

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

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

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

16. Process Evaluation of the 2012 Bright Opportunities Program

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

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

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

Evaluation Objective and High Level Findings: This report presents the results of the impact evaluation of the Program Year 2011 (PY2011) Massachusetts Prescriptive Gas Measures Program. The evaluation consists of on-site monitoring and verification of the savings for a sample of participants for four of the top five measures installed, in terms of savings.

The overall relative performance for the four measures was about 102% and the relative precision was about ±15.6%. The condensing furnace and condensing boiler measures both had relative performance greater than 100%, at about 160% and 107 % respectively. Since they represent about 85% of total program savings their performance offset the lower relative performance observed for the other two measures. Indirect water heater and infrared heating measures had lower relative performance of 79% and 20% respectively.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Gas)
- C&I Large Retrofit (Gas)
- C&I Small Retrofit (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: Condensing Boiler Savings Recommendations:

Size	Efficiency Requirement	Report 2010 Savings (MMBtu)	Report 2011 Savings (MMBtu)	Report 2012 Savings (MMBtu)
<= 300 MBH	>= 90% AFUE	22.1	29.8	**30.6**
301-499 MBH	>=90% Thermal Efficiency	42.3	56.9	**58.4**
500-999 MBH	>=90% Thermal Efficiency	77.1	104.6	**107.3**
1000-1700 MBH	>=90% Thermal Efficiency	142.6	192.1	**197.2**
1701+ MBH	>=90% Thermal Efficiency	249.0	336.2	**345.1**

Recommendation 2: Recommended Condensing Furnace Savings

Furnace Efficiency	Report 2010 Savings (MMBtu)	Report 2011 Savings (MMBtu)	Report 2012 Savings (MMBtu)
Furnace AFUE =>92%	21.1	5.9	**7.5**
Furnace AFUE =>92% w/ECM	19.6	5.5	**6.9**
Furnace AFUE =>94% w/ECM	23.6	6.2	**8.5**
Furnace AFUE =>95% w/ECM	NA	NA	**9.0**
Furnace AFUE =>96% w/ECM	NA	NA	**9.5**
Furnace AFUE =>97% w/ECM	NA	NA	**9.9**

Recommendation 3: Recommended Infrared Heater Savings

Measure Type	Report 2010 Savings (MMBtu)	Report 2011 Savings (MMBtu)	Report 2012 Savings (MMBtu)
Infrared Heater	74.4	22.3	**12.0**

Recommendation 4: Recommended Indirect Water Heater Savings

Measure Type	Report 2010 Savings (MMBtu)	Report 2011 Savings (MMBtu)	Report 2012 Savings (MMBtu)
Indirect Water Heater	30.4	20.7	**19.0**

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: PAs plan to incorporate recommendations

Savings Impact: The overall relative performance for the four measures was about 102% and the relative precision was about ±15.6%. The condensing furnace and condensing boiler measures both had relative performance greater than 100%, at about 160% and 107 % respectively. Since they represent about 85% of total program savings their performance offset the lower relative performance observed for the other two measures. Indirect water heater and infrared heating measures had lower relative performance of 79% and 20% respectively.

Formulas Used in Impact Analysis:

$$\Delta MMBtu = \Delta MMBtu$$

Application of Results: Retrospectively

How the Study Came to the Recommended Conclusions: The evaluation consists of on-site monitoring and verification of the savings for a sample of participants for four of the top five measures installed, in terms of savings. The sample sites were monitored for about eight weeks in an attempt to capture seasonally sensitive variations in energy consumption between the winter and swing seasons. The first monitoring equipment was installed in the first week of December 2012 and recovery was completed during the second week of March 2013. The on-site sample design was designed to achieve a relative precision of ± 20% at the 80% confidence interval using a two-tail test for the overall program savings.

A copy of the complete study can be found in Appendix C, Study 19.

20. Standard Boiler Research Plan and Interview Results Memo

Type of Study: Technology Evaluation
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 5/28/2013

Evaluation Objective and High Level Findings: This document summarizes the plan, execution, and the decision to re-scope the Boiler Baseline Assessment for the Massachusetts Energy Efficiency Programs' Large Commercial & Industrial Evaluation. This study was commissioned to identify the base line boiler features and operation for both prescriptive and custom boiler measures. The research was intended to encompass two elements: first boiler distributors were to be interviewed to determine the characteristic features of new code-compliant boilers and also to provide leads for standard code-compliant boilers. Secondly, a

sample of standard code compliant boilers would be metered to determine characteristic performance, with a particular interest in cycling boilers (vs. modulating firing rate). The second stage of research was expected to be M&V of non-program boilers. However, the team was unsuccessful at locating any customer both with a relatively recently installed standard efficiency boiler and willing to participate in the study through distributors, contractors, and other efficiency partners contacted.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Gas)
- C&I Large Retrofit (Gas)
- C&I Small Retrofit (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:** It is important to note that the initial scoping does not provide conclusive evidence on the absence of standard efficiency boilers in the Massachusetts market, and further research on existing installed stock and recent sales data is warranted.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study: PAs plan to incorporate recommendations. The Evaluation Working Group agreed to re-direct some of the funds not spent on metering to a boiler market investigation which would encompass a more rigorous interview sample, seek manufacturer sales data, and utilize other techniques to provide a more reliable view of the market. The results of this investigation will be presented and/or filed at a later date.

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 evaluators were unable to find base case boilers to monitor, therefore the focus turned to characterize the Massachusetts boiler market.

A copy of the complete study can be found in Appendix C, Study 20.

21. Impact Evaluation of 2011 Custom Gas Installations

Type of Study: Impact Evaluation
Evaluation Conducted by: DNV KEMA
Date Evaluation Completed: 6/17/2013

Evaluation Objective and High Level Findings: This study aims to quantify the actual energy savings due to the installation of Custom Gas measures installed through the Massachusetts Energy Efficiency Program Administrators' (PAs) Commercial and Industrial (C&I) Lost Opportunity and Large Retrofit programs in 2011.

The realization rates will be used for planning and program reporting, including program year 2012 annual reporting and any 2013-2015 program planning and subsequent year reporting, unless replaced by results from a subsequent study.

The scope of work for this impact evaluation included NSTAR's 2011 Custom Gas measures. NSTAR's 2011 results were combined with those from the other gas PAs, which were based on the 2010 program year.

Key findings include the following:

- Statewide realization rate on annual gas therms savings was 82.1% with a relative precision of +-9.4% at 80% confidence.
- NSTAR realization rate on annual gas therms savings was 84.4% with a relative precision of +/-6.9% at 80% confidence.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Gas)
- C&I Large Retrofit (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: Project documentation should include savings estimates in the native file form and support the claimed baseline.

Recommendation 2: Controls measures, particularly EMS based strategies, must be verified for proper operation, setpoints, and applicability. Savings estimates for these types of measures should include all necessary assumptions and operating characteristics well outlined. Post verification metering should be considered where savings justify the added expense or be included as a requirement of the project.

Recommendation 3: Estimated savings for measures such as combustion controls, which are based on a savings a fixed percentage of total gas used should include not only the percentage

savings, but the baseline and projected as-built efficiencies and the billed gas usage. The baseline, if currently installed, should be demonstrated using combustion gas efficiency tests or other measure of the baseline. The resulting parameters can be easily checked against acceptable ranges to validate the measure.

Recommendation 4: The evaluators recommend that PA implementers consider using the results of the savings fraction analysis performed as part of the desk review process as a sanity check of individual application savings estimates and as indicator where a deeper review of an application may be required.

Recommendation 5: Consider some summer metering for measures which involve summer gas use such as industrial processes or re-heat operations.

Recommendation 6: In considering evaluation activities for the PY2012 program, the Evaluation Group may want to consider an additional round of on-site M&V impact evaluations for all the PAs except NSTAR. It is reasonable to conclude that the realization rates may not have stabilized statewide due to the rapid and continued expansion of the programs and the intent of the PAs to improve savings estimate processes.

Recommendation 7: However, before proceeding with the on-site M&Vs, the evaluators recommend repeating the desk-review task to further test the validity of the desk review method for triggering more expensive impact evaluations.

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: This impact evaluation produced an 84% realization rate for NSTAR, which is an improvement on the previous impact evaluation result of 47%, found one year earlier. As a result, the statewide realization rate also improved to 82%.

Formulas Used in Impact Analysis: Evaluated savings were determined through custom engineering analysis similar to how tracking savings were developed.

Application of Results: Retrospectively

How the Study Came to the Recommended Conclusions: Data collection included pre and post installation billing data, power metering, temperature metering, and in some cases, trend data collected from customer energy management systems. The sample was designed to achieve 80/10% precision at the statewide level, and 80/20% at the larger PA level (Columbia gas, National Grid, NSTAR). This sample design included 50 sites statewide. Following a desk review process, which helped determine that NSTAR would be the only PA to proceed with full M&V activities, the NSTAR sample was increased from the proposed 13 sites to 16 sites to ensure that the goal of 80/20% precision was met.

A copy of the complete study can be found in Appendix C, Study 21.

F. Special & Cross Sector Studies

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:

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

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:

$$Savings_{kt} = kWh_{kt} - \widehat{kWh}^{C}_{kt}$$

$$\widehat{kWh}^{C}_{kt} = kWh^{M}_{kt} + \hat{\beta}\left(\mathbf{X}_{kt} - \mathbf{X}^{M}_{kt}\right)$$

where**:**
kWh_{kt} = the average daily electricity use by household *k* during month t;
$\widehat{kWh}^{C}_{kt}$ = the estimated counterfactual energy use by household *k* during month *t*;
kWh^{M}_{kt} = 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;
$\mathbf{X}^{M}_{kt}$ = 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[7].

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.

[7] 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)

Savings Impact:

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	Integrated Boiler /	Home Durability	Annual	$0.72	33%	$0.24	67.9%	$0.39

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Percent ROF	Overall NEI Value ($/Year)
System	Water Heater	Property Value Increase	One Time	$29.17	50%	$14.59		$19.27
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	Thermal	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)
	or equal to 96% AFUE	Comfort						
		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:

$$Overall\ NEI\ Value = [(EE\ Portion\ of\ NEI * Full\ NEI\ Value) * ROF\%] + [Full\ NEI\ Value * (1 - ROF\%)]$$

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 Residential Heating and Water Heating and Cool Smart programs evaluation,[8] 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.

[8] 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	% Change
Residential						
Residential New Construction & Major Renovations	108,130	$0	101,660	$0	-6,470	1%
Residential Heating and Water Heating	196,118	$0	184,383	$0	-11,735	-1%
MassSAVE	122,788	$0	111,447	$0	-11,341	-1%
Weatherization Program	301,511	$0	283,470	$0	-18,041	-1%
Multifamily Retrofit	80,967	$0	76,123	$0	-4,844	0%
Behavior/Feedback Program	0	0%	0	0%	0	0%
Deep Energy Retrofit	2,032	$0	1,910	$0	-122	17%
Residential Building Practices and Demonstration Program	0	0%	0	0%	0	0%
Energy Analysis: Internet Audit Program	0	0%	0	0%	0	0%
Community Based Pilots	0	$0	0	$0	0	0%
Workforce Development	0	$0	0	$0	0	0%
Statewide Marketing & Education	0	$0	0	$0	0	0%
EEAC Consultants	198,000	$1	34,964	$1	-163,036	0%
DOER Assessment	83,092	$1	94,743	$1	11,651	0%
Sponsorships & Subscriptions	0	0%	0	0%	0	0%
Residential Total	**1,092,638**	**8%**	**888,700**	**6%**	**-203,938**	**-2%**
Low-Income						
Low-Income Retrofit	336,917	6%	318,758	6%	-18,159	0%
Statewide Marketing & Education	0	0%	0	0%	0	0%
Low-Income Energy Affordability Network Funding	118,000	100%	22,246	100%	-95,754	0%
DOER Assessment	30,468	100%	34,739	100%	4,271	0%
Low-Income Total	**485,385**	**9%**	**375,743**	**7%**	**-109,642**	**-2%**
Commercial & Industrial						
C&I New Construction & Major Renovation	150,259	6%	139,106	7%	-11,153	1%
C&I Retrofit	272,577	6%	254,104	11%	-18,473	5%
C&I Direct Install	4,752	6%	4,468	2%	-284	-4%
Workforce Development	0	0%	0	0%	0	0%
Business Energy Analyzer	0	0%	0	0%	0	0%
Deep Energy Retrofit	0	0%	0	0%	0	0%
Statewide Marketing & Education	0	0%	0	0%	0	0%
EEAC Consultants	52,000	100%	9,102	100%	-42,898	0%
DOER Assessment	24,927	100%	28,423	100%	3,496	0%
Sponsorships & Subscriptions	0	0%	0	0%	0	0%
C&I Total	**504,515**	**7%**	**435,203**	**10%**	**-69,312**	**3%**
GRAND TOTAL	**2,082,537**	**$0**	**1,699,646**	**$0**	**-382,891**	**-1%**

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	$801,471	18%	$3,269,481	89%	$383,834	11%	$3,653,315	82%	$4,454,786
Actual	$763,566	19%	$2,944,885	93%	$229,773	7%	$3,174,658	81%	$3,938,224
% Difference from Planned to Actual		1%		3%		-3%		-1%	
Low-Income									
Planned	$333,196	16%	$301,729	17%	$1,431,014	83%	$1,732,743	84%	$2,065,939
Actual	$321,978	24%	$65,474	6%	$982,009	94%	$1,047,483	76%	$1,369,461
% Difference from Planned to Actual		7%		-11%		11%		-7%	
Commercial & Industrial									
Planned	$428,900	31%	$819,256	87%	$123,523	13%	$942,779	69%	$1,371,679
Actual	$416,160	40%	$557,467	88%	$78,852	12%	$636,319	60%	$1,052,479
% Difference from Planned to Actual		8%		1%		-1%		-8%	
TOTAL									
Planned	$1,563,567	20%	$4,390,466	69%	$1,938,371	31%	$6,328,837	80%	$7,892,404
Actual	$1,501,704	24%	$3,567,827	73%	$1,290,633	27%	$4,858,460	76%	$6,360,164
% Difference from Planned to Actual		4%		4%		-4%		-4%	

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	% Change
Residential	$13,234,051	50%	$14,057,579	59%	$823,528	8%
Low-Income	$5,556,026	21%	$5,467,941	23%	-$88,085	2%
Commercial & Industrial	$7,416,502	28%	$4,443,574	19%	-$2,972,928	-10%
TOTAL	$26,206,578	100%	$23,969,094	100%	-$2,237,484	0%

As shown in Table IV.C, the Company met the minimum statutory requirement by spending 23 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	469,201	625,601	782,002	565,621
Value Mechanism	275,928	367,903	459,879	340,405
Performance Metrics	137,964	183,952	229,940	189,102
Total Incentive (before-tax)	883,092	1,177,456	1,471,821	1,095,129
Total Incentive (after-tax)	536,699	715,599	894,499	665,564

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 in NSTAR Gas Company, D.P.U. 11-107 ("2012 MTM"). The Company earned $1,095,129 in actual before-tax incentives, which is 93 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.

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. The Company achieved 90 percent of its planned benefits and 93 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, the Company calculated the lifetime benefits and net benefits that each program achieved. The benefits were multiplied by the savings payout rate of $0.0079 and the net benefits were multiplied by the value payout rate of $0.0093 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.

NSTAR Gas 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 = 32% 2012 Conversion Rate = 37%
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	Exemplary (125%)	X=16, Y=120% (at Exemplary) X*Y=20 Achieved 20
C&I #2 New Construction -- Comprehensiveness and depth of savings	Exemplary (125%)	X=50%, Z=110% (at Exemplary) X*Z=55% Achieved 60%
C&I #3 Direct Install Electric and Gas Integration	Below Threshold (0%)	X=32%, Z=110% (at Threshold) X*Z=35% Achieved 28%
C&I #4 Combined Heat & Power	Below Threshold (0%)	X=15, Y=110% X*Y=17 Achieved 6
Other Funding Metric Number And Name	**Achievement Level**	**Notes**
1. Other Financing Capital	Exemplary (2012 loans issued = $674,406.41)	Exemplary = 2011 achievement plus 40% or $415,531.63
2. Cost Efficiency of Program Expenditures	Threshold (97% of design)	3.09

VI. AUDITS

Please refer to the Company's 2010 Energy Efficiency Annual Report filed on August 15, 2011 in NSTAR Gas, D.P.U. 11-64 for information related to an audit conducted on the Company's energy efficiency activities during 2010 and completed in 2011.

The following audit, related to the Company's energy efficiency activities, was completed in 2012.

Introduction and Background

Northeast Utilities' Internal Audit Department ("IAD") completed an audit of residential NSTAR energy efficiency programs administered by a third party vendor, Conservation Services Group ("CSG"). NSTAR contracted with CSG to administer 4 programs: Mass Save ($13.9m contract value), Multi-Family ($2m contract value), Residential Heating and Water Heating ("Cool Smart") ($1.3m contract value) and Community Outreach ($60k contract value).

Energy Efficiency programs provide customers with energy efficiency recommendations and incentives that enables them to identify and initiate the process of installing cost-effective energy efficiency upgrades. CSG provides initial energy assessments, incentive recommendations, manages installation work performed by third party contractors, and performs post installation inspections.

Objectives & Scope

IAD's objective was to evaluate the adequacy and effectiveness of controls over the energy efficiency programs administered by CSG. Specifically, IAD evaluated whether adequate controls are in place to ensure that:

- Program costs, including charges from third parties, are valid, supported, and in accordance with contract terms and program requirements;
- Third parties deliver services and products in accordance with contract terms and conditions, and with program requirements;
- Action plans agreed to from the 2010 Energy Efficiency Processes Audit were put in place and are working effectively.

IAD's assessment included a review of processes and controls, interviews with NSTAR Energy Efficiency and CSG management and personnel, contract and invoice review, site visits, and follow up on 2010 audit action plans.

Recommendations Included in the Final Audit

Please see attached **CONFIDENTIAL** Final Audit.

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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NSTAR Gas
IV.C. Gas PA Budgets
1. Summary Table

Program Administrator Budget, Planned (1)								
Customer Sector / Program	Program Costs							
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs	Performance Incentive (2)	Total PA Budget (3)
Residential (total)	$1,092,638	$518,379	$8,779,265	$2,207,703	$636,066	$13,234,051	$461,603	$13,695,654
Residential New Construction & Major Renovations	$108,130	$41,779	$1,363,625	$40,525	$69,343	$1,623,402	$57,771	$1,681,173
Residential Heating and Water Heating	$196,118	$209,235	$2,465,125	$133,878	$153,231	$3,157,587	$132,028	$3,289,615
MassSAVE	$122,788	$79,879	-	$1,448,300	$78,439	$1,729,406	-	$1,729,406
Weatherization Program	$301,511	$38,784	$4,062,180	$216,000	$280,646	$4,899,121	$244,745	$5,143,866
Multifamily Retrofit	$80,967	$38,702	$860,835	$260,500	$54,407	$1,295,411	$27,059	$1,322,470
Behavior/Feedback Program	-	-	-	-	-	-	-	-
Deep Energy Retrofit	$2,032	-	$27,500	$1,500	-	$31,032	-	$31,032
Residential Building Practices and Demonstration Prograr	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-
Community Based Pilots	-	-	-	$57,000	-	$57,000	-	$57,000
Workforce Development	-	-	-	$50,000	-	$50,000	-	$50,000
Statewide Marketing & Education	-	$110,000	-	-	-	$110,000	-	$110,000
EEAC Consultants	$198,000	-	-	-	-	$198,000	-	$198,000
DOER Assessment	$83,092	-	-	-	-	$83,092	-	$83,092
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
Low Income (total)	$485,385	$90,403	$3,490,087	$1,258,414	$231,737	$5,556,026	$139,288	$5,695,314
Low-Income Retrofit	$336,917	$75,403	$3,490,087	$1,258,414	$231,737	$5,392,558	$139,288	$5,531,846
Statewide Marketing & Education	-	$15,000	-	-	-	$15,000	-	$15,000
Low-Income Energy Affordability Network Funding	$118,000	-	-	-	-	$118,000	-	$118,000
DOER Assessment	$30,468	-	-	-	-	$30,468	-	$30,468
Commercial & Industrial (total)	$504,515	$175,054	$6,044,823	$504,086	$188,024	$7,416,502	$576,565	$7,993,067
C&I New Construction & Major Renovation	$150,259	$42,156	$2,029,580	$79,917	$34,424	$2,336,336	$248,418	$2,584,754
C&I Retrofit	$272,577	$75,681	$3,974,375	$370,051	$151,668	$4,844,352	$306,843	$5,151,195
C&I Direct Install	$4,752	$25,217	$40,868	$4,118	$1,932	$76,887	$21,304	$98,191
Workforce Development	-	-	-	$50,000	-	$50,000	-	$50,000
Business Energy Analyzer	-	-		-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	$32,000	-	-	-	$32,000	-	$32,000
EEAC Consultants	$52,000	-	-	-	-	$52,000	-	$52,000
DOER Assessment	$24,927	-	-	-	-	$24,927	-	$24,927
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
GRAND TOTAL	**$2,082,537**	**$783,836**	**$18,314,175**	**$3,970,203**	**$1,055,827**	**$26,206,578**	**$1,177,456**	**$27,384,034**

