2011
Gas Energy Efficiency
Annual Report

Boston Gas Company
Colonial Gas
d/b/a National Grid

August 2012

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I. Introduction

In the second full year of the three-year energy efficiency plans, as reviewed and approved by the Department of Public Utilities (the "Department") in D.P.U. 09-116 through 09-127 (the "Gas and Electric Orders"), program year 2011 continued to build on the successes of program year 2010 and showed remarkable success with respect to goal attainment and achievement of real benefits for the environment and the economy in the Commonwealth of Massachusetts. Among the many awards and accomplishments achieved during program year 2011, the American Council for an Energy-Efficient Economy ranked Massachusetts number one in the nation for its energy efficiency efforts. Collectively, the Program Administrators ("PAs") were able to deliver on their goals during program year 2011, as established in the Gas and Electric Orders and as submitted in each PA's 2011 Mid-Term Modifications filed on October 29, 2010, while maintaining the balance between meeting the budget for their programs and complying with the directives of the Green Communities Act in ensuring that they make available all cost-effective energy efficiency opportunities.

Overall, the PAs worked diligently with the Department, the Department of Energy Resources ("DOER"), the Energy Efficiency Advisory Council ("EEAC"), and other interested stakeholders to meet what were intentionally designed to be very challenging 2011 program year goals. In many cases, achievements in savings and benefits exceeded those goals. Program year 2011 performance showed that aggressive savings levels were achieved for Residential, Low-Income, and Commercial & Industrial ("C&I") programs. PAs worked well to implement the programs in the field while also continuing the unprecedented ramp up of spending and savings levels for energy efficiency programs so as to meet goals not just for program year 2011, but for the full life of the three-year plans.

The accomplishments of 2011 were achieved despite a struggling economy, a stagnant new construction market, historically low natural gas prices and a significant increase in savings goals. In the wake of challenges, including record setting weather events, the PAs continued to proactively work toward developing new delivery techniques to reach untouched customer sets and to convince customers to move forward with commitments to invest in energy efficiency.

In addition to the achievements for each PA's program implementation efforts, the PAs have made significant progress integrating gas and electric energy efficiency services, and remain committed to furthering progress in both the residential and non-residential sectors. While working to achieve their programmatic goals for 2011, the PAs have worked diligently to establish statewide marketing of energy efficiency program offerings through the use of the Mass Save® label, which won the Association of Energy Services Professionals ("AESP") Outstanding Achievement in Marketing and Communications Award in 2011. Simultaneously, the PAs have engaged in 30 studies across a wide span of program sectors to ensure that the evaluation, measurement and verification ("EM&V") elements of these program offerings remain a critical and vital tool to evaluate and transform measures in the future to meet demand in an ever changing marketplace. The PAs have worked diligently with financial institutions to explore outside financing options to better serve their C&I customers.

The PAs have continued to be engaged in the monthly EEAC process in 2011, and have worked collaboratively with the EEAC's consultants to meet stringent reporting and data collection deadlines so as to adequately monitor and review where the Plans' efforts have succeeded, and where improvement could be anticipated for the future. In all, while actively involved in program implementation efforts, the PAs have also been heavily immersed in the policy and planning that will allow for accurate data development, evaluation and measurement of successes and areas in need of modification, transparent codes and standards, and the framework necessary to ensure the ability to continue to offer successful and sustainable energy efficiency programs in the Commonwealth.

Given the unprecedented nature of these efforts and the significantly ambitious goals established in these Plans, the PAs contend that the 2011 program year performance has been an unmitigated success and has continued to exceed the expectations established by the Plan. The PAs continue their endeavors to achieve deeper savings from participating customers, and have worked to reach a broader range of customers for the implementation of all cost-effective program offerings.

A. Purpose of Annual Report

As specified by the Department in D.P.U. 08-50, 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 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 (both individually and jointly with other PAs) that have not been included in previous Annual Reports or Mid-Term Modifications, 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 2011 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 audits conducted during the past five years.
- Section VII provides detailed supporting documentation.