Program Administrator Budget, Actual (1)								
Program	Program Costs							
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs	Performance Incentive (2)	Total PA Budget (3)
Residential (total)	$888,700	$254,010	$10,119,355	$2,474,604	$320,910	$14,057,579	$429,190	$14,486,769
Residential New Construction & Major Renovations	$101,660	$25,694	$1,040,777	$51,362	$43,875	$1,263,368	$51,757	$1,315,125
Residential Heating and Water Heating	$184,383	$67,575	$3,166,079	$124,231	$72,201	$3,614,469	$119,675	$3,734,144
MassSAVE	$111,447	$79,092	-	$1,617,988	$35,930	$1,844,457	-	$1,844,457
Weatherization Program	$283,470	$25,017	$5,186,800	$336,056	$141,577	$5,972,920	$229,147	$6,202,067
Multifamily Retrofit	$76,123	$4,000	$725,699	$311,175	$27,327	$1,144,324	$28,611	$1,172,935
Behavior/Feedback Program	-	-	-	-	-	-	-	-
Deep Energy Retrofit	$1,910	-	-	$6,349	-	$8,259	-	$8,259
Residential Building Practices and Demonstration Prograr	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-
Community Based Pilots	-	-	-	$14,350	-	$14,350	-	$14,350
Workforce Development	-	-	-	$13,093	-	$13,093	-	$13,093
Statewide Marketing & Education	-	$52,632	-	-	-	$52,632	-	$52,632
EEAC Consultants	$34,964	-	-	-	-	$34,964	-	$34,964
DOER Assessment	$94,743	-	-	-	-	$94,743	-	$94,743
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
Low Income (total)	$375,743	$8,360	$4,098,480	$896,013	$89,345	$5,467,941	$204,689	$5,672,630
Low-Income Retrofit	$318,758	$1,284	$4,098,480	$896,013	$89,345	$5,403,880	$204,689	$5,608,569
Statewide Marketing & Education	-	$7,076	-	-	-	$7,076	-	$7,076
Low-Income Energy Affordability Network Funding	$22,246	-	-	-	-	$22,246	-	$22,246
DOER Assessment	$34,739	-	-	-	-	$34,739	-	$34,739
Commercial & Industrial (total)	$435,203	$149,722	$3,391,095	$157,684	$309,870	$4,443,574	$461,250	$4,904,824
C&I New Construction & Major Renovation	$139,106	$65,293	$1,551,057	$44,030	$59,465	$1,858,951	$166,696	$2,025,647
C&I Retrofit	$254,104	$56,199	$1,695,341	$73,392	$248,128	$2,327,164	$263,785	$2,590,949
C&I Direct Install	$4,468	$911	$144,697	$36,621	$2,277	$188,974	$30,769	$219,743
Workforce Development	-	-	-	$3,641	-	$3,641	-	$3,641
Business Energy Analyzer	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-
Statewide Marketing & Education	-	$27,319	-	-	-	$27,319	-	$27,319
EEAC Consultants	$9,102	-	-	-	-	$9,102	-	$9,102
DOER Assessment	$28,423	-	-	-	-	$28,423	-	$28,423
Sponsorships & Subscriptions	-	-	-	-	-	-	-	-
GRAND TOTAL	**$1,699,646**	**$412,092**	**$17,608,930**	**$3,528,301**	**$720,125**	**$23,969,094**	**$1,095,129**	**$25,064,223**

Program Administrator Budget, Percent Variance (1)								
Program	Program Costs							
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs	Performance Incentive (2)	Total PA Budget (3)
Residential (total)	-19%	-51%	15%	12%	-50%	6%	-7%	6%
Residential New Construction & Major Renovations	-6%	-39%	-24%	27%	-37%	-22%	-10%	-22%
Residential Heating and Water Heating	-6%	-68%	28%	-7%	-53%	14%	-9%	14%
MassSAVE	-9%	-1%	0%	12%	-54%	7%	0%	7%
Weatherization Program	-6%	-35%	28%	56%	-50%	22%	-6%	21%
Multifamily Retrofit	-6%	-90%	-16%	19%	-50%	-12%	6%	-11%
Behavior/Feedback Program	0%	0%	0%	0%	0%	0%	0%	0%
Deep Energy Retrofit	-6%	0%	-100%	323%	0%	-73%	0%	-73%
Residential Building Practices and Demonstration Prograr	0%	0%	0%	0%	0%	0%	0%	0%
Energy Analysis: Internet Audit Program	0%	0%	0%	0%	0%	0%	0%	0%
Community Based Pilots	0%	0%	0%	-75%	0%	-75%	0%	-75%
Workforce Development	0%	0%	0%	-74%	0%	-74%	0%	-74%
Statewide Marketing & Education	0%	-52%	0%	0%	0%	-52%	0%	-52%
EEAC Consultants	-82%	0%	0%	0%	0%	-82%	0%	-82%
DOER Assessment	14%	0%	0%	0%	0%	14%	0%	14%
Sponsorships & Subscriptions	0%	0%	0%	0%	0%	0%	0%	0%
Low Income (total)	-23%	-91%	17%	-29%	-61%	-2%	47%	0%
Low-Income Retrofit	-5%	-98%	17%	-29%	-61%	0%	47%	1%
Statewide Marketing & Education	0%	-53%	0%	0%	0%	-53%	0%	-53%
Low-Income Energy Affordability Network Funding	-81%	0%	0%	0%	0%	-81%	0%	-81%
DOER Assessment	14%	0%	0%	0%	0%	14%	0%	14%
Commercial & Industrial (total)	-14%	-14%	-44%	-69%	65%	-40%	-20%	-39%
C&I New Construction & Major Renovation	-7%	55%	-24%	-45%	73%	-20%	-33%	-22%
C&I Retrofit	-7%	-26%	-57%	-80%	64%	-52%	-14%	-50%
C&I Direct Install	-6%	-96%	254%	789%	18%	146%	44%	124%
Workforce Development	0%	0%	0%	-93%	0%	-93%	0%	-93%
Business Energy Analyzer	0%	0%	0%	0%	0%	0%	0%	0%
Deep Energy Retrofit	0%	0%	0%	0%	0%	0%	0%	0%
Statewide Marketing & Education	0%	-15%	0%	0%	0%	-15%	0%	-15%
EEAC Consultants	-82%	0%	0%	0%	0%	-82%	0%	-82%
DOER Assessment	14%	0%	0%	0%	0%	14%	0%	14%
Sponsorships & Subscriptions	0%	0%	0%	0%	0%	0%	0%	0%
GRAND TOTAL	-18%	-47%	-4%	-11%	-32%	-9%	-7%	-8%

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 in NSTAR Gas Company, D.P.U. 11-107.

NSTAR Gas
IV.D. Cost Effectiveness
1. Summary Table

Total Resource Cost Test, Planned

Sector	B/C Ratio	Net Benefits	Benefits	Costs
Residential	**1.74**	**$13,976,262**	**$32,905,105**	**$18,928,843**
Residential New Construction & Major Renovations	1.79	$2,137,882	$4,835,430	$2,697,548
Residential Heating and Water Heating	2.06	$5,387,622	$10,492,691	$5,105,068
MassSAVE		-$1,729,406	-	$1,729,406
Weatherization Program	2.02	$7,733,987	$15,283,118	$7,549,131
Multifamily Retrofit	1.74	$975,300	$2,293,866	$1,318,566
Behavior/Feedback Program		-	-	-
Deep Energy Retrofit		-$31,032	-	$31,032
Residential Building Practices and Demonstration Program		-	-	-
Energy Analysis: Internet Audit Program		-	-	-
Community Based Pilots		-$57,000	-	$57,000
Workforce Development		-$50,000	-	$50,000
Statewide Marketing & Education		-$110,000	-	$110,000
EEAC Consultants		-$198,000	-	$198,000
DOER Assessment		-$83,092	-	$83,092
Sponsorships & Subscriptions		-	-	-
Low Income	**1.42**	**$2,395,378**	**$8,090,691**	**$5,695,313**
Low-Income Retrofit	1.46	$2,558,846	$8,090,691	$5,531,845
Statewide Marketing & Education		-$15,000	-	$15,000
Low-Income Energy Affordability Network Funding		-$118,000	-	$118,000
DOER Assessment		-$30,468	-	$30,468
Commercial & Industrial	**2.40**	**$22,043,283**	**$37,809,297**	**$15,766,015**
C&I New Construction & Major Renovation	4.07	$11,445,005	$15,175,842	$3,730,837
C&I Retrofit	1.88	$10,357,390	$22,138,637	$11,781,248
C&I Direct Install	5.21	$399,815	$494,818	$95,004
Workforce Development		-$50,000	-	$50,000
Business Energy Analyzer		-	-	-
Deep Energy Retrofit		-	-	-
Statewide Marketing & Education		-$32,000	-	$32,000
EEAC Consultants		-$52,000	-	$52,000
DOER Assessment		-$24,927	-	$24,927
Sponsorships & Subscriptions		-	-	-
GRAND TOTAL	**1.95**	**$38,414,922**	**$78,805,093**	**$40,390,171**

Total Resource Cost Test, Evaluated

Sector	B/C Ratio	Net Benefits	Benefits	Costs
Residential	**1.48**	**$10,190,875**	**$31,555,835**	**$21,364,960**
Residential New Construction & Major Renovations	1.75	$1,564,991	$3,644,939	$2,079,948
Residential Heating and Water Heating	1.44	$2,941,191	$9,672,391	$6,731,200
MassSAVE		-$1,844,457	-	$1,844,457
Weatherization Program	1.73	$6,862,189	$16,260,002	$9,397,813
Multifamily Retrofit	1.81	$885,002	$1,978,503	$1,093,501
Behavior/Feedback Program		-	-	-
Deep Energy Retrofit		-$8,259	-	$8,259
Residential Building Practices and Demonstration Program		-	-	-
Energy Analysis: Internet Audit Program		-	-	-
Community Based Pilots		-$14,350	-	$14,350
Workforce Development		-$13,093	-	$13,093
Statewide Marketing & Education		-$52,632	-	$52,632
EEAC Consultants		-$34,964	-	$34,964
DOER Assessment		-$94,743	-	$94,743
Sponsorships & Subscriptions		-	-	-
Low Income	**1.98**	**$5,544,340**	**$11,216,970**	**$5,672,630**
Low-Income Retrofit	2.00	$5,608,401	$11,216,970	$5,608,569
Statewide Marketing & Education		-$7,076	-	$7,076
Low-Income Energy Affordability Network Funding		-$22,246	-	$22,246
DOER Assessment		-$34,739	-	$34,739
Commercial & Industrial	**3.28**	**$19,802,809**	**$28,476,733**	**$8,673,924**
C&I New Construction & Major Renovation	3.55	$7,283,161	$10,139,194	$2,856,033
C&I Retrofit	3.02	$11,130,636	$16,634,251	$5,503,615
C&I Direct Install	6.93	$1,457,497	$1,703,288	$245,791
Workforce Development		-$3,641	-	$3,641
Business Energy Analyzer		-	-	-
Deep Energy Retrofit		-	-	-
Statewide Marketing & Education		-$27,319	-	$27,319
EEAC Consultants		-$9,102	-	$9,102
DOER Assessment		-$28,423	-	$28,423
Sponsorships & Subscriptions		-	-	-
GRAND TOTAL	**2.00**	**$35,538,025**	**$71,249,539**	**$35,711,514**

Total Resource Cost Test, Percent Variance				
Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs**
Residential	**-15%**	**-27%**	**-4%**	**13%**
Residential New Construction & Major Renovations	-2%	-27%	-25%	-23%
Residential Heating and Water Heating	-30%	-45%	-8%	32%
MassSAVE	0%	7%	0%	7%
Weatherization Program	-15%	-11%	6%	24%
Multifamily Retrofit	4%	-9%	-14%	-17%
Behavior/Feedback Program	0%	0%	0%	0%
Deep Energy Retrofit	0%	-73%	0%	-73%
Residential Building Practices and Demonstration Program	0%	0%	0%	0%
Energy Analysis: Internet Audit Program	0%	0%	0%	0%
Community Based Pilots	0%	-75%	0%	-75%
Workforce Development	0%	-74%	0%	-74%
Statewide Marketing & Education	0%	-52%	0%	-52%
EEAC Consultants	0%	-82%	0%	-82%
DOER Assessment	0%	14%	0%	14%
Sponsorships & Subscriptions	0%	0%	0%	0%
Low Income	**39%**	**131%**	**39%**	**0%**
Low-Income Retrofit	37%	119%	39%	1%
Statewide Marketing & Education	0%	-53%	0%	-53%
Low-Income Energy Affordability Network Funding	0%	-81%	0%	-81%
DOER Assessment	0%	14%	0%	14%
Commercial & Industrial	**37%**	**-10%**	**-25%**	**-45%**
C&I New Construction & Major Renovation	-13%	-36%	-33%	-23%
C&I Retrofit	61%	7%	-25%	-53%
C&I Direct Install	33%	265%	244%	159%
Workforce Development	0%	-93%	0%	-93%
Business Energy Analyzer	0%	0%	0%	0%
Deep Energy Retrofit	0%	0%	0%	0%
Statewide Marketing & Education	0%	-15%	0%	-15%
EEAC Consultants	0%	-82%	0%	-82%
DOER Assessment	0%	14%	0%	14%
Sponsorships & Subscriptions	0%	0%	0%	0%
GRAND TOTAL	**2%**	**-7%**	**-10%**	**-12%**

NSTAR Gas
IV.D. Cost Effectiveness
2.1. Cost Summary Table

TRC Costs Summary, Planned

Programs	Program Costs (1)	Performance Incentive (2)	Participant Costs	Total Resource Costs (3)
Residential	**$13,234,051**	**$461,603**	**$5,233,189**	**$18,928,843**
Residential New Construction & Major Renovations	$1,623,402	$57,771	$1,016,375	$2,697,548
Residential Heating and Water Heating	$3,157,587	$132,028	$1,815,453	$5,105,068
MassSAVE	$1,729,406	-	-	$1,729,406
Weatherization Program	$4,899,121	$244,745	$2,405,265	$7,549,131
Multifamily Retrofit	$1,295,411	$27,059	-$3,904	$1,318,566
Behavior/Feedback Program	-	-	-	-
Deep Energy Retrofit	$31,032	-	-	$31,032
Residential Building Practices and Demonstration Program	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-
Community Based Pilots	$57,000	-	-	$57,000
Workforce Development	$50,000	-	-	$50,000
Statewide Marketing & Education	$110,000	-	-	$110,000
EEAC Consultants	$198,000	-	-	$198,000
DOER Assessment	$83,092	-	-	$83,092
Sponsorships & Subscriptions	-	-	-	-
Low Income	**$5,556,026**	**$139,288**	**$0**	**$5,695,313**
Low-Income Retrofit	$5,392,558	$139,288	-	$5,531,845
Statewide Marketing & Education	$15,000	-	-	$15,000
Low-Income Energy Affordability Network Funding	$118,000	-	-	$118,000
DOER Assessment	$30,468	-	-	$30,468
Commercial & Industrial	**$7,416,502**	**$576,565**	**$7,772,948**	**$15,766,015**
C&I New Construction & Major Renovation	$2,336,336	$248,418	$1,146,083	$3,730,837
C&I Retrofit	$4,844,352	$306,843	$6,630,053	$11,781,248
C&I Direct Install	$76,887	$21,304	-$3,187	$95,004
Workforce Development	$50,000	-	-	$50,000
Business Energy Analyzer	-	-	-	-
Deep Energy Retrofit	-	-	-	-
Statewide Marketing & Education	$32,000	-	-	$32,000
EEAC Consultants	$52,000	-	-	$52,000
DOER Assessment	$24,927	-	-	$24,927
Sponsorships & Subscriptions	-	-	-	-
GRAND TOTAL	**$26,206,578**	**$1,177,456**	**$13,006,137**	**$40,390,171**

TRC Costs Summary, Evaluated

Programs	Program Costs (1)	Performance Incentive (2)	Participant Costs	Total Resource Costs (3)
Residential	**$14,057,579**	**$429,190**	**$6,878,191**	**$21,364,960**
Residential New Construction & Major Renovations	$1,263,368	$51,757	$764,823	$2,079,948
Residential Heating and Water Heating	$3,614,469	$119,675	$2,997,056	$6,731,200
MassSAVE	$1,844,457	-	-	$1,844,457
Weatherization Program	$5,972,920	$229,147	$3,195,746	$9,397,813
Multifamily Retrofit	$1,144,324	$28,611	-$79,434	$1,093,501
Behavior/Feedback Program	-	-	-	-
Deep Energy Retrofit	$8,259	-	-	$8,259
Residential Building Practices and Demonstration Program	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-
Community Based Pilots	$14,350	-	-	$14,350
Workforce Development	$13,093	-	-	$13,093
Statewide Marketing & Education	$52,632	-	-	$52,632
EEAC Consultants	$34,964	-	-	$34,964
DOER Assessment	$94,743	-	-	$94,743
Sponsorships & Subscriptions	-	-	-	-
Low Income	**$5,467,941**	**$204,689**	**$0**	**$5,672,630**
Low-Income Retrofit	$5,403,880	$204,689	-	$5,608,569
Statewide Marketing & Education	$7,076	-	-	$7,076
Low-Income Energy Affordability Network Funding	$22,246	-	-	$22,246
DOER Assessment	$34,739	-	-	$34,739
Commercial & Industrial	**$4,443,574**	**$461,250**	**$3,769,100**	**$8,673,924**
C&I New Construction & Major Renovation	$1,858,951	$166,696	$830,386	$2,856,033
C&I Retrofit	$2,327,164	$263,785	$2,912,666	$5,503,615
C&I Direct Install	$188,974	$30,769	$26,048	$245,791
Workforce Development	$3,641	-	-	$3,641
Business Energy Analyzer	-	-	-	-
Deep Energy Retrofit	-	-	-	-
Statewide Marketing & Education	$27,319	-	-	$27,319
EEAC Consultants	$9,102	-	-	$9,102
DOER Assessment	$28,423	-	-	$28,423
Sponsorships & Subscriptions	-	-	-	-
GRAND TOTAL	**$23,969,094**	**$1,095,129**	**$10,647,291**	**$35,711,514**

TRC Costs Summary, Percent Variance				
Programs	**Program Costs (1)**	**Performance Incentive (2)**	**Participant Costs**	**Total Resource Costs (3)**
Residential	6%	-7%	31%	13%
Residential New Construction & Major Renovations	-22%	-10%	-25%	-23%
Residential Heating and Water Heating	14%	-9%	65%	32%
MassSAVE	7%	0%	0%	7%
Weatherization Program	22%	-6%	33%	24%
Multifamily Retrofit	-12%	6%	1935%	-17%
Behavior/Feedback Program	0%	0%	0%	0%
Deep Energy Retrofit	-73%	0%	0%	-73%
Residential Building Practices and Demonstration Program	0%	0%	0%	0%
Energy Analysis: Internet Audit Program	0%	0%	0%	0%
Community Based Pilots	-75%	0%	0%	-75%
Workforce Development	-74%	0%	0%	-74%
Statewide Marketing & Education	-52%	0%	0%	-52%
EEAC Consultants	-82%	0%	0%	-82%
DOER Assessment	14%	0%	0%	14%
Sponsorships & Subscriptions	0%	0%	0%	0%
Low Income	-2%	47%	-100%	0%
Low-Income Retrofit	0%	47%	0%	1%
Statewide Marketing & Education	-53%	0%	0%	-53%
Low-Income Energy Affordability Network Funding	-81%	0%	0%	-81%
DOER Assessment	14%	0%	0%	14%
Commercial & Industrial	-40%	-20%	-52%	-45%
C&I New Construction & Major Renovation	-20%	-33%	-28%	-23%
C&I Retrofit	-52%	-14%	-56%	-53%
C&I Direct Install	146%	44%	-917%	159%
Workforce Development	-93%	0%	0%	-93%
Business Energy Analyzer	0%	0%	0%	0%
Deep Energy Retrofit	0%	0%	0%	0%
Statewide Marketing & Education	-15%	0%	0%	-15%
EEAC Consultants	-82%	0%	0%	-82%
DOER Assessment	14%	0%	0%	14%
Sponsorships & Subscriptions	0%	0%	0%	0%
GRAND TOTAL	-9%	-7%	-18%	-12%

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

(3) This represents the total TRC Test costs, which does not include LBR.

NSTAR Gas
IV.D. Cost Effectiveness
3.1. Benefits Summary Table

Gas Benefits, Planned (Lifetime $)

Program	Gas	Electric			Non-Gas Non-Electric									TOTAL TRC Benefits
					Resource							Non-Resource	TOTAL	
		Summer Capacity	Winter Capacity	Energy	No. 2 Distillate	No. 4 Fuel Oil	No. 6 Fuel Oil	Propane	Wood	Water	Kerosene			
Residential	**$22,222,032**	**$95,754**	**$29,005**	**$146,902**	-	-	-	-	-	**$197,771**	-	**$10,213,641**	**$10,411,412**	**$32,905,105**
Residential New Construction & Major Renovations	$3,083,671	$95,859	$29,129	$147,339	-	-	-	-	-	$4,179	-	$1,475,254	$1,479,433	$4,835,430
Residential Heating and Water Heating	$5,994,745	-$105	-$123	-$436	-	-	-	-	-	-	-	$4,498,610	$4,498,610	$10,492,691
MassSAVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	$11,691,283	-	-	-	-	-	-	-	-	$27,115	-	$3,564,720	$3,591,835	$15,283,118
Multifamily Retrofit	$1,452,332	-	-	-	-	-	-	-	-	$166,477	-	$675,057	$841,534	$2,293,866
Behavior/Feedback Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income	**$4,310,260**	-	-	-	-	-	-	-	-	-	-	**$3,780,431**	**$3,780,431**	**$8,090,691**
Low-Income Retrofit	$4,310,260	-	-	-	-	-	-	-	-	-	-	$3,780,431	$3,780,431	$8,090,691
Commercial & Industrial	**$37,712,921**	-	-	-	-	-	-	-	-	**$96,377**	-	**$0**	**$96,377**	**$37,809,297**
C&I New Construction & Major Renovation	$15,173,320	-	-	-	-	-	-	-	-	$2,522	-	-	$2,522	$15,175,842
C&I Retrofit	$22,138,637	-	-	-	-	-	-	-	-	-	-	-	-	$22,138,637
C&I Direct Install	$400,964	-	-	-	-	-	-	-	-	$93,854	-		$93,854	$494,818
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**$64,245,212**	**$95,754**	**$29,005**	**$146,902**	-	-	-	-	-	**$294,147**	-	**$13,994,072**	**$14,288,219**	**$78,805,093**

Gas Benefits, Evaluated (Lifetime $)

Program	Gas	Electric			Non-Gas Non-Electric									TOTAL TRC Benefits
					Resource							Non-Resource	TOTAL	
		Summer Capacity	Winter Capacity	Energy	No. 2 Distillate	No. 4 Fuel Oil	No. 6 Fuel Oil	Propane	Wood	Water	Kerosene			
Residential	**$21,589,093**	**$26,528**	**$19,668**	**$127,780**	-	-	-	-	-	**$245,466**	-	**$9,547,299**	**$9,792,766**	**$31,555,835**
Residential New Construction & Major Renovations	$1,471,241	$26,531	$19,932	$129,455	-	-	-	-	-	$663	-	$1,997,118	$1,997,781	$3,644,939
Residential Heating and Water Heating	$7,679,635	-$3	-$264	-$1,674	-	-	-	-	-	-	-	$1,994,697	$1,994,697	$9,672,391
MassSAVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	$11,050,457	-	-	-	-	-	-	-	-	$118,955	-	$5,090,590	$5,209,545	$16,260,002
Multifamily Retrofit	$1,387,760	-	-	-	-	-	-	-	-	$125,848	-	$464,895	$590,743	$1,978,503
Behavior/Feedback Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income	**$5,050,313**	**$338,468**	**$42,486**	**$252,305**	-	-	-	-	-	-	-	**$5,533,398**	**$5,533,398**	**$11,216,969**
Low-Income Retrofit	$5,050,313	$338,468	$42,486	$252,305	-	-	-	-	-	-	-	$5,533,398	$5,533,398	$11,216,969
Commercial & Industrial	**$23,596,492**	-	-	-	-	-	-	-	-	**$335,331**	-	**$4,544,911**	**$4,880,242**	**$28,476,733**
C&I New Construction & Major Renovation	$10,139,194	-	-	-	-	-	-	-	-	-	-	-	-	$10,139,194
C&I Retrofit	$12,553,369	-	-	-	-	-	-	-	-	-	-	$4,080,882	$4,080,882	$16,634,251
C&I Direct Install	$903,928	-	-	-	-	-	-	-	-	$335,331	-	$464,029	$799,360	$1,703,288
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**$50,235,898**	**$364,996**	**$62,154**	**$380,085**	-	-	-	-	-	**$580,797**	-	**$19,625,608**	**$20,206,405**	**$71,249,538**