C. Summary of Program Portfolio

Tables I.A and I.B provide summary information on program performance at the portfolio and customer sector levels, respectively.[1]

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	$	63,833,756			60,975,083		-4%
Performance Incentive	$	2,186,284			2,315,111		6%
Savings & Benefits							
Gas							
Lifetime	therms	140,949,708	148,680,482	5%	121,013,500	-19%	-14%
Annualized	therms	11,176,371	11,607,933	4%	9,842,702	-15%	-12%
Electric							
Annualized Energy	kWh	368,904	754,167	104%	873,302	16%	137%
Annualized Demand							
Summer	kW	33	58	77%	132	128%	305%
Winter	kW	45	121	171%	166	37%	272%
Non-Gas Non-Electric Resources (Lifetime)	$	16,346,799	28,332,353	73%	60,133,863	112%	268%
Cost-Effectiveness							
TRC Benefits	$	178,662,816			202,266,076		13%
TRC Costs	$	93,106,711			91,246,473		-2%
Net Benefits	$	85,556,105			111,019,603		30%
BCR	n/a	1.92			2.22		16%

The Planned Values in Table I.A and all subsequent tables that contain Planned Values in this Annual Report (except as otherwise noted) were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Boston Gas Company and ColonialGas Company d/b/a National Grid, D.P.U. 10-140.

As shown in Table 1.A above, significant variances at the portfolio level between planned and evaluated occurred with Non-Gas Non-Electric Resources where the evaluated value was 268% higher than the preliminary value. In addition, significant variances at the portfolio level between planned and evaluated occurred with kWh savings, summer kW and winter kW where the evaluated value was 137%, 305% and 272% higher respectively. It should be noted that the electric savings presented here are unique to any electric savings presented in the 2011 Electric Energy Efficiency Annual Report. In general the portfolio was under spent by 4% as compared to plan.[2]

1 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.

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

Table I.B: Customer Sector Summary				
Sector	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Residential				
TRC Benefits	$	69,808,222	107,140,870	53%
TRC Costs	$	33,679,471	43,051,685	28%
Net Benefits	$	36,128,751	64,089,185	77%
BCR	n/a	2.07	2.49	20%
Low-Income				
TRC Benefits	$	24,011,468	32,876,356	37%
TRC Costs	$	15,020,452	11,777,648	-22%
Net Benefits	$	8,991,016	21,098,708	135%
BCR	n/a	1.60	2.79	75%
C&I				
TRC Benefits	$	84,843,126	62,248,851	-27%
TRC Costs	$	44,406,788	36,417,141	-18%
Net Benefits	$	40,436,338	25,831,710	-36%
BCR	n/a	1.91	1.71	-11%
TOTAL				
TRC Benefits	$	178,662,816	202,266,076	13%
TRC Costs	$	93,106,711	91,246,473	-2%
Net Benefits	$	85,556,105	111,019,603	30%
BCR	n/a	1.92	2.22	16%

As shown in Table I.B above, significant variances exist between planned and evaluated costs and benefits at the Residential, Low-income, and C&I sector levels. Overall, evaluated benefits are 13% above planned estimates. Detailed sector summaries are discussed in section II.A for the Residential sector, II.B for the Low-Income sector, and II.C for the C&I sector.

II. Program Performance

A. Residential Sector Programs

1. Summary

During 2011 the Company implemented the following residential programs and residential pilot programs:

Residential Programs:

- Residential New Construction & Major Renovation
- Residential Heating and Water Heating
- MassSAVE
- Weatherization Program
- Multifamily Retrofit
- Behavior/Feedback

Residential Pilot Programs:

- Deep Energy Retrofit
- Residential Building Practices and Demonstration
- Energy Analysis: Internet Audit
- Community Based Pilots

Tables II.A.1 and II.A.2 provide summary information on the performance of the residential programs at the sector and program levels, respectively. Sections II.A.2 and II.A.3 provide detailed information on the performance of each residential program.

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	$	31,152,066			34,115,014		10%
Performance Incentive	$	848,502			1,202,419		42%
Savings & Benefits							
Gas							
Lifetime	therms	57,500,316	54,696,672	-5%	54,813,162	0%	-5%
Annualized	therms	5,396,274	5,333,257	-1%	5,450,135	2%	1%
Electric							
Annualized Energy	kWh	200,934	576,989	187%	398,754	-31%	98%
Annualized Demand							
Summer	kW	32	57	79%	78	36%	144%
Winter	kW	24	99	318%	73	-26%	211%
Non-Gas Non-Electric Resources (Lifetime)	$	37,443	3,687,762	9749%	39,387,487	968%	105093%
Cost-Effectiveness							
TRC Benefits	$	69,808,222			107,140,870		53%
TRC Costs	$	33,679,471			43,051,685		28%
Net Benefits	$	36,128,751			64,089,185		77%
BCR	n/a	2.07			2.49		20%

During 2011, the Residential Sector spent within 10% of the planned budget, which produced preliminary year-end and evaluated savings nearly at planned estimates (-5% and 0%, respectively). Several evaluations, discussed further in the program sections below, resulted in a significant increase in a significant increase in evaluated year end lifetime Non-Gas Non-Electric Resources over preliminary values.

Table II.A.2: Residential Program Summary				
Program / Performance Category	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Residential New Construction & Major Renovations				
TRC Benefits	$	3,120,210	9,990,544	220%
TRC Costs	$	2,361,864	2,918,323	24%
Net Benefits	$	758,346	7,072,220	833%
BCR	n/a	1.32	3.42	159%
Residential Heating and Water Heating				
TRC Benefits	$	32,962,261	51,952,297	58%
TRC Costs	$	9,977,482	19,367,326	94%
Net Benefits	$	22,984,779	32,584,971	42%
BCR	n/a	3.30	2.68	-19%
MassSAVE				
TRC Benefits	$	-	-	0%
TRC Costs	$	2,546,829	3,101,738	22%
Net Benefits	$	(2,546,829)	(3,101,738)	22%
BCR	n/a	-	-	0%
Weatherization Program				
TRC Benefits	$	20,738,239	32,051,597	55%
TRC Costs	$	13,230,056	10,549,306	-20%
Net Benefits	$	7,508,183	21,502,291	186%
BCR	n/a	1.57	3.04	94%
Multifamily Retrofit				
TRC Benefits	$	9,675,890	9,556,427	-1%
TRC Costs	$	3,021,724	2,898,481	-4%
Net Benefits	$	6,654,166	6,657,946	0%
BCR	n/a	3.20	3.30	3%
Behavior/Feedback Program				
TRC Benefits	$	3,311,622	3,590,006	8%
TRC Costs	$	2,541,517	2,751,645	8%
Net Benefits	$	770,105	838,360	9%
BCR	n/a	1.30	1.30	0%
Deep Energy Retrofit				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	864,416	559,970	-35%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
Residential Building Practices and Demonstration Program				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	258,868	55,054	-79%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
Energy Analysis: Internet Audit Program				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	316,876	203,081	-36%
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	$	147,916	155,650	5%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
TOTAL				
TRC Benefits	$	69,808,222	107,140,870	53%
TRC Costs	$	33,679,471	43,051,685	28%
Net Benefits	$	36,128,751	64,089,185	77%
BCR	n/a	2.07	2.49	20%

Residential Sector Performance Highlights

During 2011, the Company 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 - In 2011, with over 100 communities adopting the Stretch Energy Code, this program, also known as the Massachusetts New Homes with ENERGY STAR program, faced a market in which energy codes continued to change. Single family development remained slow, and opportunities to capture future energy savings were becoming increasingly difficult. To address these barriers the program engaged in code support activities and offered technical assistance as well as incentives to meet this new code. The program also increased market penetration while providing energy savings for residents. During 2011, the program provided multiple trainings and participated in several recruitment events targeted at builders and allies new to performance-based construction. The program continued to participate in three pilots (multi-family new construction, major renovations, and lighting design) to aid in identifying the next generation of energy savings opportunities. Finally, the PAs in western Massachusetts participated in the *Western Massachusetts Storm Recovery Program*. The storm recovery program contacted all of the communities affected by the 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 2011, the PAs collectively achieved over 100% of their savings goals within budget due to attractive customer incentives combined with federal tax incentives. The PAs continued to successfully utilize extensive contractor outreach via supply houses and big box retailers, providing outreach to 300 supply houses and 700 contractors throughout Massachusetts and New England, which contributed to increased participation levels in this program. The PAs sponsored and participated in 22 training events in 2011 and sponsored their 11th Annual GasNetworks Fall Conference and Trade Show on September 22, 2011. Attendees included over 400 HVAC contractors from across the Commonwealth along with 23 exhibitors. The day-long conference featured a myriad of expert trainers and speakers and focused on high efficiency natural gas HVAC equipment and installation practices. The program continued its integration efforts with the Residential Cooling and Heating Equipment ("Cool Smart") program and incorporated breakout sessions to include such topics as electronically commutated motors, brushless fan motor technology, hydronic heating, on-demand water heating, condensing and modulating boilers, near boiler piping, system sizing, renewables and codes and standards. In 2011, program outreach resulted in 1,789 visits and the distribution of 102,825 residential and 21,600 commercial rebates from December 2010 through December 2011.