Gas Benefits, Percent Variance (Lifetime $)														
Program	Gas	Electric			Non-Gas Non-Electric									TOTAL TRC Benefits
					Resource							Non-Resource	TOTAL	
		Summer Capacity	Winter Capacity	Energy	No. 2 Distillate	No. 4 Fuel Oil	No. 6 Fuel Oil	Propane	Wood	Water	Kerosene			
Residential	**-3%**	**-72%**	**-32%**	**-13%**	**0%**	**0%**	**0%**	**0%**	**0%**	**24%**	**0%**	**-7%**	**-6%**	**-4%**
Residential New Construction & Major Renovations	-52%	-72%	-32%	-12%	0%	0%	0%	0%	0%	-84%	0%	35%	35%	-25%
Residential Heating and Water Heating	28%	-97%	114%	284%	0%	0%	0%	0%	0%	0%	0%	-56%	-56%	-8%
MassSAVE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Weatherization Program	-5%	0%	0%	0%	0%	0%	0%	0%	0%	339%	0%	43%	45%	6%
Multifamily Retrofit	-4%	0%	0%	0%	0%	0%	0%	0%	0%	-24%	0%	-31%	-30%	-14%
Behavior/Feedback Program	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Deep Energy Retrofit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Residential Building Practices and Demonstration Program	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Energy Analysis: Internet Audit Program	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Workforce Development	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Low Income	**17%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**46%**	**46%**	**39%**
Low-Income Retrofit	17%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	46%	46%	39%
Commercial & Industrial	**-37%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**248%**	**0%**	**0%**	**4964%**	**-25%**
C&I New Construction & Major Renovation	-33%	0%	0%	0%	0%	0%	0%	0%	0%	-100%	0%	0%	-100%	-33%
C&I Retrofit	-43%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-25%
C&I Direct Install	125%	0%	0%	0%	0%	0%	0%	0%	0%	257%	0%	0%	752%	244%
Workforce Development	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Business Energy Analyzer	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Deep Energy Retrofit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GRAND TOTAL	**-22%**	**281%**	**114%**	**159%**	**0%**	**0%**	**0%**	**0%**	**0%**	**97%**	**0%**	**40%**	**41%**	**-10%**

NSTAR Gas
IV.D. Cost Effectiveness
3.2. Savings Summary Table

Gas Savings (Annual), Planned

Program	# of Participants	Annual Gas Savings (MMBTU)	Annual Gas Savings (Therms)	Gas Lifetime Savings (Therms)	Electric			Non-Gas Non-Electric Resource							
								MMBTU						Gallons	Non-Resource (1)
					Summer Capacity (kW)	Winter Capacity (kW)	Energy (kWh)	No. 2 Distillate	No. 4 Fuel Oil	No. 6 Fuel Oil	Propane	Wood	Kerosene	Water	
Residential	**22,142**	**134,761**	**1,347,608**	**26,670,705**	**36**	**75**	**144,633**	**0**	**0**	**0**	**0**	**0**	**0**	**11,341,257**	**0**
Residential New Construction & Major Renovations	700	15,582	155,818	3,685,992	36	75	144,899	-	-	-	-	-	-	172,000	-
Residential Heating and Water Heating	6,332	40,696	406,960	7,306,931	-0.03	-0.1	-266	-	-	-	-	-	-	-	-
MassSAVE	6,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	3,300	63,580	635,804	13,854,173	-	-	-	-	-	-	-	-	-	1,564,392	-
Multifamily Retrofit	5,810	14,903	149,026	1,823,609	-	-	-	-	-	-	-	-	-	9,604,865	-
Behavior/Feedback Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Community based pilots	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income	**1,408**	**26,997**	**269,970**	**5,111,100**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Low-Income Retrofit	1,408	26,997	269,970	5,111,100	-	-	-	-	-	-	-	-	-	-	-
Commercial & Industrial	**1,312**	**348,727**	**3,487,270**	**47,800,602**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5,785,935**	**0**
C&I New Construction & Major Renovation	448	94,955	949,545	19,016,715	-	-	-	-	-	-	-	-	-	87,600	-
C&I Retrofit	559	248,654	2,486,540	28,268,766	-	-	-	-	-	-	-	-	-	-	-
C&I Direct Install	305	5,119	51,185	515,120	-	-	-	-	-	-	-	-	-	5,698,335	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**24,862**	**510,485**	**5,104,848**	**79,582,407**	**36**	**75**	**144,633**	**0**	**0**	**0**	**0**	**0**	**0**	**17,127,192**	**0**

Gas Savings (Annual), Evaluated

Program	# of Participants	Annual Gas Savings (MMBTU)	Annual Gas Savings (Therms)	Gas Lifetime Savings (Therms)	Electric			Non-Gas Non-Electric Resource							
								MMBTU						Gallons	Non-Resource (1)
					Summer Capacity (kW)	Winter Capacity (kW)	Energy (kWh)	No. 2 Distillate	No. 4 Fuel Oil	No. 6 Fuel Oil	Propane	Wood	Kerosene	Water	
Residential	**21,780**	**142,978**	**1,429,779**	**25,982,188**	**12**	**27**	**103,058**	**0**	**0**	**0**	**0**	**0**	**0**	**14,151,220**	**0**
Residential New Construction & Major Renovations	488	7,551	75,505	1,764,707	12	27	104,122	-	-	-	-	-	-	27,271	-
Residential Heating and Water Heating	5,175	52,327	523,272	9,361,894	-0.1	-0.3	-1,064	-	-	-	-	-	-	-	-
MassSAVE	7,669	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	3,758	67,605	676,052	13,103,834	-	-	-	-	-	-	-	-	-	6,863,126	-
Multifamily Retrofit	4,690	15,495	154,950	1,751,752	-	-	-	-	-	-	-	-	-	7,260,824	-
Behavior/Feedback Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Community based pilots	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income	**1,548**	**28,904**	**289,044**	**5,975,806**	**113**	**49**	**154,972**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Low-Income Retrofit	1,548	28,904	289,044	5,975,806	113	49	154,972	-	-	-	-	-	-	-	-
Commercial & Industrial	**1,406**	**246,024**	**2,460,243**	**29,892,141**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**19,691,214**	**0**
C&I New Construction & Major Renovation	371	65,530	655,303	12,630,618	-	-	-	-	-	-	-	-	-	-	-
C&I Retrofit	461	165,212	1,652,120	16,072,465	-	-	-	-	-	-	-	-	-	-	-
C&I Direct Install	574	15,282	152,820	1,189,057	-	-	-	-	-	-	-	-	-	19,691,214	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**24,734**	**417,907**	**4,179,066**	**61,850,135**	**125**	**76**	**258,030**	**0**	**0**	**0**	**0**	**0**	**0**	**33,842,434**	**0**

Gas Savings (Annual), Percent Variance																
Program	# of Participants	Annual Gas Savings (MMBTU)	Annual Gas Savings (Therms)	Gas Lifetime Savings (Therms)	Electric			Non-Gas Non-Electric								
								Resource								
								MMBTU							Gallons	Non-Resource (1)
					Summer Capacity (kW)	Winter Capacity (kW)	Energy (kWh)	No. 2 Distillate	No. 4 Fuel Oil	No. 6 Fuel Oil	Propane	Wood	Kerosene		Water	
Residential	**-2%**	**6%**	**6%**	**-3%**	**-66%**	**-64%**	**-29%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**25%**	**0%**
Residential New Construction & Major Renovations	-30%	-52%	-52%	-52%	-65%	-64%	-28%	0%	0%	0%	0%	0%	0%		-84%	0%
Residential Heating and Water Heating	-18%	29%	29%	28%	300%	114%	300%	0%	0%	0%	0%	0%	0%		0%	0%
MassSAVE	28%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Weatherization Program	14%	6%	6%	-5%	0%	0%	0%	0%	0%	0%	0%	0%	0%		339%	0%
Multifamily Retrofit	-19%	4%	4%	-4%	0%	0%	0%	0%	0%	0%	0%	0%	0%		-24%	0%
Behavior/Feedback Program	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Deep Energy Retrofit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Residential Building Practices and Demonstration Program	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Energy Analysis: Internet Audit Program	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Community based pilots	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Workforce Development	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Low Income	**10%**	**7%**	**7%**	**17%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**0%**	**0%**
Low-Income Retrofit	10%	7%	7%	17%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Commercial & Industrial	**7%**	**-29%**	**-29%**	**-37%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**240%**	**0%**
C&I New Construction & Major Renovation	-17%	-31%	-31%	-34%	0%	0%	0%	0%	0%	0%	0%	0%	0%		-100%	0%
C&I Retrofit	-18%	-34%	-34%	-43%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
C&I Direct Install	88%	199%	199%	131%	0%	0%	0%	0%	0%	0%	0%	0%	0%		246%	0%
Workforce Development	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Business Energy Analyzer	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Deep Energy Retrofit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
GRAND TOTAL	**-1%**	**-18%**	**-18%**	**-22%**	**251%**	**1%**	**78%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**98%**	**0%**

NSTAR Gas
IV. I. Cost Recovery
1. Calculation of LBR Savings

Residential Savings - Heating

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Year			2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Annual Installed Savings (therms)			90,848	168,873	44,103	130,779	74,206	78,221	65,810	101,777	103,231	129,529	190,791	159,896
Monthly Percent of Annual			19.26%	16.19%	12.09%	8.01%	3.33%	1.81%	0.09%	0.17%	2.34%	5.73%	14.29%	16.69%
Residential Monthly Savings														
Install		Annualized	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Month	Year	Savings (therms)	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Jan	2012	90,848	17,498	14,709	10,982	7,278	3,021	1,641	85	158	2,130	5,203	12,981	15,162
Feb	2012	168,873		27,342	20,413	13,528	5,615	3,050	159	294	3,958	9,672	24,130	28,184
Mar	2012	44,103			5,331	3,533	1,466	797	42	77	1,034	2,526	6,302	7,360
Apr	2012	130,779				10,477	4,349	2,362	123	227	3,066	7,490	18,687	21,826
May	2012	74,206					2,467	1,340	70	129	1,739	4,250	10,603	12,385
Jun	2012	78,221						1,413	74	136	1,834	4,480	11,177	13,055
Jul	2012	65,810							62	114	1,543	3,769	9,404	10,983
Aug	2012	101,777								177	2,386	5,829	14,543	16,986
Sep	2012	103,231									2,420	5,912	14,751	17,229
Oct	2012	129,529										7,419	18,509	21,618
Nov	2012	190,791											27,262	31,842
Dec	2012	159,896												26,686
Savings Total			17,498	42,051	36,726	34,816	16,918	10,603	615	1,312	20,110	56,550	168,349	223,316

Low-Income Savings - Heating

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Year			2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Annual Installed Savings (therms)			12,131	6,859	28,351	10,305	45,857	9,776	14,101	13,562	47,870	39,050	3,455	57,727
Monthly Percent of Annual			19.26%	16.19%	12.09%	8.01%	3.33%	1.81%	0.09%	0.17%	2.34%	5.73%	14.29%	16.69%
Low-Income Monthly Savings														
Install		Annualized	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Month	Year	Savings (therms)	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Jan	2012	12,131	2,337	1,964	1,466	972	403	219	11	21	284	695	1,733	2,025
Feb	2012	6,859		1,111	829	549	228	124	6	12	161	393	980	1,145
Mar	2012	28,351			3,427	2,271	943	512	27	49	665	1,624	4,051	4,732
Apr	2012	10,305				826	343	186	10	18	242	590	1,472	1,720
May	2012	45,857					1,525	828	43	80	1,075	2,626	6,553	7,653
Jun	2012	9,776						177	9	17	229	560	1,397	1,632
Jul	2012	14,101							13	25	331	808	2,015	2,353
Aug	2012	13,562								24	318	777	1,938	2,263
Sep	2012	47,870									1,122	2,742	6,840	7,989
Oct	2012	39,050										2,237	5,580	6,517
Nov	2012	3,455											494	577
Dec	2012	57,727												9,634
Savings Total			2,337	3,075	5,722	4,618	3,442	2,046	119	246	4,427	13,052	33,053	48,240

C&I Savings - Heating

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Year			2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Annual Installed Savings (therms)			332,410	57,869	3,625	146,687	68,343	82,111	70,263	139,982	43,663	80,833	175,704	########
Monthly Percent of Annual			19.26%	16.19%	12.09%	8.01%	3.33%	1.81%	0.09%	0.17%	2.34%	5.73%	14.29%	16.69%
C&I Monthly Savings														
Install		Annualized	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Month	Year	Savings (therms)	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Jan	2012	332,410	64,025	53,820	40,182	26,629	11,053	6,004	313	578	7,792	19,038	47,498	55,477
Feb	2012	57,869		9,369	6,995	4,636	1,924	1,045	54	101	1,356	3,314	8,269	9,658
Mar	2012	3,625			438	290	121	65	3	6	85	208	518	605
Apr	2012	146,687				11,751	4,877	2,650	138	255	3,438	8,401	20,960	24,481
May	2012	68,343					2,272	1,234	64	119	1,602	3,914	9,766	11,406
Jun	2012	82,111						1,483	77	143	1,925	4,703	11,733	13,704
Jul	2012	70,263							66	122	1,647	4,024	10,040	11,726
Aug	2012	139,982								243	3,281	8,017	20,002	23,362
Sep	2012	43,663									1,023	2,501	6,239	7,287
Oct	2012	80,833										4,630	11,550	13,491
Nov	2012	175,704											25,107	29,324
Dec	2012	1,147,046												191,436
Savings Total			64,025	63,189	47,615	43,306	20,247	12,481	715	1,567	22,149	58,750	171,682	391,957

Residential Savings - Non-Heating

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Year			2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Annual Installed Savings (therms)			8,891	16,051	2,017	12,965	5,364	6,975	4,126	6,522	8,724	7,494	9,206	3,379
Monthly Percent of Annual			13.52%	12.98%	11.88%	8.87%	7.35%	6.04%	4.84%	4.23%	4.68%	5.88%	8.55%	11.19%
Residential Monthly Savings														
Install			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Month	Year	Annualized Savings (therms)	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Jan	2012	8,891	1,202	1,154	1,056	789	654	537	430	376	416	523	760	995
Feb	2012	16,051		2,083	1,906	1,424	1,180	970	777	679	751	944	1,372	1,795
Mar	2012	2,017			240	179	148	122	98	85	94	119	172	226
Apr	2012	12,965				1,150	953	783	627	549	606	762	1,109	1,450
May	2012	5,364					394	324	260	227	251	315	459	600
Jun	2012	6,975						421	338	295	326	410	596	780
Jul	2012	4,126							200	175	193	243	353	462
Aug	2012	6,522								276	305	384	558	730
Sep	2012	8,724									408	513	746	976
Oct	2012	7,494										441	641	838
Nov	2012	9,206											787	1,030
Dec	2012	3,379												378
Savings Total			1,202	3,237	3,202	3,542	3,329	3,157	2,730	2,662	3,350	4,654	7,553	10,260

Low-Income Savings Non-Heating

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Year			2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Annual Installed Savings (therms)			0	0	0	0	0	0	0	0	0	0	0	0
Monthly Percent of Annual			13.52%	12.98%	11.88%	8.87%	7.35%	6.04%	4.84%	4.23%	4.68%	5.88%	8.55%	11.19%
Low-Income Monthly Savings														
Install			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Month	Year	Annualized Savings (therms)	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Jan	2012	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	2012	0		0	0	0	0	0	0	0	0	0	0	0
Mar	2012	0			0	0	0	0	0	0	0	0	0	0
Apr	2012	0				0	0	0	0	0	0	0	0	0
May	2012	0					0	0	0	0	0	0	0	0
Jun	2012	0						0	0	0	0	0	0	0
Jul	2012	0							0	0	0	0	0	0
Aug	2012	0								0	0	0	0	0
Sep	2012	0									0	0	0	0
Oct	2012	0										0	0	0
Nov	2012	0											0	0
Dec	2012	0												0
Savings Total			0	0	0	0	0	0	0	0	0	0	0	0

C&I Savings - Non-Heating

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Year			2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Annual Installed Savings (therms)			8,256	10,420	13,679	12,936	3,114	12,521	9,325	9,289	3,893	5,192	8,248	14,833
Monthly Percent of Annual			7.41%	12.96%	9.98%	11.16%	3.29%	12.81%	2.74%	6.02%	6.30%	7.62%	9.28%	10.42%
C&I Monthly Savings														
Install			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Month	Year	Annualized Savings (therms)	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
Jan	2012	8,256	612	1,070	824	921	271	1,057	226	497	520	629	766	861
Feb	2012	10,420		1,351	1,040	1,163	342	1,334	285	627	657	794	967	1,086
Mar	2012	13,679			1,366	1,526	449	1,752	375	824	862	1,043	1,270	1,426
Apr	2012	12,936				1,443	425	1,657	354	779	815	986	1,201	1,349
May	2012	3,114					102	399	85	187	196	237	289	325
Jun	2012	12,521						1,603	343	754	789	954	1,162	1,305
Jul	2012	9,325							255	561	588	711	866	972
Aug	2012	9,289								559	586	708	862	968
Sep	2012	3,893									245	297	361	406
Oct	2012	5,192										396	482	541
Nov	2012	8,248											766	860
Dec	2012	14,833												1,546
Savings Total			612	2,421	3,230	5,053	1,589	7,802	1,923	4,788	5,258	6,755	8,992	11,645

NSTAR Gas
V.D. Competitive Procurement Process
1. Outsourced Services Table

Outsourced Services Planned, 2012

Program	Outsourced?	Program Planning and Administration	Marketing and Advertising	Sales, Technical Assistance & Training	Evaluation and Market Research	TOTAL
Residential						
Residential New Construction & Major Renovations	Yes	$11,783	$41,779	$40,525	$59,241	$153,328
	No	$96,347	-	-	$10,102	$106,449
	% Outsourced	11%	100%	100%	85%	59%
Residential Heating and Water Heating	Yes	$21,372	$209,235	$133,878	$130,907	$495,392
	No	$174,746	-	-	$22,324	$197,070
	% Outsourced	11%	100%	100%	85%	72%
MassSAVE	Yes	$27,686	$79,879	$1,448,300	$67,011	$1,622,876
	No	$95,102	-	-	$11,428	$106,530
	% Outsourced	23%	100%	100%	85%	94%
Weatherization Program	Yes	$32,857	$38,784	$216,000	$239,759	$527,400
	No	$268,654	-	-	$40,887	$309,541
	% Outsourced	11%	100%	100%	85%	63%
Multifamily Retrofit	Yes	$8,823	$38,702	$260,500	$46,481	$354,506
	No	$72,144	-	-	$7,926	$80,070
	% Outsourced	11%	100%	100%	85%	82%
Behavior/Feedback Program	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Deep Energy Retrofit	Yes	$221	-	$1,500	-	$1,721
	No	$1,811	-	-	-	$1,811
	% Outsourced	-	-	100%	-	49%
Residential Building Practices and Demonstration Program	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Energy Analysis: Internet Audit Program	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Community based pilots	Yes	-	-	$57,000	-	$57,000
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Workforce Development	Yes	-	-	$50,000	-	$50,000
	No	-	-	-	-	-
	% Outsourced	-	-	100%	-	100%
Statewide Marketing & Education	Yes	-	$110,000	-	-	$110,000
	No	-	-	-	-	-
	% Outsourced	-	100%	-	-	100%
EEAC Consultants	Yes	$198,000	-	-	-	$198,000
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
DOER Assessment	Yes	$83,092	-	-	-	$83,092
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
Sponsorships & Subscriptions	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Residential TOTAL	**Yes**	**$383,834**	**$518,379**	**$2,207,703**	**$543,399**	**$3,653,315**
	No	**$708,804**	**-**	**-**	**$92,667**	**$801,471**
	% Outsourced	**35%**	**100%**	**100%**	**85%**	**82%**
Low Income						
Low-Income Retrofit	Yes	$36,716	$75,403	$1,258,414	$198,742	$1,569,275
	No	$300,201	-	-	$32,995	$333,196
	% Outsourced	11%	100%	100%	86%	82%
Statewide Marketing & Education	Yes	-	$15,000	-	-	$15,000
	No	-	-	-	-	-
	% Outsourced	-	100%	-	-	100%
Low-Income Energy Affordability Network Funding	Yes	$118,000	-	-	-	$118,000
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
DOER Assessment	Yes	$30,468	-	-	-	$30,468
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
Low Income TOTAL	**Yes**	**$185,184**	**$90,403**	**$1,258,414**	**$198,742**	**$1,732,743**
	No	**$300,201**	**-**	**-**	**$32,995**	**$333,196**
	% Outsourced	**38%**	**100%**	**100%**	**86%**	**84%**
Commercial & Industrial						
C&I New Construction & Major Renovation	Yes	$16,374	$42,156	$79,917	$25,653	$164,100
	No	$133,885	-	-	$8,771	$142,656
	% Outsourced	11%	100%	100%	75%	53%
C&I Retrofit	Yes	$29,704	$75,681	$370,051	$113,023	$588,459
	No	$242,873	-	-	$38,645	$281,518
	% Outsourced	11%	100%	100%	75%	68%
C&I Direct Install	Yes	$518	$25,217	$4,118	$1,440	$31,293
	No	$4,234	-	-	$492	$4,726
	% Outsourced	11%	100%	100%	75%	87%
Workforce Development	Yes	-	-	$50,000	-	$50,000
	No	-	-	-	-	-
	% Outsourced	-	-	100%	-	100%
Business Energy Analyzer	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Deep Energy Retrofit	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Statewide Marketing & Education	Yes	-	$32,000	-	-	$32,000
	No	-	-	-	-	-
	% Outsourced	-	100%	-	-	100%
EEAC Consultants	Yes	$52,000	-	-	-	$52,000
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
DOER Assessment	Yes	$24,927	-	-	-	$24,927
	No	-	-	-	-	
	% Outsourced	100%	-	-	-	100%
Sponsorships & Subscriptions	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
C&I TOTAL	**Yes**	**$123,523**	**$175,054**	**$504,086**	**$140,116**	**$942,779**
	No	**$380,992**	**-**	**-**	**$47,908**	**$428,900**
	% Outsourced	**24%**	**100%**	**100%**	**75%**	**69%**
TOTAL						
GRAND TOTAL	**Yes**	**$692,541**	**$783,836**	**$3,970,203**	**$882,257**	**$6,328,837**
	No	**$1,389,997**	**-**	**-**	**$173,570**	**$1,563,567**
	% Outsourced	**33%**	**100%**	**100%**	**84%**	**80%**