After embarking on an extensive competitive bidding process, the PAs secured a new rebate processing vendor in 2011. During the transition to the new vendor, the PAs continued to experience steady demand. The transition did present some challenges, which included an increase in year-end claims, the carryover of unprocessed rebate applications from the previous vendor, the design and launch of the 2012 rebate form, and the integration of data systems. Each PA has successfully transitioned to the new vendor.

- MassSAVE/Weatherization - In 2011 the MassSAVE Residential Conservation Services program was fully integrated with the gas Weatherization program to provide customers with fuel blind energy services through the Home Energy Services ("HES") program. Mid-year, the program transitioned to offering customers one comprehensive Home Energy Assessment ("HEA") and incorporated additional market actors. Two groups of MassSAVE participating contractors, Home Performance Contractors ("HPCs") and Independent Installation Contractors ("IICs"), now provide services in addition to those offered by the lead vendor.

  After the integration of additional contractors into the program, a Contractor Best Practices Working Group was developed to continue PA commitment to ongoing communication with participating contractors in the program. The group serves as a forum to provide an open line of communication between PAs, lead vendors, HPCs and IICs to discuss any matters related to the program with an independent third-party facilitator. Best Practices Working Group achievements in 2011 include:

  - Assistance with contractor permit acquisition and a continued focus on improving and streamlining the process
  - Subsidized marketing materials offered to both IICs and HPCs
  - A contractor portal on the MassSAVE website for easy access to contractor relevant documents
  - Development of a form and process for pricing adjustments
  - Customer acquisition assistance for contractors bringing in customers who move forward with implementing weatherization work
  - Various lead vendor process enhancements
  - Workforce development including subsidies for various trainings including:
    - Weatherization Boot Camp
    - Combustion Safety Training
    - Weatherization Crew Chief Training
    - Building Analyst Training

In addition, HEAT Loan offerings were extended to include many gas customers in municipal electric territories to provide qualified customers with zero percent interest loans up to $25,000 with terms up to seven years.

- Multi-Family Retrofit - The Multi-Family Market Integrator continued to be an invaluable resource to the PA multi-family working group in 2011. Monthly activity reports were developed to track program progress. The Multi-Family Market Integrator continued to report a trend of successfully enrolled facilities, which was the result of the relationships they have built with property owners, authorized representatives, and property managers. In addition, the statewide MassSAVE advertising campaign was noted as a source of program inquiry.

Most PAs were close to or exceeded program goals in 2011 with a strong enrollment and high level of pipeline projects into the residential Multi-Family Retrofit program. The PAs continue to integrate the C&I program, where applicable, to better address the whole facility and maximize savings opportunities. Energy efficient lighting, instant savings measures, and weatherization were in high demand from this market sector.

2. Residential Programs

a. Residential New Construction and Major Renovation

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

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

Definition of Program Participant: A participant is defined as a completed housing unit.

Targeted End-Uses:
- Heating
- Air Duct
- Hot Water
- Envelope

Delivery Mechanism: The program was administered by each PA 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: D.P.U. 09-121, Exhibit NG-1.

Table II.A.3: Residential New Construction & Major Renovations							
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	$	2,336,436			2,805,461		20%
Performance Incentive	$	25,193			112,862		348%
Participants	Homes	881			855		-3%
Program Cost / Participant	$	2,652			3,281		24%
Savings & Benefits							
Gas							
Lifetime	therms	2,289,383	4,600,442	101%	4,586,660	0%	100%
Annualized	therms	97,008	200,895	107%	199,517	-1%	106%
Average Measure Life	yrs	24	23	-3%	23	0%	-3%
Electric							
Annualized Energy	kWh	200,934	576,989	187%	398,754	-31%	98%
Annualized Demand							
Summer	kW	32	57	79%	78	36%	144%
Winter	kW	24	99	318%	73	-26%	211%
Non-Gas Non-Electric Resources (Lifetime)	$	37,443	34,624	-8%	2,974,242	8490%	7843%
Cost-Effectiveness							
TRC Benefits	$	3,120,210			9,990,544		220%
TRC Costs	$	2,361,864			2,918,323		24%
Net Benefits	$	758,346			7,072,220		833%
BCR	n/a	1.32			3.42		159%

There are two main reasons for the variance between planned and preliminary savings, one responsible for increased gas savings and one responsible for increased electric savings. It should be noted that the electric savings presented here are unique to any electric savings presented in the Residential New Construction & Major Renovation program in the 2011 Electric Energy Efficiency Annual Report.

Preliminary Gas savings increased from planned due to the fact that more homes completed in the upper tiers of the program than was originally planned. Forty-two percent of the homes coming through the 2011 program were Tier II or higher while only 22% were planned at this level. Homes which completed in the upper tier levels in 2011 achieved savings approximately three times those of homes completing in the lower tiers. Additionally, costs are 20% higher than planned budgets, due to the fact that Tier II homes have higher incentive levels than lower tiers.

Preliminary Electric Savings increased from planned savings due to significantly more lighting being installed than was originally planned. A total of approximately 8,000 bulbs and fixtures were installed through the program while only 531 were originally planned.

In addition, there are two main reasons for the variance between preliminary electric savings and net benefits to evaluated electric savings and net benefits.

The decrease in evaluated electric savings compared to preliminary is due to incorporating results of baseline penetration of energy efficient lighting and appliances found in the Mini-Baseline study. The increase in evaluated net benefits compared to preliminary is primarily due to the results of The Massachusetts Special and Cross-Sector Studies Area, Residential and Low

Income Non-Energy Impacts (NEI) study, which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.

The following EM&V studies included in the Annual Report apply to this program:

Massachusetts Residential New Construction Home Buyer Survey:
This study examined what buyers look for in a new home, awareness of ENERGY STAR homes, the role of ENERGY STAR certification in new home shopping, perceptions of ENERGY STAR homes, and reactions to recent changes in the program. The study also provides updates of similar surveys conducted in 2002, 2003, 2004, and 2006. The results of this study did not impact the 2011 evaluated results. This study is discussed in more detail in Section III, Study 1.

Massachusetts Residential New Construction Focus Groups with Participant Builders:
This study assessed participating builders' experience with the Program and their reactions to changes made in 2011 and changes which may be forthcoming in 2012. The results of this study did not impact the 2011 evaluated results. This study is discussed in more detail in Section III, Study 2.

Massachusetts Mini Baseline Study of Homes Built at the End of the 2006 IECC Cycle:
This study was conducted in partnership with DOER to assess compliance with basic building code prescriptive path requirements at the end of the 2006 International Energy Conservation Code (IECC) code cycle, provide a preliminary assessment of how current new single-family residential building characteristics compare to current User Defined Reference Home (UDRH) inputs, and conduct audits of energy efficient lighting and appliances within the homes. The study also compared building practices, equipment efficiencies, and other characteristics in custom versus spec built homes. Results from this study reduced the electric savings based on the penetration rates of high efficiency lighting and appliances. This study is discussed in more detail in Section III, Study 3.

Demand Impact Model User Manual:
The Demand Impact Model User Manual was updated to reflect new load shape data, per-unit measure energy savings, and ISO-NE definitions of peak periods. The results of this study were applied to 2011 study results with the overall effect varying by PA. The Company saw a minimal impact in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 9.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The New Construction and Major Renovations program is cost-effective with a BCR of 3.42.

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.

Targeted End-Uses: Space and Water Heating fueled by natural gas.

Delivery Mechanism: The program was administered by each PA 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 PAs. 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: D.P.U. 09-121, Exhibit NG-1.

Table II.A.4: 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	$	8,341,531			14,457,286		73%
Performance Incentive	$	409,545			553,697		35%
Participants	Rebates	22,044			23,790		8%
Program Cost / Participant	$	378			608		61%
Savings & Benefits							
Gas							
Lifetime	therms	27,095,618	27,992,842	3%	25,869,318	-8%	-5%
Annualized	therms	1,534,388	1,707,004	11%	1,389,425	-19%	-9%
Average Measure Life	yrs	18	16	-7%	19	14%	5%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	-	-	0%	20,944,674	0%	0%
Cost-Effectiveness							
TRC Benefits	$	32,962,261			51,952,297		58%
TRC Costs	$	9,977,482			19,367,326		94%
Net Benefits	$	22,984,779			32,584,971		42%
BCR	n/a	3.30			2.68		-19%

There are two main reasons for the variance between planned budget and Preliminary spending.