Outsourced Services Actual, 2012

Program	Outsourced?	Program Planning and Administration	Marketing and Advertising	Sales, Technical Assistance & Training	Evaluation and Market Research	TOTAL
Residential						
Residential New Construction & Major Renovations	Yes	$11,545	$25,694	$51,362	$31,263	$119,864
	No	$90,115	-	-	$12,612	$102,727
	% Outsourced	11%	100%	100%	71%	54%
Residential Heating and Water Heating	Yes	$20,939	$67,575	$124,231	$44,332	$257,077
	No	$163,445	-	-	$27,869	$191,313
	% Outsourced	11%	100%	100%	61%	57%
MassSAVE	Yes	$26,530	$79,092	$1,617,988	$32,709	$1,756,319
	No	$84,917	-	-	$3,221	$88,138
	% Outsourced	24%	100%	100%	91%	95%
Weatherization Program	Yes	$32,191	$25,017	$336,056	$90,535	$483,799
	No	$251,279	-	-	$51,042	$302,321
	% Outsourced	11%	100%	100%	64%	62%
Multifamily Retrofit	Yes	$8,644	$4,000	$311,175	$17,432	$341,251
	No	$67,478	-	-	$9,895	$77,373
	% Outsourced	11%	100%	100%	64%	82%
Behavior/Feedback Program	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Deep Energy Retrofit	Yes	$217	-	$6,349	-	$6,566
	No	$1,693	-	-	-	$1,693
	% Outsourced	11%	-	-	-	79%
Residential Building Practices and Demonstration Program	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Energy Analysis: Internet Audit Program	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Community based pilots	Yes	-	-	$14,350	-	$14,350
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	100%
Workforce Development	Yes	-	-	$13,093	-	$13,093
	No	-	-	-	-	-
	% Outsourced	-	-	100%	-	100%
Statewide Marketing & Education	Yes	-	$52,632	-	-	$52,632
	No	-	-	-	-	-
	% Outsourced	-	100%	-	-	100%
EEAC Consultants	Yes	$34,964	-	-	-	$34,964
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
DOER Assessment	Yes	$94,743	-	-	-	$94,743
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
Sponsorships & Subscriptions	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Residential TOTAL	**Yes**	**$229,773**	**$254,010**	**$2,474,604**	**$216,271**	**$3,174,658**
	No	**$658,927**	**-**	**-**	**$104,639**	**$763,566**
	% Outsourced	**26%**	**100%**	**100%**	**67%**	**81%**
Low Income						
Low-Income Retrofit	Yes	$37,971	$1,284	$896,013	$48,154	$983,422
	No	$280,787	-	-	$41,191	$321,978
	% Outsourced	12%	100%	100%	54%	75%
Statewide Marketing & Education	Yes	-	$7,076	-	-	$7,076
	No	-	-	-	-	-
	% Outsourced	-	100%	-	-	100%
Low-Income Energy Affordability Network Funding	Yes	$22,246	-	-	-	$22,246
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
DOER Assessment	Yes	$34,739	-	-	-	$34,739
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
Low Income TOTAL	**Yes**	**$94,956**	**$8,360**	**$896,013**	**$48,154**	**$1,047,483**
	No	**$280,787**	**-**	**-**	**$41,191**	**$321,978**
	% Outsourced	**25%**	**100%**	**100%**	**54%**	**76%**
Commercial & Industrial						
C&I New Construction & Major Renovation	Yes	$13,880	$65,293	$44,030	$48,515	$171,718
	No	$125,225	-	-	$10,950	$136,176
	% Outsourced	10%	100%	100%	82%	56%
C&I Retrofit	Yes	$26,939	$56,199	$73,392	$199,884	$356,414
	No	$227,165	-	-	$48,244	$275,409
	% Outsourced	11%	-	100%	81%	56%
C&I Direct Install	Yes	$507	$911	$36,621	$1,662	$39,702
	No	$3,961	-	-	$615	$4,575
	% Outsourced	11%	100%	100%	73%	90%
Workforce Development	Yes	-	-	$3,641	-	$3,641
	No	-	-	-	-	-
	% Outsourced	-	-	100%	-	100%
Business Energy Analyzer	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Deep Energy Retrofit	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
Statewide Marketing & Education	Yes	-	$27,319	-	-	$27,319
	No	-	-	-	-	-
	% Outsourced	-	100%	-	-	100%
EEAC Consultants	Yes	$9,102	-	-	-	$9,102
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
DOER Assessment	Yes	$28,423	-	-	-	$28,423
	No	-	-	-	-	-
	% Outsourced	100%	-	-	-	100%
Sponsorships & Subscriptions	Yes	-	-	-	-	-
	No	-	-	-	-	-
	% Outsourced	-	-	-	-	-
C&I TOTAL	**Yes**	**$78,852**	**$149,722**	**$157,684**	**$250,061**	**$636,319**
	No	**$356,351**	**-**	**-**	**$59,809**	**$416,160**
	% Outsourced	**18%**	**100%**	**100%**	**81%**	**60%**
TOTAL						
GRAND TOTAL	**Yes**	**$403,580**	**$412,092**	**$3,528,301**	**$514,486**	**$4,858,460**
	No	**$1,296,065**	**-**	**-**	**$205,639**	**$1,501,704**
	% Outsourced	**24%**	**100%**	**100%**	**71%**	**76%**

Outsourced Services Percent Variance, 2012						
Program	**Outsourced?**	**Program Planning and Administration**	**Marketing and Advertising**	**Sales, Technical Assistance & Training**	**Evaluation and Market Research**	**TOTAL**
Residential						
Residential New Construction & Major Renovations	Yes	-2%	-39%	27%	-47%	-22%
	No	-6%	0%	0%	25%	-3%
	% Outsourced	4%	0%	0%	-17%	-9%
Residential Heating and Water Heating	Yes	-2%	-68%	-7%	-66%	-48%
	No	-6%	0%	0%	25%	-3%
	% Outsourced	4%	0%	0%	-28%	-20%
MassSAVE	Yes	-4%	-1%	12%	-51%	8%
	No	-11%	0%	0%	-72%	-17%
	% Outsourced	6%	0%	0%	7%	1%
Weatherization Program	Yes	-2%	-35%	56%	-62%	-8%
	No	-6%	0%	0%	25%	-2%
	% Outsourced	4%	0%	0%	-25%	-2%
Multifamily Retrofit	Yes	-2%	-90%	19%	-62%	-4%
	No	-6%	0%	0%	25%	-3%
	% Outsourced	4%	0%	0%	-25%	0%
Behavior/Feedback Program	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Deep Energy Retrofit	Yes	-2%	0%	323%	0%	282%
	No	-6%	0%	0%	0%	-6%
	% Outsourced	0%	0%	-100%	0%	63%
Residential Building Practices and Demonstration Program	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Energy Analysis: Internet Audit Program	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Community based pilots	Yes	0%	0%	-75%	0%	-75%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Workforce Development	Yes	0%	0%	-74%	0%	-74%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	0%	-52%	0%	0%	-52%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
EEAC Consultants	Yes	-82%	0%	0%	0%	-82%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
DOER Assessment	Yes	14%	0%	0%	0%	14%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Sponsorships & Subscriptions	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Residential TOTAL	**Yes**	**-40%**	**-51%**	**12%**	**-60%**	**-13%**
	No	**-7%**	**0%**	**0%**	**13%**	**-5%**
	% Outsourced	**-26%**	**0%**	**0%**	**-21%**	**-2%**
Low Income						
Low-Income Retrofit	Yes	3%	-98%	-29%	-76%	-37%
	No	-6%	0%	0%	25%	-3%
	% Outsourced	9%	0%	0%	-37%	-9%
Statewide Marketing & Education	Yes	0%	-53%	0%	0%	-53%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Low-Income Energy Affordability Network Funding	Yes	-81%	0%	0%	0%	-81%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
DOER Assessment	Yes	14%	0%	0%	0%	14%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Low Income TOTAL	**Yes**	**-49%**	**-91%**	**-29%**	**-76%**	**-40%**
	No	**-6%**	**0%**	**0%**	**25%**	**-3%**
	% Outsourced	**-34%**	**0%**	**0%**	**-37%**	**-9%**
Commercial & Industrial						
C&I New Construction & Major Renovation	Yes	-15%	55%	-45%	89%	5%
	No	-6%	0%	0%	25%	-5%
	% Outsourced	-8%	0%	0%	9%	4%
C&I Retrofit	Yes	-9%	-26%	-80%	77%	-39%
	No	-6%	0%	0%	25%	-2%
	% Outsourced	-3%	-100%	0%	8%	-17%
C&I Direct Install	Yes	-2%	-96%	789%	15%	27%
	No	-6%	0%	0%	25%	-3%
	% Outsourced	4%	0%	0%	-2%	3%
Workforce Development	Yes	0%	0%	-93%	0%	-93%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Business Energy Analyzer	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Deep Energy Retrofit	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	0%	-15%	0%	0%	-15%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
EEAC Consultants	Yes	-82%	0%	0%	0%	-82%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
DOER Assessment	Yes	14%	0%	0%	0%	14%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Sponsorships & Subscriptions	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
C&I TOTAL	**Yes**	**-36%**	**-14%**	**-69%**	**78%**	**-33%**
	No	**-6%**	**0%**	**0%**	**25%**	**-3%**
	% Outsourced	**-26%**	**0%**	**0%**	**8%**	**-12%**
TOTAL						
GRAND TOTAL	**Yes**	**-42%**	**-47%**	**-11%**	**-42%**	**-23%**
	No	**-7%**	**0%**	**0%**	**18%**	**-4%**
	% Outsourced	**-29%**	**0%**	**0%**	**-15%**	**-5%**

NSTAR Gas
VII. Appendix
B.1. Master Summary

Gas PA's Master Summary of Energy Efficiency Activities

Sector	TRC Benefits ($)							TRC Costs ($)			TRC B/C Ratio	Net Benefits
	Gas	Electric			Non-gas Non-elec Resource	Non-Resource	TOTAL BENEFITS	PA	Customer	TOTAL		
		Summer Capacity	Winter Capacity	Energy								
Planned												
Residential	$22,222,032	$95,754	$29,005	146,902.44	$197,771	$10,213,641	$32,905,105	$13,695,654	$5,233,189	$18,928,843	1.74	$13,976,262
Low Income	$4,310,260	-	-	-	-	$3,780,431	$8,090,691	$5,695,314	$0	$5,695,313	1.42	$2,395,378
C&I	$37,712,921	-	-	-	$96,377	-	$37,809,297	$7,993,067	$7,772,948	$15,766,015	2.40	$22,043,283
TOTAL	$64,245,212	$95,754	$29,005	146,902.44	$294,147	$13,994,072	$78,805,093	$27,384,034	$13,006,137	$40,390,171	1.95	$38,414,922
Evaluated												
Residential	$21,589,093	$26,528	$19,668	$127,780	$245,466	$9,547,299	$31,555,835	$14,486,769	$6,878,191	$21,364,960	1.48	$10,190,875
Low Income	$5,050,313	$338,468	$42,486	$252,305	-	$5,533,398	$11,216,969	$5,672,630	$0	$5,672,630	1.98	$5,544,340
C&I	$23,596,492	-	-	-	$335,331	$4,544,911	$28,476,733	$4,904,824	$3,769,100	$8,673,924	3.28	$19,802,809
TOTAL	$50,235,898	$364,996	$62,154	$380,085	$580,797	$19,625,608	$71,249,538	$25,064,223	$10,647,291	$35,711,514	2.00	$35,538,025
Perent Variance												
Residential	-3%	-72%	-32%	-13%	24%	-7%	-4%	6%	31%	13%	-15%	-27%
Low Income	17%	0%	0%	0%	0%	46%	39%	0%	-100%	0%	39%	131%
C&I	-37%	0%	0%	0%	248%	0%	-25%	-39%	-52%	-45%	37%	-10%
TOTAL	-22%	281%	114%	159%	97%	40%	-10%	-8%	-18%	-12%	2%	-7%

Notes:

(1) GHG for information purposes only; it is not included in TRC test

NSTAR Gas
VII. Appendix
B.1. Master Summary

Gas PA's Master Summary of Energy Efficiency Activities

Sector	Savings										Avg Measure Life (yrs.)	TR Energy Cost ($/Lifetime-Therms saved)	Emissions Reductions (Short Tons) (1)				Participants
	Gas (Therms)		Electric Energy (kWh)		Summer Electric Capacity (kW)		Winter Electric Capacity (kW)		Non-gas non-elec Resources				NOx	SOx	CO2 (MA Only)	CO2 (Regional)	
	Annualized	Lifetime (2)	Annualized	Lifetime	Annualized	Lifetime	Annualized	Lifetime	Annualized	Lifetime							
Planned																	
Residential	1,347,608	26,670,705	144,633	1,671,311	36	679	75	632	-	-	20	$0.71	NA	NA	156,711	156,600	22,142
Low Income	269,970	5,111,100	-	-	-	-	-	-	-	-	19	$1.11	NA	NA	29,860	29,860	1,408
C&I	3,487,270	47,800,602	-	-	-	-	-	-	-	-	14	$0.33	NA	NA	279,260	279,260	1,312
TOTAL	5,104,848	79,582,407	144,633	1,671,311	36	679	75	632	-	-	16	$0.51	NA	NA	465,831	465,721	24,862
Evaluated																	
Residential	1,429,779	25,982,188	103,058	1,541,635	12	192	27	456	-	-	18	$0.82	NA	NA	152,619	152,517	21,780
Low Income	289,044	5,975,806	154,972	3,070,028	113	2,263	49	977	-	-	21	$0.95	NA	NA	36,557	36,354	1,548
C&I	2,460,243	29,892,141	-	-	-	-	-	-	-	-	12	$0.29	NA	NA	174,636	174,636	1,406
TOTAL	4,179,066	61,850,135	258,030	4,611,663	125	1,850	76	1,125	-	-	15	$0.58	NA	NA	363,811	363,506	24,734
Perent Variance																	
Residential	6%	-3%	-29%	-8%	-67%	-72%	-64%	-28%	0%	0%	-8%	16%	NA	NA	-3%	-3%	-2%
Low Income	7%	17%	0%	0%	0%	0%	0%	0%	0%	0%	9%	-15%	NA	NA	22%	22%	10%
C&I	-29%	-37%	0%	0%	0%	0%	0%	0%	0%	0%	-11%	-12%	NA	NA	-37%	-37%	7%
TOTAL	-18%	-22%	78%	176%	247%	172%	1%	78%	0%	0%	-5%	14%	NA	NA	-22%	-22%	-1%

Notes:
(1) GHG for information purposes only; it is not included in TRC test

Annual Emmision Reduction

Sector	Emissions Reductions (Short Tons)			
	NOx	SO2	CO2	NOTES
Planned				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	324	850	925	
Low Income	65	170	170	
C&I	837	2,200	2,200	
TOTAL	1,226	3,220	3,295	
Evaluated				
Residential	343	902	955	
Low Income	69	182	262	
C&I	591	1,552	1,552	
TOTAL	1,004	2,636	2,769	

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)

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: 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

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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 - NSTAR Gas
2012 Annual Report Results

	NSTAR Gas	Segment %	Residential	Low Income	C&I	Total	Comment
1	Planned Benefits		$ 32,905,105	$ 8,090,691	$ 37,809,297	$ 78,805,093	Planned Benefits
2	Achieved Benefits		$ 31,555,835	$ 11,216,970	$ 28,476,733	$ 71,249,539	IV. D. Cost Effectiveness 1. Summary Table
3	Savings Payout Rate 2012		0.0079	0.0079	0.0079	0.0079	Exhibit D, Attachment 2 in NSTAR Gas, D.P.U. 11-107 dated 10/28/11
4	**Savings Incentives**		**$ 250,509**	**$ 89,047**	**$ 226,065**	**$ 565,621**	Line 2 times Line 3
5	Actual Costs		$ 21,397,374	$ 5,607,229	$ 8,789,240	$ 35,793,843	Total TRC Costs (which includes Line 6 below)
6	Performance Incentive Included in Cost		$ 461,604	$ 139,287	$ 576,565	$ 1,177,457	Estimated Performance Incentive before final run
7	Achieved Net Benefits (excluding performance incentives)		$ 10,620,065	$ 5,749,029	$ 20,264,059	$ 36,633,153	Line 2 - (Line 5 - Line 6)
8	Value Payout Rate 2012		0.0093	0.0093	0.0093	0.0093	Exhibit D, Attachment 2 in NSTAR Gas, D.P.U. 11-107 dated 10/28/11
9	**Value Incentives**		**$ 98,685**	**$ 53,422**	**$ 188,299**	**$ 340,405**	Line 7 times Line 8
10	**Performance Metrics**		**$ 79,997**	**$ 62,220**	**$ 46,886**	**$ 189,102**	Line 47
11	**Total Peformance Incentives**		**$ 429,190**	**$ 204,688**	**$ 461,250**	**$ 1,095,129**	Line 4 + Line 9 + Line 10
	Performance Metric Allocation - Targets (2012)						
12	Targets		$ 66,223	$ 51,506	$ 66,223	$ 183,952	Exhibit D, Attachment 2 in NSTAR Gas, D.P.U. 11-107 dated 10/28/11
13	All Sector Metrics					20.0%	Exhibit D, Attachment 2 in NSTAR Gas, D.P.U. 11-107 dated 10/28/11
14	1. Financing Metric	25%	$ 3,311	$ 2,575	$ 3,311	$ 9,198	Line 13* Line 12 * segment%
15	2. Cost-Effiency of Program Expenditures	75%	$ 9,933	$ 7,726	$ 9,933	$ 27,593	Line 13* Line 12 * segment%
16	Total All Sector Metrics		$ 13,245	$ 10,301	$ 13,245	$ 36,790	Line 14 + Line 15
17	Remaining Peformance Metrics after All Sector Metrics		$ 52,978	$ 41,205	$ 52,978	$ 147,161	Line 12 - Line 16
	Residential						
18	1. MassSAVE/Weatherization: Deeper Savings	60.0%	$ 31,787			$ 31,787	Line 17 * segment %
19	2. MassSAVE/Weatherization: Lost/Marketing Opportuni	40.0%	$ 21,191			$ 21,191	Line 17 * segment %
	Low Income						
20	1. Best Practices Technical Review Sub-committee/New	50.0%		$ 20,603		$ 20,603	Line 17 * segment %
21	2. Multi-Family Building Inventory	50.0%		$ 20,603		$ 20,603	Line 17 * segment %
	Commercial & Industrial						
22	1. Retrofit -- Depth of savings	25.0%			$ 13,245	$ 13,245	Line 17 * segment %
23	2. New Construction -- Comprehensiveness and depth o	25.0%			$ 13,245	$ 13,245	Line 17 * segment %
24	3. Direct Install Electric and Gas Integration	25.0%			$ 13,245	$ 13,245	Line 17 * segment %
25	4. Combined Heat & Power	25.0%			$ 13,245	$ 13,245	Line 17 * segment %
26	Total Target Peformance Metrics		$ 66,223	$ 51,506	$ 66,223	$ 183,952	Line 14+ line 15 + Line 18 to 25

2012 Energy Effiency Performance Incentives - NSTAR Gas
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	97%	97%	97%		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			125%		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	$ 4,139	$ 3,219	$ 4,139	$ 11,497	Line 14 * Line 27
38	2. Cost-Effiency of Program Expenditures	$ 9,635	$ 7,494	$ 9,635	$ 26,765	Line 15 * Line 28
	Residential					
39	1. MassSAVE/Weatherization: Deeper Savings	$ 39,734			$ 39,734	Line 18 * Line 29
40	2. MassSAVE/Weatherization: Lost/Marketing Opportunity	$ 26,489			$ 26,489	Line 19 * Line 30
	Low Income					
41	1. Best Practices Technical Review Sub-committee/New Measures		$ 25,753		$ 25,753	Line 20 * Line 31
42	2. Multi-Family Building Inventory		$ 25,753		$ 25,753	Line 21 * Line 32
	Commercial & Industrial					
43	1. Retrofit -- Depth of savings			$ 16,556	$ 16,556	Line 22 * Line 33
44	2. New Construction -- Comprehensiveness and depth of savings			$ 16,556	$ 16,556	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	$ 79,997	$ 62,220	$ 46,886	$ 189,102	Sum lines 37 to 46
48	Percent of Goal				103%	Line 47 / Line 26

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	RFP # 4 and 5 were issued on behalf of the electric PAs and are, therefore, not included in NSTAR Gas Company's 2012 Energy Efficiency Annual Report				
5					
6	NSTAR Electric & NSTAR Gas only	Municipal Program	Awarded to 12 vendors: AECOM, National Resource Management, Northern Energy Services, Prism, Horizon Solutions, World Energy, Hobart Energy, Nxegen, TNT Energy, Rise Engineering, Source One, and Atlantic Energy	22	17
7	NSTAR Gas only	NSTAR Gas Savings Fall 2012 Campaign	Awarded to 2 vendors: Munro and FW Webb	6	3

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

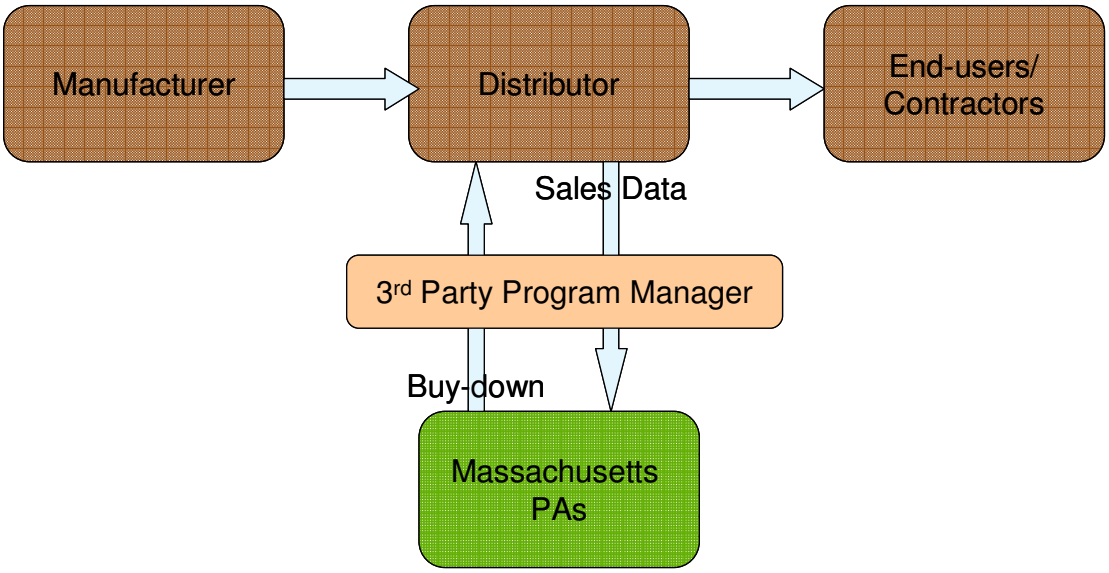

Figure 1: Upstream Program Model

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.