In 2011, the PAs discontinued the rebates for some of the lower efficiency equipment such as 92% Furnaces, Steam Boilers and Water Heaters 0.62 EF. The Company continued to honor rebates for customers who installed equipment in 2010 but applied for rebates in 2011. A higher than anticipated number of customers applied for rebates, resulting in spending that was not initially planned for.

Additionally, the Company had planned to launch its hard-to-reach initiative in 2011, but experienced delays in defining customers who qualified as hard-to-reach. Equipment rebated under the hard-to-reach initiative had higher net-to-gross ("NTG") ratios than equipment rebated through the regular program (non hard-to-reach), allowing the Company to achieve its savings targets using the planned budget. As a result of the initiative's delayed launch and in order to achieve the planned savings targets, the Company had to rebate more non hard-to-reach equipment than planned to make up for the lack of hard-to-each rebates. The hard-to-reach initiative was successfully launched in 2012.

Evaluated gas savings decreased 19% from preliminary year-end estimates. This decrease is primarily due to the results of the Estimated Net-To-Gross (NTG) Factors for the Massachusetts Program Administrators 2010 Residential New Construction Programs, Residential HEHE and Multi-Family Gas Programs, and C&I Gas Programs which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.

The evaluated Non-Gas Non-Electric benefits are $20,944,674. The non-electric benefit value is due to the results of The Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) study, which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109. The Company previously did not estimate any non-energy benefits for this program.

There are no EM&V studies included in the Annual Report that apply to this program.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The Residential Heating and Water Heating program is cost-effective with a BCR of 2.68.

c. Residential MassSAVE/Weatherization (Home Energy Services)

Purpose/Goal: The purpose of the MassSAVE/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 condo 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 MassSAVE is defined as the number of instant savings measures (faucet aerators and showerheads) installed.

Targeted End-Uses:

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

Delivery Mechanism: The MassSAVE 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 MassSAVE 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 HEAs, and implemented weatherization measures. IICs provided installation of weatherization measures for those customers who received a 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 a HPC or IIC, had to have a quality control inspection performed by the PA-vendor or third-party vendor when the work was completed. This ensured high quality was maintained, and installations met Building Performance Institute standards or similar standards set by the PAs.

After a competitive bidding process, the gas and electric PAs contracted 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 HES members on program successes and identified areas of possible improvement.

The HES members 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: D.P.U. 09-121, Exhibit NG-1.

Table II.A.5: 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	$	2,546,829			3,101,738		22%
Performance Incentive	$	-			-		0%
Participants	Audits	7,000			12,746		82%
Program Cost / Participant	$	364			243		-33%
Savings & Benefits							
Gas							
Lifetime	therms	-	-	0%	-	0%	0%
Annualized	therms	-	-	0%	-	0%	0%
Average Measure Life	yrs	-	-	0%	-	0%	0%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	-	-	0%	-	0%	0%
Cost-Effectiveness							
TRC Benefits	$	-			-		0%
TRC Costs	$	2,546,829			3,101,738		22%
Net Benefits	$	(2,546,829)			(3,101,738)		22%
BCR	n/a	-			-		0%

In April 2010, the Company initiated a program model change, with the integration of the gas weatherization program into the MassSAVE Residential Conservation Services ("RCS") program model.

The RCS program spent 22% more than Planned in 2011. The main reason for this variance is due to the Company performing more audits than planned. Originally, the Company had budgeted and planned for 7,000 audits. By year-end, the Company had performed 12,746 audits, an 82% variance.

There are two main reasons why the Company saw an increase in the number of audits than originally anticipated: (1) the Company collaboration with the City of Boston's Renew Boston Residential Community Outreach Initiative significantly increased the number of audits over what was planned; and (2) audits are now billed to a utility based on heating fuel, which resulted in the local gas companies covering the administrative costs of the audit instead of electric companies in locations where customers heat with gas.

There are no savings or evaluations associated with the gas RCS program. All savings in 2011 are accounted for under the Weatherization Program, discussed below.