January 19, 2012

RFP #2184
Municipal Program
Scope of Work

Municipal Program Scope of Work

A Program to Deliver Great Service to our Municipal Customers

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1.0 INTRODUCTION

In 2008 NSTAR Commercial and Industrial Energy Efficiency group launched the Municipal Program, a program designed specifically for NSTAR municipal customers. The focus of the program is to serve cities, towns, county and state government.

Municipalities in the NSTAR territory make up roughly 17% of all usage and opportunity. Since 2008, the municipal program has saved over 90 million kWh. The incentive for program year 2011 was $0.25 for every NSTAR approved kWh saved. The 2011 program also had a cap of "up to" 70% of the total labor and material project cost.

NSTAR Account Executives and Program Managers work closely with the municipality to ensure a clear and streamlined process to participate in energy efficiency programs. The program offers turnkey services resulting in seamless participation for the municipalities.

The Municipal Program is focused on a holistic approach which **must** include comprehensive solutions for both electric and gas Energy Conservation Measures (ECM's). The expectation of the Vendor is to consider energy efficiency measures for all fuel types, particularly natural gas, offering customers a seamless approach to energy efficiency.

1.1 The Green Communities Act

The Green Communities Act (Chapter 25A, section 14) has provided additional opportunities for the Municipal Program to flourish to grow by leaps and bounds as we work in direct partnership with the Massachusetts Department of Energy Resources (DOER).

In February of 2008, the DOER reintroduced the Energy Audit Program (EAP). Of the 351 cities and towns in Massachusetts, over one third has applied to be a "Green Community". It is

expected that at least another one third will be applying for this status during the length of this contract. NSTAR Electric and Gas works closely with the DOER's regional Green Community Coordinators and the local natural gas utilities to offer a "team" approach in working as partners for the first time in the Commonwealth of Massachusetts's history. The program has been very successful to date yet we all as a team try to find new ways and better solutions to deliver the best possible program to the cities and towns of Massachusetts.

The Green Communities Act of 2008 authorizes a State Agency, Building, Authority or local governmental body to contract directly with their gas or electric utility supplier for "energy conservation projects" having a "total project cost" of $100,000 or less.

The spirit of the Green Communities Act is to provide limited exemptions from the competitive requirements of the public construction bid laws. See Section 4.5 - Attachment A of the RFP solicitation document for additional details of the Green Communities Act, Chapter 25A.

2.0 EXECUTIVE SUMMARY

2.1 Municipal Program (MP)

The Municipal Program (MP) is a suite of energy efficiency programs, open only to NSTAR municipal (city, town, county or state government) customers, to retrofit existing equipment with more energy efficient systems. The program goal is to identify all cost-effective efficiency retrofit opportunities and provides direct installation, financial incentives, and other strategies to encourage the early replacement of existing equipment with high efficiency alternatives, as well as the installation of new equipment. All energy-using systems are eligible for improvements including but not limited to: lighting, controls, refrigeration controls, energy management systems, motors and variable speed drives, and other site specific custom measures, including natural gas measures. Where appropriate, retrofitting multiple and interacting end uses are coordinated to ensure optimal system design (e.g., resizing and replacement of cooling equipment at the time of a comprehensive lighting replacement).

Customer incentives are provided to reduce the cost of installing energy efficient equipment. Customer incentives are based on the total KW hours saved and installed cost of the retrofits. All qualifying Municipal customers are eligible for an incentive up to 70% of the total installed cost.

The Program is a turnkey program that offers customers a single source of information, technical assistance and financial incentives. NSTAR has offered the Program over the past 3 years through six (6) prime contractors. The contractors are responsible for the following elements: 1) marketing to NSTAR customers; 2) performing site visits and collecting all equipment and energy data, identifying and reporting on all efficiency opportunities, performing analysis, and making recommendations to customer; 3) presentation of the recommendations to the customer and obtaining customer agreement to proceed with the installation; 4) preparation and submission of completed customer incentive applications; 5) installation of eligible measures; 6) tracking various levels of program activity through the Company's database and data collection protocols; 7) tracking and setting aside all equipment for proper disposal.

Our review indicates that our municipal customers are encountering two barriers to participate in the Municipal Program. First is the impact on limited budgets, the "we can't afford to save money" paradigm. Energy efficiency projects generally do not get funding at the local level, no matter how cost effective, because of other demands on municipal budgets. Second is the complications created by city or town finance regulations. Projects may require funding approval at town meetings; loans may require reviews by a finance committee. The MP will ensure that the goals of customer commitment and maximum savings per dollar are met by offering a diversity of financing options. By overcoming the financial barriers we will assist the municipal customer to save money, reduce environmental impact and move toward a better environment.

2.2 Alternative Bids for Performance Contractors

Refer to Section 3.2.6 of the RFP solicitation document regarding alternate bids from Performance Contractors.

3.0 MUNICPAL PROGRAM PROCESS

The Municipal Program process is focused on the needs of the customer. NSTAR will act as an agent of the municipal customer, providing technical and financial assistance at no cost. The customer will provide access, direction, opportunity and project oversight.

The process begins with a call to action to cities and towns. NSTAR, through the Account Executives and the Municipal Program Manager will contact each municipal customer to raise awareness of the program. Each municipal customer that answers the call to action will meet with NSTAR to discuss opportunities. These meetings will be used to discover customer pain points, learn about upcoming projects and set expectations. NSTAR will provide energy efficiency experts to assess the opportunities at a high level, based on industry standards, bill analysis and experience. Opportunities that pass a high level screening will receive a scoping audit. The scoping audit will capture and report major measures, and cost and benefit information in the form of a Project Proposal. Each Project Proposal will be reviewed for cost and benefit based on industry standards and facility operating assumptions. The Municipal customer and NSTAR will assess the Project Proposal to determine which opportunities best fit the Municipal budget.

The outline for the Municipal program process is:

- Outreach, NSTAR contacts municipal customers
- Team Meeting, NSTAR and the municipal contact person meet to discuss the program
- Assessment, determine and classify opportunities, determine financial track
- Audit/engineer the proposal savings and costs
- Proposal evaluation, proposals are judged based on relative merit
- Implementation, project is installed
- NSTAR will perform a post-installation inspection.

4.0 MARKETING AND OUTREACH

The Company requires a detailed strategic marketing plan from each vendor that describes **in detail** how the Vendor will meet the demands of the Municipal Program. The vendor will be responsible for marketing this program directly to eligible cities, towns, county government and state agencies in NSTAR's service territory. See Section 4.6 - Attachment B of the RFP solicitation document for a copy of NSTAR's Service Territory Map. There are no assigned territories in the Municipal Program. The NSTAR Municipal Program Manager will act as the clearinghouse so that multiple vendors are not competing with each other for that particular customer.

Vendors are encourages to work closely with the Company to provide suggestions in developing marketing material that will help promote the program and increase participation.

The Company will work with the vendors to make available specific information, including usage history, and past customer participation. It is expected the Vendor will perform marketing primarily through direct contact (in person, by phone, email or by mail).

The expectation is for the Vendor to be heavily involved with the communities they serve, including but not limited to events such as town meetings, and local Green and Efficiency events.

The Company will reach out to the Municipal customer to solicit participation in the MP. The vendor will provide support and expertise on a as needed basis under the direction of the Company during the solicitation/outreach process. The outreach will begin through established contacts at the municipality. A one page marketing piece/project summary will be prepared to assist the Account Executive. A successful outreach will result in a Team Meeting.

4.1 Team Meeting

NSTAR will coordinate a meeting with the Municipal customer to discuss the MP. This first meeting will serve to introduce the parties, create the team, define roles and discuss opportunities. Present at the meeting will be:

- ✓ NSTAR Account Executive as Meeting Leader

- ✓ Municipal Approval Authority (ability to authorize Municipal employee participation)
- ✓ Municipal Point of Contact
- ✓ NSTAR Municipal Program Manager
- ✓ Municipal Subject Matter Experts (at discretion of the municipality)
- ✓ MA DOER (Massachusetts Department of Energy and Resources) if the community is applying for Green Communities Status

A second Team meeting may result in an MOU (Memorandum of Understanding) defining the roles and obligations of the team.

When the signed MOU has been received by the NSTAR's Account Executive, the Municipal Program Manager and/or Account Executive will coordinate an Assessment meeting. The NSTAR Municipal Program Manager will be responsible for the collection and safekeeping of all documentation.

5.0 ASSESSMENT

The NSTAR Municipal Program Manager will coordinate an Assessment meeting(s) with:

- ✓ NSTAR Account Executive
- ✓ Municipal Point of Contact
- ✓ Municipal Subject Matter Experts
- ✓ NSTAR EE Engineering representative/Energy Auditing firm
- ✓ DOER Green Communities Coordinator

This assessment meeting(s) will serve to introduce the parties, define roles, discuss opportunities and determine the projects financial track.

The following Energy Conservation Measures (ECM) lists the type of measures that should be considered. Any measure that reduces electrical energy usage (kWh) and provides Demand Reduction (kW), is eligible for consideration.

Comprehensive Design

- Combinations of measures that exceed the individual savings of any measure

Lighting

- Lighting fixtures
- Lighting control
- Day lighting controls
- Occupancy sensors

HVAC & Refrigeration

- Chiller system replacements or upgrades
- Packaged cooling unit replacement/upgrade
- Variable-air-volume conversion
- Air or water side economizer
- Variable speed drive installations
- Energy management system installation/optimization
- Exhaust hood and fan replacement/control

Miscellaneous

- Project improving building hot water efficiency
- Compressed air system optimization
- Any measures involving switching from electric (heating and domestic hot water) to natural gas heating and domestic hot water

Ineligible Measures

The following Measures and types of Measures are ineligible for participation in the MP:

- Time dependent projects, such as New Construction or Equipment Replacement
- All technologies that are below federal and state minimum efficiency standards

- All measures that decrease only building plug loads
- Projects that save energy because of business operational changes
- Any measure that does not reduce electrical energy consumption (kWh), natural gas savings (therms), or other qualifying fossil fuels.
- Measures required by law or code, or that represent standard industry practice
- Measures not cost effective or not approved as viable according to NSTAR and PA accepted criteria
- Measures that can not be verified using NSTAR approved protocols

6.0 AUDIT

NSTAR will supply technical expertise to perform a detailed audit(s) that will be used to submit a proposal for consideration in the MP. All ECM's that have been identified during the assessment process will be audited. The audit will consist of a detailed engineering analysis resulting in a report to be included in the vendor's proposal. The following materials will be required to constitute a complete proposal:

- Municipal application, completed and signed
- Team Meeting
- Engineering Analysis/Energy Audit Report
    a. Energy Conservation Measure Form, with energy use calculations attached, for each ECM in the proposal
    b. Cost-effectiveness calculation and Benefit/Cost Ratio (BCR) estimation using the provided spreadsheet
    c. All applicable manufacturers, cut sheets and specification documents.

All estimates of Energy Savings, Demand Reduction and other benefits must be made using accepted engineering methods and standards. Manual calculations, spreadsheets and computer

models may be used for any calculation. Any proprietary spreadsheets or computer models must be included in excel format. All baseline and operating assumptions must be clearly presented.

Any proposal that is not complete will be returned to the contact person at the Vendor for re-submittal.

The Vendor will be responsible for conducting a comprehensive energy analysis at the customer's facility including both electric, gas, and fossil fuel measures as pertinent to whole building energy savings. The analysis will be a total and complete inventory of all lighting, energy management controls, and mechanical systems at a customer's facility that are currently used in normal operation. The analysis will not include systems that are installed but not energized on a normal basis. Other newer systems may be excluded from the analysis at the discretion or the vendor or the Company.

In addition to performing the traditional lighting analysis, the Vendor will be responsible for identifying various "custom" lighting installations and non-lighting opportunities. The analysis will include collection of data and identification of efficiency opportunities for electrical and gas end-uses, including motors, variable speed drives, HVAC, lighting, energy management systems, refrigeration, compressed air, and any other electrical equipment and natural gas measures that the customer may use. The Vendor will document the existing equipment at each customer's facility, and make recommendations for energy efficiency improvements.

All energy conservation measures (ECM) will be screened by the Company using the Vendor provided implementation costs and savings. Vendor is required to submit to the Company, economic analyses to screen identified opportunities for cost-effectiveness, prior to implementation.

The Vendor shall produce a proposal for presentation to the customer with recommendations and associated customer economics (cost, utility co-pay, simple payback, etc.) only after the Company has approved said customer proposal, including, but not limited to, the EEMs, engineering analysis, customer incentive, and implementation costs. Costs used in the analysis must include all components, including labor, materials and any fees. For custom measures in areas outside of the Vendor's expertise, the Vendor will estimate preliminary costs and savings,

to be refined further by specialized contractors, if pursued by the Customer. 12 month prior customer usage data, both kWh and therms, will be required on all proposals.

For custom ECMs, the Company reserves the right to use the contractor's reasonable costs in order to determine the correct incentive amount. **(b)** The Company will recognize installation costs only to the extent that they are reasonable and actually incurred by the Customer. **(c)** If custom ECMs are being installed by a contractor under a "shared savings" contract, the Company reserves the right to determine the cost of purchasing and installing the ECMs based on the reasonable retail costs of purchasing the equipment and installing the ECMs.

7.0 MUNICIPAL PROJECT EVALUATION

Projects will be reviewed by NSTAR Engineers.

Each project will be evaluated based on the following criteria;

- ✓ Comprehensiveness has the municipal customer and NSTAR Vendor used a systems approach?
- ✓ Requested incentive, how will this project impact the NSTAR MP budget?
- ✓ Energy Demand (kW) Reduction, will this project help to reduce peak demand?
- ✓ Energy Use (KWH) Reduction, what is the energy impact of this project?
- ✓ Non-Electric benefits, what additional benefits does this project bring?
- ✓ Project Schedule, when can the project be completed?

8.0 IMPLEMENTATION

Implementation will include the design, installation, calibration and operation as described in the audit report. Implementation will begin with the approval of NSTAR. A pre-inspection, by NSTAR, verifying that the baseline is as listed in the study may, or may not be, completed prior to implementation. A pre-approval letter will be issued by the NSTAR Municipal Program

Manager. The project must be implemented as proposed. The NSTAR Municipal Program Manager will schedule regular meetings with the implementation team and schedule project inspections with the NSTAR Field Monitors to ensure that the project is on schedule and built as proposed.

In the event that a project is unable to begin at the proposed project start date NSTAR reserves the right to reallocate funds to another project.

In the event that a project fails to meet project milestones NSTAR reserves the right to substitute contractors.

9.0 PAYMENT

NSTAR will release the funds to the contractor(s) when the project is complete. A project will be complete when the municipal point of contact signs the MP Application form. Payments will not be made until specified conditions have been fulfilled to the satisfaction of NSTAR. These conditions will include the successful completion of the measures in accordance with the minimum requirements protocol.

At the time of the Company's verification of the Customer's installation or at any other time upon the Company's request, the Vendor shall give the Company copies of all itemized invoices (including all materials, labor, and equipment discounts) reflecting the actual cost of purchased materials and installing the ECMs. The itemized invoices shall include a breakdown of all ECMs purchased for installation under this Agreement. In addition, the Company may request any other reasonable documentation or verification of the cost to the Customer of purchasing and installing the ECM's. The Company reserves the right at any time to require invoices from the Vendor's subcontractor's to determine the price paid by the Vendor (including any discounts).

Payment will not be issued until these stipulations have been met.

10.0 TERMS AND CONDITIONS

1. **Customer Eligibility -** The Municipal Program is available to all municipal customers in the NSTAR territory that contribute to the energy conservation fund.
2. **Incentives -** Subject to these Terms and Conditions, NSTAR ("the Company") will pay for the installation of those electric conservation measures ("ECMs") approved by the Company
3. **Program Changes, Suspension & Cancellation (a)** The Municipal Program and these Terms and Conditions may be changed by the Company at any time without notice. Pre-approved applications, however, will be processed to completion under the Terms and Conditions in effect at the time of the pre-approval by the Company. **(b)** The Company reserves the right, for any reason, to stop pre-approving applications at any time without notice. In particular, the Company is not obligated to pre-approve any application for an incentive that may result in the Company exceeding its regulatory imposed budget for the program. **(c)** The program described in this application may be altered, suspended, or canceled by the Company at any time without prior notice. The Customer is not entitled to any program benefits or review of its application in such a circumstance. Submission of a completed proposal does not entitle the Customer to program participation.
4. **Customer Application and Analysis (a)** In addition to completing the worksheet, the Customer may be required by the Company to provide an analysis of the energy savings potential of the proposed ECMs. In some cases, the analysis must be prepared by a Professional Engineer licensed in the Commonwealth of Massachusetts. Nameplate data may be required for ECMs having incentives based on peak demand. **(b)** The Company will independently review the Customer's application and analysis to determine the energy savings and demand reduction potential. The Company reserves the right to reject or modify any calculations, based on the Company's own analysis.
5. **Pre-Approval and Pre-Installation Survey (a)** The Company is not bound to pay any Incentives unless the Company pre-approves the ECMs proposed by the Customer and completes a satisfactory pre-installation survey of the Customer's facilities. **(b)** The Company reserves complete discretion to approve or disapprove of any proposed ECMs.

6. **Pre-Approval Letter** After an application is approved by the Company, the Customer will receive written notification of the pre-approved incentive amount and the date that the ECMs must be fully installed to qualify for incentive payments. Any ECMs installed prior to the issuance of the Company's written authorization will be deemed an unauthorized installation and the Company will have no obligation to pay incentives for those ECMs.

7. **Monitoring** The Company reserves the right to perform pre- and post-installation monitoring of the installed ECMs in order to determine the actual kW reduction and energy savings.

8. **Site-Specific Custom Measures** The Company will only approve of those site-specific custom ECMs that the Company believes have cost-effective energy and demand reduction potential. In any case, the Company reserves sole discretion to approve or disapprove of any such ECMs proposed.

9. **Limited Scope of Review** The scope of review by the Company of the design and installation of the ECMs is limited solely to determining whether program conditions have been met. It does not include any kind of safety review. Inspections by the Company shall not constitute a representation or warranty by the Company as to the proper implementation or effectiveness of the ECMs and shall not constitute an assumption by the Company of any liability with respect to the ECMs.

10. **Incentive Amounts (a)** before pre-approving any incentive amount requested by the Customer, the Company reserves the right to adjust and/or negotiate the incentive amount. **(b)** Once a incentive amount is pre-approved, the Company will pay no more than the cost to the Customer of purchasing and installing the ECM, or the pre-approved incentive amount, whichever is less. **(c)** The Company reserves the right to lower the incentive amount if the quantity and/or cost of ECMs actually installed by the Customer differ from the pre-approved amounts. Not withstanding any other provision of these Terms and Conditions, the Company reserves the right to seek a refund for incentives paid if, at any time, it learns that the agreed to ECMs were not actually and properly installed or have subsequently been disconnected.

11. **Installation Schedule Requirements (a)** Unless the Customer has submitted (prior to pre-approval of the application) a specific installation schedule which is accepted by the Company, the ECMs must be installed within 180 days of the date of pre-approval. **(b)** Every

Customer unable to complete the installation of the ECMs within the applicable "sunset period" must submit an installation schedule prior to pre-approval and provide reasons why the installation cannot be completed with in the "sunset period". If the Customer provides a reasonable basis for not being able to install the measures within the applicable sunset period, the Company, in its reasonable judgment, will accept the schedule. If the Company is not reasonably satisfied with the reasons given, however, the Company reserves the right to reject the application or require installation at an earlier date. **(c)** If the Customer is unable to begin or complete an installation on schedule (or within the applicable "sunset period"), the Customer must notify the Company immediately upon learning that the installation will be delayed and provide the reasons why. The Company reserves the right to cancel the application, if, in the Company's judgment, the Customer has not or is not proceeding diligently to complete the installation as soon as possible or, in the Company's judgment, the measures are not likely to be installed within one year of the pre-approval date. **(d)** Notwithstanding provisions in (a) through (c) above, if the Customer has not completed installation within 180 days from the pre-approval date, the Company reserves the right, at its complete discretion, to cancel the application.

12. **Vendor Selection** The Company acknowledges that the Customer may elect any vendor or contractor to perform the work contemplated by this Application, even after the Application is submitted for pre-approval by the Company. Not withstanding the foregoing, the Customer acknowledges that the Company has the right not to allow a vendor or contractor to participate in this program.

13. **Post-Installation Verification** The Company is not bound to pay any incentives until it has performed a satisfactory post-installation verification of the installation. If the Company determines that the ECMs were not installed in a manner that is consistent with the purpose of achieving energy savings or if the installation was not consistent with generally accepted good engineering practices, the Company may require changes before making any payments. The Company will not pay incentives until it has been verified that the Customer has received, as appropriate, final drawings, operation and maintenance manuals, and operator training.

14. **Installation Cost** At the time of the Company's verification of the Customer's installation or

at any other time upon the Company's request, the Vendor shall give the Company copies of all itemized invoices (including all materials, labor, and equipment discounts) reflecting the costs of purchasing and installing the ECMs. The itemized invoices shall include a breakdown of all ECMs purchased for installation under this Agreement. In addition, the Company may request any other reasonable documentation or verification of the cost to the Customer of purchasing and installing the ECM's. The Company reserves the right at any time to require invoices from the Vendor's subcontractor's to determine the price paid by the Vendor (including any discounts).**Payment will not be issued until these stipulations have been met**.