Table II.A.6: 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	$	10,777,538			7,293,222		-32%
Performance Incentive	$	268,109			401,676		50%
Participants	Accounts	4,730			4,302		-9%
Program Cost / Participant	$	2,279			1,695		-26%
Savings & Benefits							
Gas							
Lifetime	therms	16,945,225	15,565,503	-8%	18,185,909	17%	7%
Annualized	therms	845,079	758,521	-10%	866,793	14%	3%
Average Measure Life	yrs	20	21	2%	21	2%	5%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	-	-	0%	10,035,772	0%	0%
Cost-Effectiveness							
TRC Benefits	$	20,738,239			32,051,597		55%
TRC Costs	$	13,230,056			10,549,306		-20%
Net Benefits	$	7,508,183			21,502,291		186%
BCR	n/a	1.57			3.04		94%

The variance between planned budget and preliminary spending in 2011 is due to reaching savings goals with fewer dollars than planned. In the Plan, the Company used a deemed savings approach for insulation and air sealing measures. In mid-2011, the Company began using vendor calculated energy savings for measures installed in the program which included savings for domestic hot water measures that were not originally accounted for in the planned targets. As a result of using the vendor's calculated energy savings, the Company achieved, on average, more savings per participant and was able to reach its planned savings targets without spending its planned budget.

Evaluated therm savings increased 14% from preliminary year-end estimates. This increase is due to the results of the NTG evaluation described below.

Evaluated Non-Gas Non-Electric Benefits are $10,035,722. The non-energy benefit value is due to the results of The Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) study, which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109. The Company previously did not estimate any non-energy benefits for this program.

The following EM&V studies included in the Annual Report apply to this program:

Home Energy Services Net-to-Gross Evaluation:
This impact evaluation determined measure-specific and program-level NTG ratios for the HES program. The information was gathered through Customer Self-Reporting and Statistical Market Share Modeling/Discrete Choice. The study determined a total average NTG ratio of 113%, but depending on measure mix, the net effect will vary for each PA. The Company saw a net increase in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 4.

Home Energy Services Packaged Measure Pilot Evaluation:
This study was designed to evaluate a pilot initiative in the HES program that offered program participants a different incentive structure if they implemented a greater number of measures. Study conclusions and recommendations were based on interviews, surveys, and historical data. This study does not affect 2011 results. This study is discussed in more detail in Section III, Study 13.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The Weatherization program is cost-effective with a BCR of 3.04.

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 a residential dwelling unit served under this program.

Targeted End-Uses:

- Lighting
- Heating, Ventilation, and Air Conditioning
- Motors and Drives
- Refrigeration
- Domestic Hot Water
- Building Envelope
- End Use Behavior

Delivery Mechanism: The program was administered cooperatively by the gas and electric PAs. 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: D.P.U. 09-121, Exhibit NG-1.

Table II.A.8: Multifamily 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	$	2,195,691			2,267,876		3%
Performance Incentive	$	119,171			107,104		-10%
Participants	Units	3,213			5,618		75%
Program Cost / Participant	$	683			404		-41%
Savings & Benefits							
Gas							
Lifetime	therms	8,645,490	4,183,529	-52%	3,434,448	-18%	-60%
Annualized	therms	395,199	312,481	-21%	257,573	-18%	-35%
Average Measure Life	yrs	22	13	-39%	13	0%	-39%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	-	3,653,138	0%	5,432,798	49%	0%
Cost-Effectiveness							
TRC Benefits	$	9,675,890			9,556,427		-1%
TRC Costs	$	3,021,724			2,898,481		-4%
Net Benefits	$	6,654,166			6,657,946		0%
BCR	n/a	3.20			3.30		3%

Preliminary lifetime and annual therm savings are 52% and 21% less than planned, respectively. For the plan, the Company used a deemed savings amount per participant to estimate savings for insulation and air sealing measures. The gas Multi-Family Retrofit program is still relatively new, and these deemed savings estimates represented the best information available at the time the Plan was filed. In 2011, the Company accounted for preliminary savings through vendor calculated savings. The vendor calculated savings were lower than the planned estimates, and therefore the main driver of the variance between planned and preliminary savings.

Evaluated therm savings are 18% less than preliminary year-end estimates. This change is due to the results of impact evaluation described below.

Evaluated Non-Gas Non-Electric Benefits are 49% higher than Preliminary year-end estimates. This increase is due to the results of The Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) study, which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.