15. **Removal of Equipment** The Customer agrees, as a condition of participation in the program, to remove and dispose of the equipment being replaced by the ECMs in accordance with all laws, rules, and regulations. The Customer agrees not to install any of this equipment in the service territory of the Company or its affiliates.

    General Waste Disposal The Vendor shall be responsible for the proper disposal of all waste materials resulting from the implementation of the project, including, but not limited to fixtures, with the exception of those materials, including lamps and ballasts, secured by the Company's Recycling Vendor. The Vendor shall be responsible for ensuring that the worksite is left in a neat and orderly manner with no negative impact to the customer or their business operations

    Hazardous Waste Disposal The company will maintain responsibility for providing the Vendor access to services that provide proper disposal of all ballasts and fluorescent lamps, as well as hazardous material associated with the project implementation, removed from Customers' facilities. The Vendor will track all equipment removed from each facility, and will either set them aside at the Customer's facility or transport and store them at a central facility for pick up by the Company' service provider. The Vendor shall be responsible for maintaining a record of the waste generated at the customer's facility and will coordinate and verify that said waste has been collected by the Company's service provider in a timely manner.

16. **Review of Specifications, Submittals and Drawings** The Customer will provide the

Company with a copy of the specifications for the construction of the Facility that will be provided to its construction contractors. Such specifications must include the ECMs. The Company may refuse to pay incentives if the specifications do not adequately provide for installation of the ECMs consistent with good engineering and energy-efficient design practices. Customer will, upon request by the Company, provide a copy of the as-built drawings and/or equipment submittals for the Facility. The Company may refuse to pay incentives if the final submittals and drawings do not adequately reflect the installation of the ECMs consistent with the original design intent as identified on the Customer application and worksheets.

17. **Date of Incentive Payments** The Company expects to pay the incentive within thirty (30) business days after satisfactory post installation verification and verification of installation costs, all in accordance with the program specifications.

18. **Payments Assignable to Contractors** The Customer may direct that incentives be paid directly to the Customer's contractor.

19. **Customer Must Pay All Taxes** The benefits conferred upon the Customer through participation in this program may be taxable by the federal, state, and local government. The Customer is responsible for declaring and paying all such taxes. The Company and the Company's contractor are NOT responsible for the payment of any such taxes.

20. **Follow-up Visits (a)** The Company reserves the right to make a reasonable number of follow-up visits to Customer's Facility during the 36 months following the Actual Completion Date. Such visit(s) will be at a time convenient to the Customer, made with at least one week advance notice given to the Customer by the Company. **(b)** The purpose of the follow-up visit(s) is to provide the Company with an opportunity to review the operation of the ECMs for program evaluation purposes. **(c)** During the follow-up visit(s), the Company or its Affiliates may make suggestions to the Customer regarding operation of the ECMs, but the Customer is under no obligation to follow any such suggestions. If the Customer does follow any suggestions, however, the Company will not be liable to the Customer in tort (including negligence) for the Customer's reliance on the suggestions. **(d)** The Company is under no obligation to (i) make follow-up visits, (ii) review the operation of

the ECMs, or (iii) make any suggestions of any kind to the Customer.

21. **Publicity of Customer Participation** Unless the Customer objects in writing at the time of submitting an application, the Company may publicize the fact of the Customer's participation in the program, the results, the amount of incentives paid to the Customer, and any other information which reasonably relates to the Customer's participation.

22. **Limitation of Liability** The Company's liability under this agreement will be limited to paying the incentives specified in this agreement. Neither the Company nor any of its affiliates shall be liable to the Customer for any consequential or incidental damages or for any damages in tort (including negligence) caused by any activities associated with this Municipal Program.

23. **Standards/Warranties.** The Vendor shall warrant all work to be performed in a neat and workman like manner taking all reasonable necessary precautions to ensure a minimal impact to the customer's facility and operations. The Vendor and all subcontractors shall be professional and courteous in nature and shall execute the work in accordance with standard trade practices. The Vendor may subcontract the work performed; however, the Vendor shall be responsible for the acts and omissions of the subcontractor, as well as for the acts and omissions of any and all persons employed by the Vendor and its subcontractors. If the Company determines the Vendor or any subcontractor is incompetent or has acted in an inappropriate or undesirable manner, the Company shall notify the Vendor. The Vendor shall immediately take the necessary steps to remedy the problem, including the cancellation of any subcontractor agreements or the removal of any persons performing the substandard work.

    The Vendor shall offer a minimum two-year warranty, including labor, from the date of original installation for the installation of each product, except lamps, found to be defective. Lamps will have a one-year unconditional warranty. The Vendor will also notify the Company of all unusual and/or recurring customer equipment performance problems, and shall describe the resolution of all warranty work related to such problems.

    The Proposal shall indicate any other warranty services you can offer. Vendors should fully

describe their proposed customer complaint resolution approach, and describe their quality control procedures

24. **No Warranties (a)** The Company does not endorse, guarantee, or warrant any particular manufacturer or product, and the Company provides no warranties, expressed or implied, for any product or services. The Customer's reliance on warranties is limited to any warranties that may arise from, or be provided by contractors, vendors, etc. **(b)** The Customer acknowledges that neither the Company nor any of its consultants are responsible for assuring that the design, engineering and construction of the Facility or installation of the ECMs is proper or complies with any particular laws (including patent laws), codes, or industry standards. The Company does not make any representations of any kind regarding the results to be achieved by the ECMs or the adequacy or safety of such measures.

25. **Replacement of Burn-Outs** Customers who install energy-efficient lighting ECMs are expected to replace any of the energy-efficient lights that burn out with lights of similar or superior energy savings efficiency at the Customer's expense.

25. **Obligations Between the Parties** Customer understands and acknowledges that Vendor is not an agent, contractor or subcontractor of the Company with respect to the installation of any ECM. In the event of the failure of any ECM to perform as expected, Customer agrees that Customer's sole recourse is to Vendor and not the Company. The Company shall not maintain, remove or perform any work whatsoever on the ECMs installed. Customer understands and acknowledges that its participation in the Municipal Program is voluntary and that it has approved Vendor to install the ECMs proposed by Vendor. Customer agrees that is shall not hold the Company liable for Vendors failure to perform its obligations under this agreement, for failure of the ECMs to function, for any damage to Customer's premises caused by Vendor or for any and all damages to property or injury to persons caused by the ECMs.

26. **Compliance with Laws** The Customer is responsible for obtaining any and all necessary licenses and permits related to the installation of ECMs and agrees to comply with all federal, state and local laws and regulations with regard to installation of ECMs, including, but not limited to, M.G.L.c. 143, § 3L.

27. Miscellaneous (a) These Terms and Conditions and this program application constitute the entire agreement between the parties and supersede all other communications and representations. **(b)** Paragraph headings are for the convenience of the par-ties only and are not to be construed as part of these Terms and Conditions. **(c)** If any provision of the Terms and Conditions is deemed invalid by any court or administrative body having jurisdiction, such ruling shall not invalidate any other provision, and the remaining Terms and Conditions shall remain in full force and effect in accordance with their terms.

28. Recapture of Payments If the Customer either: **(1)** substantially reduces the percentage of its energy needs which it is purchasing from the Company because it has switched to other non-electrical energy supplies, **(2)** begins to generate some or all of its own electricity requirements, **(3)** increases the amount of its pre-existing self-generation or cogeneration, the Company may require the Customer to reimburse the Company for all or a portion of the incentive. The Customer shall notify the Company prior to initiating any of the events specified in (1), (2), and (3) above.

29. Confidentiality

The Company agrees that it will treat the information it receives from respondents and any guarantors in a confidential manner and will not, except as required by law or regulatory authority, disclose such information to any third party or use such information for any purpose other than in connection with its evaluation of respondents' qualification to bid in the auction process described herein.

The Company may supply the Vendor with confidential customer information. All such information is the exclusive property of the Company. The Vendor shall not sell, barter or exchange any information provided for this Program, including but not limited to the customer information. The Vendor shall not copy customer information without prior written consent provided by the Company.

The Vendor and its employees, subcontractors and agents shall not use the customer information or the delivery of the Program for the generation of leads for sales of non-energy-efficiency services or products the Vendors may offer. The Vendor shall have each employee, subcontractor and agent with access to any information provided by the Company for this Program to sign a statement expressing this confidentiality agreement.

11.0 DEFINITIONS

Annualized Energy Savings: This is the same as Energy Savings as defined below.

Baseline: Actions that a Customer would be inclined or required to take without utility intervention in the project.

Retrofit Measures: the Baseline will be the existing condition.

Billing Demand: The highest billed electric demand (kW) during the 12 billing periods prior to date that the MRP was issued.

Calendar Year: The twelve-month period beginning January 1 and ending December 31.

Comprehensive: A design approach for analyses of a project that has as its central tenet that the building is an integrated system. Any energy efficiency inquiry represents an opportunity to examine other existing mechanical and electrical systems within the building to improve the efficiency of these systems.

NSTAR has as its goal that all cost effective energy conservation measures will be implemented.

Customer: A company or individual who purchases electric distribution services from NSTAR under one or more non-residential rate tariffs.

EESP: Energy efficiency services provider

Energy Savings: The difference in estimated electrical consumption for typical Calendar Year between Baseline operating conditions and operation after energy efficiency measure implementation.

Facility: A commercial sector building or equipment located in the NSTAR service territory currently using electrical distribution services from NSTAR

Incremental Cost: The difference between the Installed Costs of the Baseline and high efficiency conditions for any measure.

Total Incremental Cost: The sum of the Incremental Cost for all measures in the proposal.

Installed Cost: The cost of bringing a measure to a complete and operating condition. It includes the cost of design, engineering, supervision, commissioning, materials, labor and all other necessary costs.

Total Installed Cost: the sum of the Installed Costs for all Measures in the proposal.

Measure: Any device or system designed, specified or installed through the NSTAR offerings that increases the end use efficiency of electric consumption and provides Peak Demand Reduction, relative to a defined Baseline standard of efficiency or demand.

Early Replacement Measure: A Measure where a piece of equipment is being considered for replacement prior to the end of its expected life due primarily to energy efficiency considerations. For example, the replacement of an inefficient, operating, 10-year old air compressor that has an expected life of 20 years.

Retrofit Measure: A Measure that is being considered where Energy Savings is the primary emphasis. The existing situation must be operating correctly and expected to be able to continue for an indefinite period. For example, efficiency improvements which are achieved by converting a chilled water pumping system from primary pumping to variable volume primary/secondary pumping.

Measurement and Verification (M&V) Protocol: Standards for inspection procedures, and the Measurement and Verification of Energy Savings.

Requested Utility Incentive: A payment requested from the Utilities to help the Municipal Customer to complete the implementation of the Study or Measures specified in the proposal.

Peak Demand: For the purposes of the MP program, Peak Demand is defined as the electric demand of a facility, which is coincident with the peak load of the electric system.

Peak Demand Impact: For the purposes of the MP program, the following will apply:

- Summer: Summer Peak Demand Impact is defined as a reduction or increase in facility Peak Demand, which is expected to occur between X PM and X PM, weekdays from X 1 through Y 30.
- Winter: Winter Peak Demand Impact is defined as a reduction or increase in facility Peak Demand that is expected to occur between X AM and X PM, weekdays from X 1 through y 31.

Renewable: Commercially available renewable energy technology, located on the customer's side of the meter.

Site: A distinct Facility or geographic location with an associated electric account with NSTAR. A single Facility with more than one associated account with NSTAR will be considered a single site. Multiple buildings, such as a campus, with one associated account with NSTAR will be considered a single site.

Study: A detailed energy, engineering and economic evaluation of the proposed measures.

Study Cost: The cost to conduct the Study in order to fully document the project scope including all Energy Savings calculations and associated costs.

The Vendor and its staff responsible for implementing the NSTAR Municipal Program must follow the procedures and processes to obtain the "NSTAR Contractor" badge from The Company. A completed background check including, but not limited to: criminal check, social security verification and a drivers license check.

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SCOPE OF WORK

NSTAR Gas Savings Fall 2012 Campaign

Preferred Distributor

This attachment provides the scope of work to be provided by the Preferred Distributor for the proposed NSTAR Gas Savings Initiative.

1. Campaign Description

The goal of this initiative is to promote energy efficiency and reduce the demand for natural gas by utilization of water conservation measures such as energy efficient pre-rinse spray valve, showerhead, and faucet aerator equipment. The eligible measures offer significant energy savings at modest incremental costs vis-à-vis conventional technologies. Hospitality and higher education market segments have been identified as initial targets for this initiative. Other segments may be added to the initiative in future.

NSTAR will partner with select distributor(s) to offer incentives to buy down the cost of higher efficiency equipment at the wholesale level as shown in Figure 1. Customers will order from the Preferred Distributor(s) and will self-install the equipment. Customers will then ship the replaced (existing) equipment to the distributors. The Preferred Distributor(s) will be responsible for collecting sales data, completing a custom application for each customer, tracking and reporting shipped and returned material.

NSTAR will launch this campaign in early October 2012.

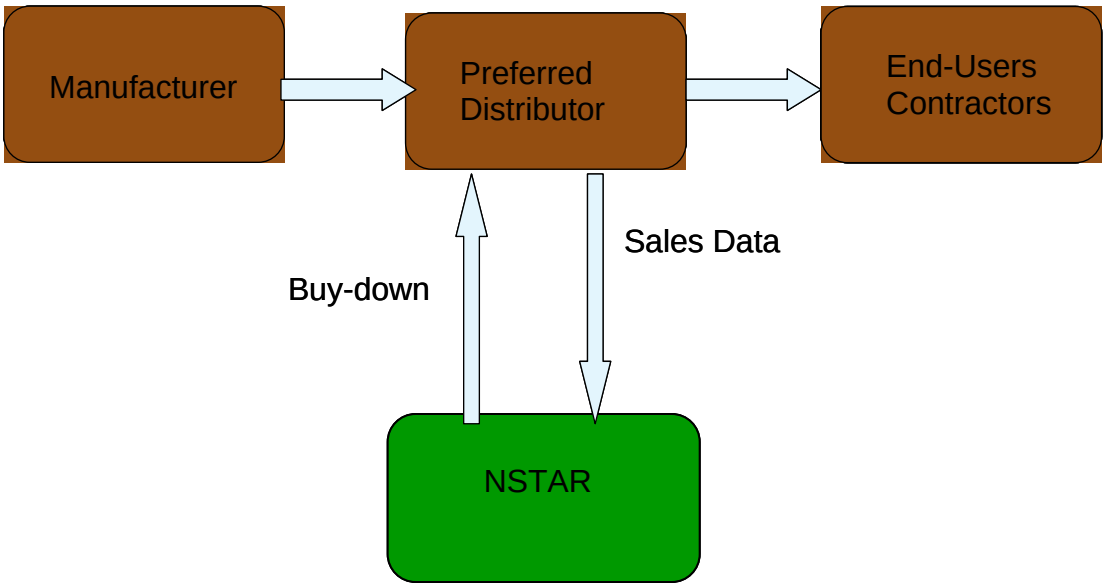


Figure 1: Proposed Program Model

2. Program Scope

Territories: NSTAR Gas Service Territory (see Appendix 1 for further definition)

Program Administrators: NSTAR

3. Preferred Distributor Responsibilities

Implementation of the program including:

- Tracking and report orders by customer
- Extending incentives to participating customers at the time of sale
- Completing NSTAR custom application form with relevant project data
- Collection and verification of old equipment from customers
- Attend weekly sales call (in person or over phone)
- Targeting eligible customers to increase sales

4. Eligible Equipment

Incentives to NSTAR customers will be offered for the following equipment. Distributors should provide a preferred price for NSTAR. Tiered level pricing, based on volume discounts, should be provided in the quote.

Pre-Rinse Spray Valves

Manufacturer	Model	Rated Spec (GPM)
Fisher Manufacturing Company	Ultra-Spray 2949	1.15
Niagara Conservation	N2180	1.28

Faucet Aerator

Manufacturer	Model	Rated spec (GPM)
Niagara Conservation	N3205N	0.50

Showerheads

Manufacturer	Model	Rated spec (GPM)
Niagara Conservation	N2150-CH	1.50
Niagara Conservation	N2150-CH-TP	1.50
Niagara Conservation	N2515-CH	1.50
Niagara Conservation	N2517-CH	1.75
Niagara Conservation	N2915-CH	1.50
Niagara Conservation	N2917-CH	1.75

Distributors are requested to provide pricing for comparable products that will provide cost savings and/or increased reliability. The reason for proposing the alternative or additional products must be clearly stated in the RFQ response.

Note: At NSTAR's discretion, once the program is launched, NSTAR may request that additional equipment be added to the program.

5. Desired Qualifications

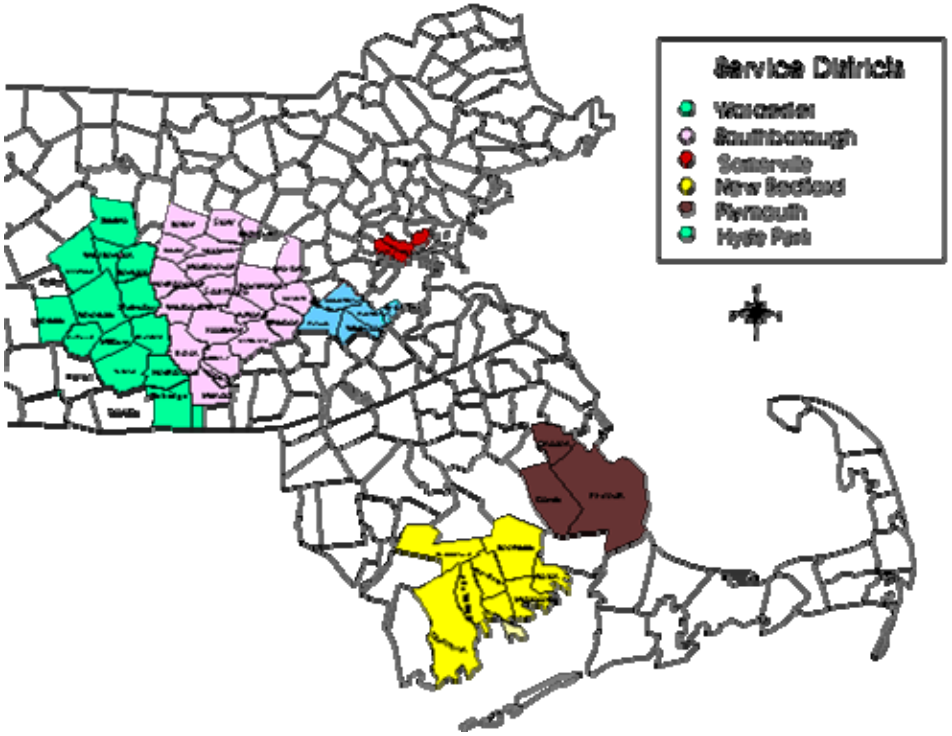
Ideal Preferred Distributor candidates will have:

- Proven expertise in managing similar Energy Efficiency incentive initiatives
- Electronic database/system to track and report order data (quantities, types, model number, installation site data, etc.) by customer
- Capability to complete NSTAR application in a timely manner
- Stock availability of eligible products.
- Dedicated resources to market the program to eligible customers

Appendix 1: NSTAR Gas Service Territory

NSTAR Gas Service Territory

Town	Region	Town	Region
Auburn	Worcester	Shrewsbury	Southborough
Holden	Worcester	Southborough	Southborough
Leicester	Worcester	Stow	Southborough
Millbury	Worcester	Upton	Southborough
Sterling	Worcester	Uxbridge	Southborough
Sutton	Worcester	Westborough	Southborough
West Boylston	Worcester	Wayland	Southborough
Worcester	Worcester	Cambridge	Somerville
Ashland	Southborough	Medford	Somerville
Berlin	Southborough	Somerville	Somerville
Bolton	Southborough	Acushnet	New Bedford
Boylston	Southborough	Dartmouth	New Bedford
Framingham	Southborough	Fairhaven	New Bedford
Grafton	Southborough	Freetown	New Bedford
Holliston	Southborough	Marion	New Bedford
Hopedale	Southborough	Mattapoisett	New Bedford
Hopkinton	Southborough	New Bedford	New Bedford
Hudson	Southborough	Rochester	New Bedford
Marlborough	Southborough	Carver	Plymouth
Maynard	Southborough	Duxbury	Plymouth
Mendon	Southborough	Kingston	Plymouth
Milford	Southborough	Plymouth	Plymouth
Millville	Southborough	Dedham	Hyde Park
Natick	Southborough	Dover	Hyde Park
Northborough	Southborough	Hyde Park	Hyde Park
Northbridge	Southborough	Needham	Hyde Park
Sherborn	Southborough	Westwood	Hyde Park



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APPENDIX E

OTHER SUPPORTING DOCUMENTATION

SECTION 2

COMPETITIVE PROCUREMENT DOCUMENTATION

SAMPLE TERMS & CONDITIONS

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ONE NSTAR WAY, SE 250
WESTWOOD, MA 02090

CONSULTING SERVICES AGREEMENT

by and between

NSTAR ELECTRIC & GAS CORPORATION
(COMPANY)

and

_____
(SUPPLIER)

IN WITNESS WHEREOF, the Parties hereby agree the terms and conditions described in the attached Consulting Services Agreement are executed on the day and year last written below.

The Parties agree that the counterpart, facsimile or electronically reproduced signatures of the Parties are intended to authenticate this writing, and to have the same force and effect as manual signatures.

_____	NSTAR ELECTRIC & GAS CORPORATION
(SUPPLIER)	(COMPANY)
NAME _____	NAME _____
PRINTED NAME_____	PRINTED NAME _____
TITLE _____	TITLE_____
DATE _____	DATE _____

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PREFACE

The CONSULTING SERVICES AGREEMENT, hereafter referred to as the Agreement, is the standard Terms and Conditions under which NSTAR Electric & Gas Corporation (Company) will contract for engineering, consulting or other technical or administrative services. It does not preclude a service provider (Supplier) from submitting more favorable or competitive terms in the future, which may be accepted by the Company.

1.0 SCOPE OF SERVICES

Supplier agrees to perform for the Company and those entities that directly or indirectly control or are controlled by, or are under common control or ownership with, the Company on or after the effective date of this Agreement ("Affiliates"), from time to time services as specified in a Contract or Contract Release (Contract) issued by the Company (referred to as the "Services" herein). "Contract" means the document issued by the Company awarding the work to the Contractor, describing generally the work to be performed by the Contractor, the time for commencement and completion of the work, and the amounts and manner of payment to the Contractor for the work. "Contract Release" means the document issued by the Company implementing a scope of work made under a blanket master Contract. Such Contract shall specifically refer to this Agreement and shall also indicate whether reimbursement is to be made on a Fixed Price (Section 2.1) or Recoverable Cost (Section 2.2) basis. Supplier shall indicate its acceptance by having each Contract signed by an authorized representative of the Supplier and returning it to the Company. No work is to be performed without a fully-executed Agreement and applicable Contract.

This Agreement is not exclusive, and nothing herein shall be deemed to prevent the Company from engaging other parties to perform such Services, or from performing such Services using its own employees.

2.0 COMPENSATION AND PAYMENT

The Contract shall specify whether Services are to be provided on a Fixed Price or Recoverable Cost basis.

2.1 Contracts on Fixed Price Basis

2.1.1 For performance of the Services described in each Contract, Company shall pay Supplier the Fixed Price set forth in such Contract in accordance with the payment schedule set forth in the Contract.

2.1.2 At any time, in accordance with procedure agreed upon by the parties, Company may request changes in writing, for additions or deletions to the Services in each Contract. In the event of any such change, Supplier shall promptly prepare and submit to Company a statement of the increase or decrease in cost, if any, to the Services and shall also inform Company as to whether such change may result in an alteration of the schedule to complete the Services. An amendment to such Contract describing the change, the effect, if any, on the schedule and cost of the Services shall be promptly agreed to and signed by Company and Supplier, and no change shall be binding in the absence of a fully-executed amendment.

2.2 Contracts on a Recoverable Cost Basis

Each Contract shall include an estimate of the charges to be paid to Supplier on a Recoverable Cost basis, and Supplier shall not incur costs exceeding such estimate without an executed amendment to the applicable Contract

2.2.1 Recoverable Costs

The Company shall reimburse Supplier for costs and expenses incurred by Supplier in the performance of the Services in accordance with rates established by Supplier and provided in Appendix A (attached) and the expense guidelines set forth herein. Recoverable costs and expenses include the following:

2.2.1.1 Payroll and Related Personnel Costs

The hourly rates in Appendix A shall be fully loaded rates, including, but not limited to salaries (including vacation and holiday allowances), social and retirement benefits, all payroll taxes and all premiums for liability and property damage insurance, Workers' Compensation and Employer's Insurance and all insurance premiums measured by payroll costs, other benefits and contributions or taxes imposed by any applicable law or regulations, all overhead costs.

2.2.1.2 Other Costs and Rates

All expenses must be reasonable and directly associated with the delivery of the services. The supplier shall provide with each proposal an estimate of the expenses anticipated to be necessary to accomplish the scope of work authorized by the Company. In no circumstance shall such expenses exceed 15% of the costs incurred pursuant to 2.2.1.1 above. Additionally, Supplier must comply with the recoverable expense guidelines attached as Appendix B.

NOTE: For local personnel, travel costs shall be limited to the difference in mileage from the Company required work location and the normal work location with no other allowances made.

2.2.1.2.1 The cost of all materials and supplies other than engineering supplies used or consumed in the performance of the Services. Engineering supplies used or consumed in the performance of the Services shall be included in Section 2.2.1.1.

2.2.1.2.2 All costs associated with models (including the cost of floor space occupied by models), reproduction of plans, specifications, reports and other data, at rates listed in Appendix A.

2.2.1.2.3 Use of Data Processing computers, including related operator time, and use of standard programs at rates listed in Appendix A.

2.2.2 Rate Stability

Rates are to be fixed for a period of one year or for the duration of the Contract or Contract Release, whichever is longer.

2.3 Invoicing

On or before the tenth (10^{th}) day of each month, the Supplier shall submit an invoice for the Services performed or payment milestones achieved during the preceding calendar month, supported by copies of payroll abstracts, vouchers and other supporting documentation required by the Company. For reimbursable expenses, copies of all invoices, receipts, etc. for amounts greater than $25 should be included, in accordance with Internal Revenue Service Guidelines. Final invoicing shall be rendered within 30 days of submitting the notice of completion, referred to in Section 10.0. The Company shall pay all undisputed invoices within thirty (30) days of receipt of such invoice, provided any applicable payment milestone has been achieved. All claims for monies due or to become due from the Company shall be subject to the right of the Company to deduct and set off any amounts due from Supplier, or on account of claims against the Supplier. A sample invoice is included as Appendix C showing minimum data required to process an invoice.

The Company may withhold payment of all or any portion of amounts due to the extent necessary to protect the Company from loss, including, without limitation, loss from any of the following circumstances: (a) defective Work not remedied; (b) claims filed against the Company or the Contractor, or reasonable evidence indicating probable filing of such claims, by any subcontractor or supplier of Contractor, or any third party, associated with the Work; (c) other failure of Contractor to make proper and timely payments to subcontractors or suppliers; or (d) damage to another contractor or third party caused by Contractor, its subcontractors or suppliers.

2.4 Examination of Accounts

The Supplier shall maintain, during the course of Services, and retain, for not less than six (6) years after completion thereof, complete and accurate records of all of the Supplier's costs which are chargeable to the Company. The Company shall have the right at its expense, and upon notice to Supplier, at any time during ordinary business hours, to inspect and audit such records. The records to be maintained and retained by the Supplier shall include (without limitation): (a) payroll records accounting for the total-time distribution of the Supplier's employees working full or part time on the Services (to permit tracing to payrolls and related tax returns) as well as canceled payroll checks or signed receipts for payroll payments in cash; (b) invoices and receipts for purchases, receiving and issuing documents, and all the other unit-inventory records for the Supplier's stores stock or capital items; and (c) paid invoices and canceled checks for materials purchased and for the subcontractors' and any other third parties' charges; (d) other documents and information relating to the achievement of performance or payment milestones, or deliverables.

The Supplier shall comply with any other audit and record-keeping requirements specified in the Contract.

3.0 CALCULATIONS, DRAWINGS, PLANS AND SPECIFICATIONS

All calculations, drawings, plans, specifications, reports and other deliverables shall be delivered to Company in accordance with the schedule in the applicable attachments hereto and the Contract. Further, all specifications, plans, drawings and data supplied by the Company shall remain the property of the Company, shall be treated as confidential and proprietary material and shall be

returned to the Company upon request. All specifications, plans, drawings and data supplied by the Supplier under this Contract shall become the property of the Company, free from any restriction or limitation on modification, reproduction, distribution and use, including, without limitation, use in subsequent solicitations of proposals from bidders. The Company shall also have access to drawings and other work in process.

4.0 PROFESSIONAL RESPONSIBILITIES

4.1 General Responsibility and Warranty

Supplier assumes professional and technical responsibility for the performance of its services in connection with work assignments under this Agreement in accordance with the terms of this Agreement and the best professional standards and practices, and any additional guarantee or warranty specified in the applicable Contract. If, during the performance of Services or within three (3) years following completion thereof, such Services fail to meet the aforesaid standards, the Supplier shall promptly furnish all remedial services and products necessary to correct such deficiencies at the Supplier's cost and expense, and Supplier shall further be responsible for reimbursement of the Company's costs or losses related to such deficiencies during the referenced three year period.

4.2 Independent Contractor

It is the intent of this Agreement that the relationship of the Company and the Supplier be that of 'contracting party for services and independent contractor,' respectively.

4.3 OSHA Hazard Communication Standard

Supplier, prior to bringing hazardous chemicals or substances onto a Company facility and/or arranging for transportation of such chemicals or substances to a Company facility, shall notify Company management and provide the required MSDS for those items. Supplier is hereby notified that the Company has in place a Hazardous Communication Program in accordance with 29 CFR 1910.1200. This document is available for review and inspection by the Supplier or its representative.

4.4 Protection of Company Property

Supplier shall protect all Company property in its possession or utilized in the performance of the Services from any damage or loss. Company property destroyed, damaged, lost or stolen, except by act or omission of the Company, shall be replaced or repaired to the Company's satisfaction at Supplier's expense. Supplier shall also protect Company customer information from disclosure or loss pursuant to Section 24.0 hereof.

4.5 Compliance with Laws and Company Corporate Policies

Supplier will comply with all applicable laws, ordinances, rules, regulations, codes, and orders of any public body having jurisdiction, and shall perform the Services using licensed (as applicable) and properly qualified personnel. In addition, Supplier shall comply with all applicable Company policies to the extent the Supplier is performing Services at the Company's premises or the premises of the Company's customers, or is otherwise representing the Company in interactions with any

third parties. Refer to Appendix D for a list of applicable Company Corporate Policies and as such may be revised by the Company from time to time.

4.6 Removal of Supplier's Employees

The Supplier agrees to use only experienced, responsible, and qualified personnel to perform the Services and further agrees to follow Company policies and procedures during the course of the same. The Company may require that the Supplier remove from the project persons who do not satisfy the aforementioned requirements or endanger persons or property, or whose continued work is inconsistent with the successful completion of the Services.

4.7 Periodic Reporting

Upon the request of the Company the Supplier shall promptly submit a report detailing the status of the Services including the progress toward achieving completion of any deliverables or performance milestones.

4.8 Schedule Commitment

The Supplier agrees to perform the Services in accordance with the schedule approved by the Company. The parties agree that time is of the essence hereof.

5.0 INDEMNIFICATION

5.1 Supplier shall indemnify, defend (with counsel acceptable to the Company) and save harmless the Company, its officers, employees and Affiliates from and against all actions, claims, costs, damages, expenses and liability whatsoever for injury (including death) to persons (including employees, agents or subcontractors of Supplier) or damage or loss to property, whether in contract or in tort, or based on strict liability, which relate to or arise from: the Services; the failure by Supplier to satisfy any term, condition or obligation under this Agreement, the Supplier's failure to pay any and all federal or state payroll taxes or contributions for unemployment insurance, health insurance, workmen's compensation, pensions and retirement benefits; the negligence, or willful or reckless misconduct of persons performing the Services; or, the misuse or prohibited disclosure of Confidential information or NPI (as referenced in section 24 hereof), including the economic loss suffered by the Company or the owner of the NPI as a result of the prohibited disclosure or use.

5.2 The Supplier shall be responsible for the proper execution and completion of the Services and shall take all necessary precautions for prevention of injury to persons or damage or loss to property in connection with the Services.

5.3 Supplier shall also indemnify, defend (with counsel acceptable to Company) and save harmless the Company, its officers, employees and Affiliates from all actions, claims, costs, damages, expenses and liability whatsoever arising or resulting from allegations that the Services or any products or deliverables provided by Supplier infringe on or violate any patent, trademark, copyright, trade secret or any other proprietary interest. If the Company is enjoined from the use of services on the basis of infringement, the Supplier shall, at its expense, and at the option of the Company, either (a) procure for the Company the right of continued use, (b) replace or modify the same to make them non-infringing, or (c) remove the same at no cost to the Company, and refund the purchase price and all associated costs.

6.0 INSURANCE

Without limiting any of the other obligations or liabilities of the Supplier, the Supplier shall provide and maintain at its own expense (including deductibles) the following minimum insurance coverages:

6.1 Worker's Compensation and Employer's Liability Insurance in statutory amounts, with a minimum coverage amount of $500,000, to provide for payment to Supplier's employees employed on or in connection with the Services covered by this Agreement and/or their dependents, of Workers' Compensation benefits including, when required, Occupational Disease benefits in accordance with applicable law (including, without limitations, the U. S. Longshoremen's and Harbor Workers' Compensation Act and the Jones Act).

6.2 Commercial General Liability Insurance including Premises-Operations, Owners' and Contractors' Protective Liability and Completed Operations Insurance with combined single limit of $1,000,000 each occurrence for bodily and/or personal injury, including death and property damage. This policy is to also include Broad Form Property Damage, Blanket Contractual Liability (including obligations assumed under the indemnity provisions of this contract) and XCU hazards. Underwriters shall waive all rights of recovery against the Company.

6.3 Primary Comprehensive Automobile Public Liability (including owned, nonowned and hired automotive equipment), used in connection with the Supplier's Services; with a combined single limit for bodily injury or death and property damage of $1,000,000 per accident. This policy will also provide coverage for Automobile Comprehensive Fire and Theft, and Collision insurance. Underwriters shall waive all rights of recovery against the Company.

6.4 Professional Liability (Errors and Omissions) Insurance with limits of not less than $2,000,000 unless otherwise specified by the Company, and Electronic Data Processors Errors and Omissions insurance with limits of not less than $5,000,000.

6.5 Except as to Item 6.1, the Company and its Affiliates shall be included as an additional insured on all policies specified herein. The naming of the Company as an additional insured shall not obligate the Company to pay any premium on the policies. Such insurance shall be primary insurance and shall contain a Severability of Interest clause with respect to each insured. The "Other Insurance" clause of such policies shall be modified, if necessary, to specify that any separate insurance maintained in force by the Company shall be considered excess insurance and shall not contribute with insurance extended by Supplier's and/or subcontractor's insurer(s) under this requirement.

6.6 Supplier shall, ten (l0) days before commencing Services under this Agreement and prior to expiration of any policy of insurance, deliver to NSTAR Electric & Gas Corporation, One NSTAR Way, Westwood, MA 02090 Attention: Procurement Director, three (3) copies of the Certificate(s) of Insurance completed by his insurance carrier or agent certifying that minimum insurance coverages as required above are in effect and will not be canceled or changed until thirty (30) days after written notice is given to the Company. The Supplier further agrees to deliver within ten (l0) days of requests two copies of each of the above policies to the NSTAR Electric & Gas Corporation, One NSTAR Way, Westwood, MA 02090 Attention: Procurement Director, if so requested by the Company.

7.0 ASSIGNMENT

The Supplier shall not assign this Agreement, the services, or any monies due or to become due hereunder without the advance written consent of the Company, which may be withheld at the Company's discretion.

8.0 SUBCONTRACTORS

Unless otherwise provided, Contractor may engage subcontractors for portions of the Work, provided, however that the Company shall have the right to review the list of proposed subcontractors and to object to any particular subcontractor, in which event Contractor shall provide a substitute subcontractor. The Company shall not enter into any agreements with subcontractors, nor shall the Company be liable to any subcontractor by reason of this Contract. The Contractor shall bind every subcontractor to the terms of this Contract, as far as applicable to the subcontracted Work. The delegation of any portion of the Work to a subcontractor shall not operate to relieve the Contractor of full responsibility for the prompt and faithful execution of the entire Work. The Company assumes no obligation to pay or to see to the payment of any sum due to any subcontractor.

Contractor shall provide the Company with the originals of all warranty documents pertaining to Goods or Services provided by each subcontractor. The Contractor shall extend to the Company the same releases and indemnities in connection with the Work that Contractor obtains from its subcontractors, if such releases or indemnities afford the Company a greater degree of protection.

9.0 TERMINATION

9.1 Termination for Default

The Company may terminate this Agreement or any Contract or Contract Release without prejudice to any other right or remedy Company may have, and without recourse against the Company, upon written notice to Supplier if: (1) Supplier should be adjudged bankrupt, (2) Supplier should make a general assignment for the benefit of his creditors or becomes insolvent, or (3) Supplier shall fail to comply with any of the provisions, commitments, schedules, covenants, specifications, instructions, and conditions of this Agreement or a Contract.

9.2 Termination for Convenience of the Company

The Company may terminate for convenience a Contract or Contract Release, in whole or in part by written notice to the Supplier. In the event of such termination, the Company shall pay Supplier for all outstanding invoices associated with Services by Supplier up to the effective date of termination. The Company shall not be obligated to pay any other amounts to Supplier on account of such termination for convenience. This provision shall not be deemed to limit or otherwise affect the Company's right to terminate this Agreement or any Contract or Contract Release on account of the default of the Supplier.

10.0 NOTICE OF COMPLETION

Upon completion of the Services under each Contract Release, Supplier shall notify the Company in writing in the form of notice letter, Attachment #1, of the date of said completion. To the extent the Company determines such Services are not complete, Supplier shall promptly complete such Services and the above procedure shall be repeated.

11.0 SEVERABILITY

In the event that any of the provisions, or portions or application thereof, of this Agreement are held to be unenforceable or invalid by any court of competent jurisdiction, Company and Supplier

shall negotiate an equitable adjustment in the provisions of this Agreement with a view toward effecting the purpose of this Agreement and the validity and enforceability of the remaining provisions, or portions or applications thereof, shall not be affected thereby.

12.0 DISPUTE RESOLUTION

All disputes arising under this Agreement or with respect to its interpretation, whether involving law or fact or both, or extra work, or the scope of work, and all claims for alleged breach of Agreement, shall be submitted by the Supplier in writing to the Company within the earlier of: seven (7) days following the identification of the claim, or the date for submittal of the invoice for the applicable period. This notice shall include: the amount of the claim, a detailed description of the facts surrounding the claim (including any supporting documentation), and the impact of the claim on the scope or schedule of the Services. While the claim is pending, the Supplier shall continue performance of the Services. In addition, the Supplier shall submit such additional information regarding the claim as the Company may request. Any claim not presented within the time limit specified in this provision shall be deemed to have been waived. Within thirty (30) days of the receipt of the claim the Company shall inform the Supplier of the acceptance, rejection or modification of the claim. If the Supplier does not agree with this decision, the Supplier may refer the dispute to the duly authorized representatives of the parties for resolution. Should such officers fail to resolve the dispute within fourteen (14) days after such referral, either Party may seek such further legal recourse as such Party sees fit. In no event shall the Supplier allow the dispute to delay the Services, but may notify the Company promptly that Supplier is proceeding with the Services under protest.

13.0 LAW CONTROLLING

This Agreement is executed with reference to the laws of the Commonwealth of Massachusetts and the rights and liabilities of the parties and the construction and effect of every provision hereof shall be subject to and construed according to said laws. The courts of the Commonwealth of Massachusetts shall be the venue for resolving any dispute hereunder, unless the parties otherwise agree in writing.

14.0 LIENS AND ATTACHMENTS

The Supplier shall not place nor permit any lien, notice of contract, or attachment to be placed upon any property of the Company. In the event that any such lien, notice of contract, or attachment is imposed, Supplier shall immediately discharge the same at Supplier's expense. Until such lien, notice of contract, or attachment is removed, no payment will be made for any claim hereunder.

15.0 TAXES, INSURANCE, PREMIUMS

All Massachusetts State Sales Tax on materials and equipment rentals or any other taxable items will be paid for directly by the Supplier and not the Company. Said Massachusetts State Sales Tax shall be included in all proposals submitted. If appropriate, Company shall provide applicable sales tax exemption certificates upon request.

The Supplier agrees to assume full responsibility with respect to the Services covered by this Agreement for the payment of all federal, state and local taxes and assessments associated with any payments made to Supplier hereunder, and any with respect to any persons performing the Services all federal or state payroll taxes or contributions, unemployment insurance, worker's compensation, pensions, annuities, and similar benefits, in conformity with applicable law, regulations and rules.

16.0 AMENDMENTS

It is understood and agreed that amendments, when issued, shall be subject to all the terms, provisions and conditions of this Agreement and any applicable Contract.

17.0 EQUAL OPPORTUNITY CLAUSE

This Contract is subject to federal and state laws and regulations regarding nondiscrimination. As a material term of this contract, Contractor agrees to comply with all such applicable laws and regulations. The terms and provisions of the Equal Opportunity Clause, Sections 60-1.4, 250.4 and 741.4 of Chapter 60 of Title 41 of the Code of Federal Regulations, regarding "Nondiscrimination in Employment by Government Contractors and Subcontractors", are incorporated by reference and made a part of this Agreement. In addition, the Supplier agrees to comply with the provisions of 29 CFR Part 470. Upon request, the Supplier shall supply the Company with a certificate demonstrating compliance with the foregoing.

18.0 ORDER OF PRECEDENCE

Should a conflict arise among the various documents which comprise the Agreement between the parties, the order of precedence shall be as follows:

18.1 This Consulting Services Agreement
18.2 Any Appendices and Attachments to this Agreement
18.3 The Contract and subsequent Amendments
18.4 Any Plans and Specifications specifically referenced in the Contract
18.5 The Company’s RFP referenced in the Contract
18.6 The Supplier’s proposal, excluding commercial or contractual provisions, referenced in the Contract

19.0 CONFORMITY WITH THE COMPANY'S PRACTICES AND PROCEDURES

Supplier agrees to comply with Company's standard practices and procedures regarding access to and activity performed at all the Company's facilities.

20.0 NONWAIVER

The Company's failure to insist on strict performance of any term, condition, or instruction, or to exercise any right or privilege here included or its waiver of any breach, shall not constitute a waiver of any failure in the future to observe such term, condition, instruction and/or any other right or privilege.

21.0 ENTIRE AGREEMENT

This Agreement constitutes the entire agreement between the parties hereto relating to the subject matter hereof, and supersedes any previous agreements or understandings. No preprinted terms and conditions contained in the Supplier's documents with respect to the Services shall be effective to modify or add to the terms and conditions which are contained in this Agreement unless agreed to in writing by both parties.

22.0 TERM OF AGREEMENT

This Agreement shall remain in force and effect from the effective date until the completion of the Services, unless earlier terminated in accordance with the terms hereof. This Agreement may be extended by mutual written agreement of the parties.

23.0 NOTICES AND CORRESPONDENCE

Except as specifically provided to the contrary, all notices and correspondence permitted or required to be given under this Agreement shall be in writing and shall be deemed duly given if delivered personally, by facsimile by confirmation of receipt, by courier, by evidence of delivery or on the fifth day following the date on which each such notices is deposited postage prepaid in the United States Mail. All notices, requests or communications shall be delivered or sent to the other party at the address shown below or to any other address as the party may designate by ten (10) days prior written notice given in accordance with this provision.

If to Company:	If to Supplier:
NSTAR Electric & Gas Corporation	
One NSTAR Way – SE250	
Westwood, Massachusetts 02090-9230	
Attention: Procurement Director	Attention:

24.0 CONFIDENTIALITY AND PROTECTION OF COMPANY AND CUSTOMER INFORMATION

In performing its obligations under this Agreement, Supplier shall comply with any and all applicable company policies as described in Appendix D, and as such policies may be revised by the Company from time to time.

A. Company Information

The Supplier agrees to keep confidential all information provided by the Company (Confidential Information) pursuant to this Agreement. Supplier also acknowledges such Confidential Information may constitute "critical infrastructure" for purposes of state and federal law, policy or regulation. Confidential Information is not to be reproduced or disclosed to any third party, without the Company's permission. Confidential Information is not to be used by anyone other

than the party to who disclosed, nor used for any purpose other than the performance of Services. Confidential Information shall be destroyed or returned to the Company (at the Company's election) upon completion of the Services or at such earlier time as requested by the Company, and Supplier shall not retain any copies (including in electronic format) of the same. To the extent the Confidential Information relates to "critical infrastructure" as reference herein, Supplier acknowledges and agrees further restrictions regarding such information apply under of state and federal law, policy and regulation.

B. Protection of Non-Public Information

To the extent Supplier (or its subcontractors or any other party acting by or on behalf of Supplier) is provided or has access to non-public information pertaining to the Company's customers, employees, shareholders, contractors, suppliers or any other party ("NPI"), the following provisions apply: The Supplier warrants and represents that the Supplier and its subcontractors and all other persons or entities having access to Company NPI by or through the Supplier have the appropriate safeguards in place to prevent the disclosure or use of any NPI received from the Company or its customers, and further agrees to use such information solely for the purpose of performing Services for the Company under this Agreement. Such safeguards shall include, without limitation, security policies, tools and processes restricting access to such NPI to persons on a need-to-know basis, adequately training and notifying its employees and contractors of the restrictions associated with such information, identifying and correcting any impermissible use or disclosure, and immediately reporting any such use or disclosure. Supplier also agrees to comply with all applicable state, federal and local laws, regulations, codes and policies regarding the protection of customer information, and the avoidance of theft or fraud through the improper use or disclosure of such information, including, without limitation, Mass. Gen. Laws c93H and the regulations promulgated thereunder. Upon the request of the Company, the Supplier shall provide the Company with detailed information and documentation regarding such safeguards, and with certifications regarding the same by an authorized officer of the Supplier, and the Company shall have the right to monitor and audit the compliance of the Supplier at any time with the requirements of this provision. All such NPI shall be returned to the Company upon the Company's request (or destroyed if so directed by the Company), and the Supplier shall retain no copy or other record thereof. The Supplier shall give immediate notice to the Company of any incident that may cause such NPI to be disclosed or otherwise used in an unauthorized manner. Such immediate notice shall be given first by telephone to the Company's Director of Procurement, Barbara Sinisgalli, at 781-441-8117, and to the Company's General Counsel, Douglas Horan, at 617-424-2635, and shall be followed by a more complete written notice to be sent by express mail overnight courier by the close of business on the day that the incident took place and capable of delivery on the day following the date of the notice. Such notice shall set forth all relevant information regarding the incident, including the specific nature and extent of the disclosure / use, the measures taken and to be taken to retrieve and restore the NPI and/or to otherwise prevent the unauthorized use or disclosure of the NPI. The Supplier shall, at its sole cost, cooperate fully with the Company and, as necessary, any law enforcement, regulatory authority, insurance carrier, auditors, attorneys and other parties in the investigation and evaluation of such incident, and shall implement at its sole cost any remedial measures recommended by any such parties as approved by the Company.

C. Protection of Information / Legal and Regulatory Proceedings

Supplier understands and acknowledges the failure the Supplier to honor its obligations with respect to Confidential Information and NPI will result in immediate and irreparable harm and that monetary damages may be inadequate compensation or remedy. Accordingly, Supplier agrees that NSTAR (and in the case of Company customer information, such customer(s) will be entitled to all monetary and equitable remedies available, including injunctive relief, to enforce the terms of this Agreement.

In addition to the foregoing, if Supplier becomes legally compelled to disclose any Confidential Information or NPI, Supplier shall provide advance written notice to the Company, shall provide the Company with the opportunity to seek a protective order or other means to limit the disclosure of the Confidential Information and/ or NPI, and shall inform any recipient of the Confidential Information or the NPI of the restrictions and provisions of this Agreement.

25.0 PROHIBITION ON PUBLICITY

The Supplier may not advertise or promote using the name of the Company, the terms or existence of this Agreement, or the Supplier's relationship with the Company.

26.0 GIFTS, GRATUITIES AND CONFLICTS OF INTEREST

The exchange or offer of any money, gifts, services, or other benefits or gratuities by either party hereto to the other party hereto is hereby prohibited. This prohibition shall be applicable to the party's officers, employees, agents, employees and family members of the foregoing. Supplier hereby represents that to the best of its knowledge and/or belief, no economic, beneficial or employment, or managerial relationship exists between Supplier and any employee of the Company, or any member of such employee's family, which may tend to influence such employee (or those family members) in the performance of his or her duties on behalf of the Company. In the event Supplier becomes aware of any of the foregoing, the Supplier shall promptly advise the Company. Supplier further agrees to disclose any claim against the Company or the Company's Affiliates, or the existence of any relationship with any other entity which is or may be adverse to the interests of the Company. In the event any activities or circumstances as described in this Section 26 arise, the Company shall have the right to elect to terminate this Agreement, effective upon the provision of written notice to the Supplier, without further recourse against the Supplier, and Supplier shall further retain all other rights and remedies in law or equity.

27.0 BACKGROUND CHECKS

Contractor shall comply with the Contractor Background Check Policy attached as Appendix E hereto, and as such Policy may be revised by the Company from time to time.

APPENDIX A

SCHEDULE OF RATES

TABLE OF CONTENTS

Section	Description	Page
1.0	Billing Rates by Category	
2.0	Support Rates	
3.0	Other (Specify)	

APPENDIX B

REIMBURSABLE EXPENSE GUIDELINES

Purpose

Expenses shall be recoverable only to the extent that they have been approved in writing by an authorized representative of the company in advance of being incurred.

The following are established guidelines for the reimbursement of ordinary, necessary and reasonable business expenditures that are incurred by Suppliers of NSTAR when performing services under a contract that allows for the reimbursement of prudently incurred expenses.

General Expense Guidelines

Expenses which are not directly associated with Supplier's work for NSTAR are not eligible for reimbursement. Costs associated with personal activities or entertainment shall not be reimbursed. In no event shall reimbursable expenses exceed 15% of the contract price, unless otherwise specified in a Contract. Suppliers and their employees are expected to exercise conservative, sound business judgment when incurring reimbursable expenses. Original Receipts are required for all expenditures of twenty-five dollars ($25.00) or more, in order for them to be reimbursed. In addition, the employee should submit receipts for lesser amounts if available.

Supplier's employees are reminded that reimbursable expenditures are subject to review at any time without advance notice, including a comparison of submitted receipts with records held by issuing vendors.

All requests for reimbursement of expenses shall be submitted to NSTAR within 45 days if the incurrence of such expense. Supplier shall provide such additional supporting documentation as NSTAR may request, and to the extent such documentation is not promptly provided the reimbursement request shall be denied.

Air Travel

Airline reservations should be made at the earliest possible date to allow time to secure the lowest possible fare. Supplier's employees will utilize Lowest Fare Routing (LFR). Travelers may not specify an airline to accumulate mileage unless rates for use of these airlines are consistent with Lowest Fare Routing. The Company may request the investigation of alternative airlines and flights to save costs. Supplier's employees will be expected to adhere to these arrangements in order to receive approval for their trip. The Company will only reimburse expenses for coach seating.

Rental Cars

Rental cars should be used only when the overall cost would be less than that for taxis or other means of transportation. If chosen, insurance will be the responsibility of the Contractor. Rental cars should be compact unless there is a business reason to do otherwise (i.e., number of people to be transported). If two or more Supplier's employees are traveling to the same destination, they should share a vehicle unless business circumstances prohibit it. The Company will only reimburse the cost of rental cars and fuel used for travel on Company business.

Lodging

Hotel/motel reservations are to be made, whenever possible, through the Company's travel coordinator or Procurement department to obtain the best corporate rates. The minimum corporate single rate should be requested and selected at all hotels and motels. If the Company provides Supplier with a discounted rate at a hotel/motel close to the Supplier's work location, the Company will only compensate Supplier at the rate provided if Supplier's employees make alternative lodging accommodations at a higher rate.

When hotel/motel reservation cancellation is necessary, it is the Supplier's responsibility to cancel reservations made directly. If cancellation is not made in time to avoid a charge, that expense will not be reimbursed.

Meals

The cost of meals incurred by employees of Supplier while traveling on Company business should be reasonable and appropriate to the nature of the business trip. Charges for alcoholic beverages will not be accepted.

APPENDIX C

SAMPLE INVOICE

DATE:_____ Invoice #_____

JOHN DOE CORP.
10 HIGH STREET
BOSTON, MA 02111

TO: NSTAR ELECTRIC & GAS CORPORATION
Accounts Payable
P.O. Box 250
NORWOOD, MA 02062-0250

Contract #_____

Contract Release #:_____

BRIEF DESCRIPTION OF SERVICES PERFORMED IN ACCORDANCE WITH CONTRACT

LABOR	Description	Hours	Rate	Extension
	Consulting Engineer	8	$10.00	$ 80.00
	Technician	8	9.00	72.00
	Draftsman	8	8.00	64.00
	Secretary	8	7.00	56.00
		Sub-Total		$272.00

MATERIALS SUPPLIES: Itemized with paid vouchers attached

EXPENSES/PER DIEM RATES: Itemized with vouchers attached

SUB-CONTRACT WORK: Totals with paid vouchers attached

Sub-Total $000.00

GRAND TOTAL $272.00

APPENDIX D

COMPANY CORPORATE POLICIES

Where the Services involve one or more of the following: (i) interaction with the Company's employees, (ii) work on the Company's premises, (iii) access to Company facilities; or (iv) access to Company Information or other confidential Information as described in Section 24 of the Terms and Conditions , the Supplier shall comply with the following policies, together with such newly-issued and/or revised policies as in effect from time to time, to the same degree such policies apply to NSTAR employees (or contractors as referenced therein), and to the extent such policies are applicable to the Services then being provided by the Supplier:

1. Anti-Fraud
2. Communication
3. Dress Code
4. Drug and Alcohol
5. Environmental
6. Fleet Use
7. Integrity of Company Records
8. Protection of Critical Energy Infrastructure Information
9. Safety
10. Security
11. Sexual Harassment
12. Smoking

The Company shall issue a copy of such policies to the Supplier, and shall make newly-issued and revised policies available to the Supplier from time to time as such are issued. A softcopy of the policies listed above is provided below. A hardcopy is available on request.

Anti-Fraud.pdf

Communication.pdf

Dress Code.pdf

Drug and Alcohol.pdf

Environmental.pdf

Fleet Use.pdf

Integrity of Company Records.pd

Protection of Critical Energy Infrastructure

Safety.pdf

Security.pdf

Sexual Harassment.pdf

Smoking.pdf

APPENDIX E

CONTRACTOR BACKGROUND CHECK POLICY

Policy

NSTAR Contractors are required to ensure that their employees and subcontractors providing services for NSTAR successfully pass a Contractor Employee background check. These background checks are to be done by the Contractor at the Contractor's expense prior to that person performing or continuing work for NSTAR, and for administering a background check program on a continuous basis throughout the period of performance of services for NSTAR. The Contractor is responsible to maintain documentation regarding these background checks through the term of the agreement and for three years following the expiration or other termination of the agreement, which documentation shall be available for review and audit by NSTAR. The Contractor shall be responsible for designing and administering the background check program, provided that such program satisfies the minimum requirements specified below. It is the Contractor's responsibility to maintain compliance with all applicable laws and regulations in conducting background checks and maintaining information relating thereto, including without limitation the Fair Credit Reporting Act and the Consumer Credit Reporting Reform Act of 1996.

Minimum Requirements

Two levels of baseline background checks are required for Contractors, depending upon the nature and location of the work that they will perform. Additional requirements beyond these baselines may be required by NSTAR based upon risk assessments or legal requirements.

Level 1 baseline background checks require identity verification and verification of legal rights to work in the USA (or other host country where the services for NSTAR are performed) and are required of all persons.

Level 2 baseline background checks require, in addition to Level 1 checks, a seven-year criminal history search, a seven-year Sex Offender Registry check, a seven-year residential address verification, three-year employment history verification, and motor vehicle driving record checks (if responsibilities include driving) and are required for all persons who will be performing work for NSTAR and meet any of the following criteria:

- When a criminal background check is required by law, regulation or other legal requirement.
- The person will have direct contact with customers in a non-public location.
- The person will have access to non-public personal information or other information required to be protected under applicable law, regulation or other legal requirement.
- The person has unescorted access to locations containing critical cyber assets (e.g. SCADAS, Computer Rooms, Tel Data Rooms) or where critical functions are performed, or other locations deemed sensitive by NSTAR. This will include critical Gas and Electric infrastructure locations such as substations, gate stations, compressor stations, energy control centers, energy management systems, remote monitoring and control locations, communications centers, and critical backup systems.
- The person will have direct and/or remote electronic access to NSTAR cyber assets (hardware/software) or records (electronic, paper, etc.).

- The person is providing software, database, application development services, critical systems operation, management, maintenance, or repair services, physical or computer security services, or compliance services for NSTAR, whether on-site or remotely.
- The person will have access to information or systems where there is a risk that significant damage or loss could occur.

In the event that Contractor determines to employ or retain any person who has a current misdemeanor case pending or has been convicted of a misdemeanor in the last five years, Contractor shall notify NSTAR by telephone and email (Nicholas.Gianturco@nstar.com, 781-441-8538) of its intention to do so, together with Attachment #2 "NSTAR Contractor Background Check Exception Request Form". In no event shall Contractor assign a person who the Contractor has actual knowledge of having a current felony case pending or having been convicted of a felony.

Supplemental Background Check Requirements

NSTAR may require additional checks to be performed if warranted by the nature of the work and where the work will be performed. Access to highly sensitive information or critical infrastructure locations, for example, may warrant such supplemental checks as credit history or homeland security checks. NSTAR shall determine the need for supplemental background checks by considering the risks involved with the work and the mitigation achieved by performing the supplemental checks.

Supplemental checks that may be required include:

- Five (5) panel drug screening
- Education/verification of degrees
- Validations of required licenses (professional and/or legally required)
- Credit history
- Global screening of offshore international/foreign national persons
- Homeland Security checks
- US Citizenship and Immigration Services E-Verify
- Criminal History Check updates every 7 years

Minimum Background Screening Requirements

1. Identification Verification/Eligibility to Work in the Country
Contractors performing services for NSTAR must be able to provide evidence to NSTAR or its agent that they have verified Contractor Employees' identities and that all Contractor Employees are legally eligible to work in the country where the work is to be performed. NSTAR requires that U.S. Contractors complete a Social Security trace and or a Consent Based Social Security Number Verification – CBSV on their Contractor Employees and match results of this check with other identification documents provided by their employees. This search reveals all names and addresses historically associated with the Contractor Employees provided number, along with the date and state of issue, and verifies if the number is currently valid and logical. This search may also reveal the use of multiple social security numbers, AKAs/aliases, and additional employment information that can then be used to determine the parameters of other aspects of the background investigation. Adverse action should not be taken based solely on this information and may require further verification with the Social Security Administration (SSA) or the Department of Homeland Security (DHS).

2. Criminal History Background Checks
Contractors shall ensure that all their employees performing work or providing services to NSTAR are subjected to a criminal history background check. Such checks shall be conducted on all names, including alias names that are provided or developed, and include County, State, and Federal checks based on jurisdictions of work and residence for the past 7 years, as well as international jurisdictions, if available. Checks must be performed on all current Contractor Employees and any new Contractor Employees hired or assigned to support the NSTAR contract. If the Contractor has had a pre-employment criminal history check process in place and can provide documented evidence that employees assigned to the NSTAR contract have been subjected to the criminal history check within the last 3 years, then additional checks are not necessary. Contractor Employees who work in certain sensitive areas that fall under regulatory requirements, i.e., NERC, are subject to additional criminal history checks. If required, this information is contained in the supplemental background check information above.

The following criteria will be used as guidance by NSTAR in making the determination of whether the Contractor Employee will be allowed to perform work specified in the contract between your company and NSTAR. These criteria should also be evaluated by the contractor prior to making a request to NSTAR for the Contractor Employee to be approved for assignment to the NSTAR contract:

- Number of convictions
- Nature, seriousness and date(s) of occurrence of the offense
- Rehabilitation
- Relevance of the crime committed in relationship to the work to be performed
- Unreasonable risk posed to NSTAR property or to the safety of employees, other Contractors and/or customers

During the term of the contract if the Contractor becomes aware of information concerning a criminal conviction of a Contractor Employee that would fit the above criteria for reporting to NSTAR, this information shall be forwarded to NSTAR's Security Department for determination whether the Contractor Employee should be allowed to continue working or providing services for NSTAR.

3. Sex Offender Registry Search
Most states maintain a sex offender database that is available as a source of public record. Individuals convicted of such crimes as sexual assault, aggravated criminal sexual conduct, luring or enticing, and kidnapping, or who have been found to be repetitive and compulsive by experts and the courts are required to register with their state authorities. Specific registration requirements are dictated by state laws and are based on dates of offense, sentence and/or release from custody. Consistent with the scope of the Criminal History Search, a search will be conducted in the applicant's provided and developed names, in the state(s) of the applicant's residence and place of work, if a statewide repository is maintained and accessible as public record.

4. Residential Address Verification
Contractors must perform a seven-year address verification on all **new** Contractor Employees hired to support the NSTAR contract. The purpose of this check is to confirm that the address exists and relates to a real property, and to establish that the individual permanently resides or previously resided at the address. Verifying the address given by a prospective employee is important because it confirms that other information provided is correct. An individual may wish to omit their current or former address to conceal adverse information, such as criminal convictions.

5. Employment History Verification
Contractors must perform a three-year prior employment history verification on all **new** Contractor Employees hired to support the NSTAR contract. The purpose of this check is important as it serves to

check the accuracy of information provided by the applicant. This check may also reveal prior employment with NSTAR that should be further explored. An individual may wish to omit prior employment history to conceal adverse information, such as criminal convictions.

6. Motor Vehicle Driving Record Check

All Contractor Employees who are required to operate a motor vehicle in conjunction with their contract with NSTAR must be legally licensed and hold a valid driver's license appropriate to the vehicle being driven. This requirement applies to both Contractor-owned or leased vehicles and NSTAR-owned/leased vehicles. A motor vehicle driving record check to include a commercial driver license search, when applicable, must be conducted by the Contractor annually in order to validate this requirement.

7. Employees Previously Terminated or Removal from NSTAR Work for Cause

NSTAR will not permit Contractor Employees who were previously employed by NSTAR and were terminated by NSTAR for cause, or Contractor Employees who were previously removed form working on any contract for NSTAR to work for NSTAR.

8. NSTAR's Right to Revise Requirements for Contractor Background Checks

NSTAR reserves the right to revise its requirements for Contractor Employee background checks during the contract term, which the Contractor must comply with. Any such revisions will be provided in writing.

ATTACHMENT #1

NOTICE OF COMPLETION
CONTRACT NUMBER
CONTRACT DATED , 20

The Services provided pursuant to the Agreement dated _____ and the Contract / Contract Release dated _____. 20_____. including all amendments as of the date of this Notice, (hereinafter called the "Project") between NSTAR Electric & Gas Corporation ("Company") and_____("Supplier") has been completed as of_____, 20__.

BY:_____

TITLE:_____

DATE: _____

ATTACHMENT #2

NSTAR Contractor Background Check Exception Request Form

Section A: Exception Request (to be completed by Contractor)	
Requestor's First and Last Name and Phone Number:	Name of Contractor/Vendor:
Date of Exception Request:	NSTAR Contract Number, if applicable:
Description of work/services provided by Contractor/Vendor:	
Location where work/services are provided:	
Description of exception requested and rationale for exception:	

ACKNOWLEDGEMENT BY REQUESTOR

By signing below, I hereby certify that the information submitted on this form is accurate and complete.

Requestor's Signature: _____ Date: _____

Section B: Management Review/Authorization (to be completed by NSTAR):		
Conclusion, recommendation, and agreed action, if any:		
Business Risk Description/Impact Assessment:		
Start and end period for which exception is granted:		
Name of Procurement Manager:	Title:	
Signature:		Date:
Name of Corporate Security Manager:	Title:	
Signature:		Date:

Note: Exception may not be granted that:

- Allow unescorted access to critical assets
- Violate regulatory requirements

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APPENDIX E

OTHER SUPPORTING DOCUMENTATION

SECTION 3

AUDIT DOCUMENTATION

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Northeast Utilities

COMPANY CONFIDENTIAL

Internal Audit Department

Energy Efficiency Program Audit

Final Report

Audit Team
Edyta Grabowy, Senior Auditor
Shannon Llewellyn, Senior Auditor

Signed: _____
R. S. Smith, Director

Signed: _____
J. L. Lucy, Manager

Date: July 26, 2012
Report#: [XXX]

This engagement was conducted in conformance with the *International Standards for the Professional Practice of Internal Auditing*

INTERNAL AUDIT REPORT

INTRODUCTION AND BACKGROUND

The Internal Audit Department (IAD) has completed an audit of residential NSTAR Energy Efficiency Programs administered by a third party vendor Conservation Services Group (CSG). NSTAR contracted with CSG to administer 4 programs: Mass Save ($13.9m contract value), Multi-Family ($2m contract value), Cool Smart ($1.3m contract value) and Community Outreach ($60k contract value).

Energy Efficiency programs provide customers with energy efficiency recommendations and incentives that enables them to identify and initiate the process of installing cost-effective energy efficiency upgrades. CSG provides initial energy assessments, incentive recommendations, manages installation work performed by third party contractors, and performs post installation inspections.

OBJECTIVES & SCOPE

Our overall audit objective was to evaluate the adequacy and effectiveness of controls over the Energy Efficiency Programs administered by Conservation Services Group. Specifically, we evaluated whether adequate controls are in place to ensure that:

- Program costs, including charges from third parties, are valid, supported, and in accordance with contract terms and program requirements
- Third parties deliver services and products in accordance with contract terms and conditions, and with program requirements
- Action plans agreed to from the 2010 Energy Efficiency Processes Audit were put in place and are working effectively

Our assessment included a review of processes and controls, interviews with Energy Efficiency and Conservation Services Group management and personnel, contract and invoice review, site visits, and follow up on 2010 audit action plans.

CONCLUSIONS

[redacted]

Based on the audit results, we have identified the following **Opportunities for Improvement**:

[redacted]

OPPORTUNITIES FOR IMPROVEMENT

1. Compliance with Procurement Guidelines

Audit Results

[redacted]

Recommendation

[redacted]

Management Response (T. Subrahmanian & P. Conner)

[redacted]

2. Verification of Invoices to Contract Pricing

Audit Results

[redacted]

Recommendation

[redacted]

Management Response (T. Subrahmanian & P. Conner)

[redacted]

3. Payment Practice for Multi-family Inspections

Audit Results

[redacted]

Recommendation

[redacted]

Management Response (T. Subrahmanian & P. Conner)

[redacted]

APPENDIX F

LOST BASE REVENUE

Information on savings on which Lost Base Revenue is based is included in the Company's D.P.U. 08-50-C Support Tables. Please see Appendix B, Section 1. These savings are provided in a format and method consistent with the methodology historically approved by the Department in all of the Company's Local Distribution Adjustment Factor Filings.