The following EM&V studies included in the Annual Report apply to this program:

Massachusetts Multifamily Market Characterization and Potential Study:
The primary objective of this market characterization study was to assess the potential energy efficiency savings available in multifamily buildings within Massachusetts. The results of this study did not impact the 2011 evaluated results but is being used to inform ongoing planning and program design. This study is discussed in more detail in Section III, Study 5.

Massachusetts Multifamily Program Process Evaluation:
This study assessed program processes and developed recommendations for program improvement by interviewing program staff, implementation staff, and customers. The results of this study did not impact the 2011 evaluated results but is being used to inform ongoing program design. This study is discussed in more detail in Section III, Study 6.

Massachusetts Multifamily Program Impact Analysis:
The objective of this impact evaluation was to provide program attribution information and a set of savings approaches that could be used by all PAs. These objectives were accomplished by interviewing key stakeholders, developing conclusions, and offering recommendations for future program improvement. 2011 results were negatively affected by the 18% free-ridership number derived from this study. This study is discussed in more detail in Section III, Study 7.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The Multifamily retrofit program is cost-effective with a BCR of 3.30.

e. Behavior/Feedback

Purpose/Goal: The goal of the Behavior/Feedback program was to lower residential customer energy consumption by educating and motivating customers to take energy saving actions and behaviors by providing a home energy report with normative comparisons and recommendations.

Targeted Customers: The program is targeted to residential customers with high energy usage.

Definition of Program Participant: A participant is defined as one residential household.

Targeted End-Uses: The program targeted all residential end-uses through either motivating customers to change their behavior to save energy or to take energy saving actions.

Delivery Mechanism: Participants received information on their household energy consumption compared to similar households through monthly Home Energy Reports and an Energy Insider website. The program was administered independently by National Grid via a third party vendor.

Significant Differences in Actual Program Design from Approved Program Design: The program added 24,000 participants to the planned number of participants.

Docket/Exhibit where the Program is Discussed and Approved: D.P.U. 09-121, Exhibit NG-1.

Table II.A.8: Behavior/Feedback 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	$	2,515,032			2,724,566		8%
Performance Incentive	$	119,171			27,080		-77%
Participants	Accounts	200,000			209,052		5%
Program Cost / Participant	$	13			13		4%
Savings & Benefits							
Gas							
Lifetime	therms	2,524,600	2,354,356	-7%	2,736,827	16%	8%
Annualized	therms	2,524,600	2,354,356	-7%	2,736,827	16%	8%
Average Measure Life	yrs	1	1	0%	1	0%	0%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	-	-	0%	-	0%	0%
Cost-Effectiveness							
TRC Benefits	$	3,311,622			3,590,006		8%
TRC Costs	$	2,541,517			2,751,645		8%
Net Benefits	$	770,105			838,360		9%
BCR	n/a	1.30			1.30		0%

The Behavior/Feedback program did not experience any significant variances between planned and preliminary results.

The evaluated results are 8% higher than planned results and 16% higher than preliminary year-end results. The Evaluated results are higher than Preliminary year-end results due to the impact evaluation described below. The report showed either higher or lower savings and higher or lower baseline consumption depending on the cohort, but overall the evaluated savings were higher.

The following EM&V studies included in the Annual Report apply to this program:

The Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report:
This second formal report of the three-year cycle evaluates the savings impacts of the behavior/feedback programs and pilots. The report also compares savings between opt-in and opt-out behavior programs and identifies savings from participation in other residential programs. The report includes a process evaluation of an opt-in Behavior/Feedback pilot and a demographic analysis of an opt-out program. This evaluation increases the 2011 evaluated results. The study is discussed in more detail in Section III, Study 26.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan.

The Behavior/Feedback program is cost-effective with a BCR of 1.30.

3. Residential Pilot Programs

The following section describes the Company's residential pilot program activities for 2011.

a. Deep Energy Retrofit

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

Targeted Customers and Definition Of Pilot Program Participants:

- Home owners, property owners, and property managers considering renovations and willing to invest in extensive carbon reductions
- Advanced Remodelers and Builder Remodelers
- Architects
- Designers
- Trade allies
- Others involved in renovation or restoration of residential buildings

Targeted End-Uses: To dramatically reduce the amount of energy used in existing residences consisting of:

- Advanced building shell
- High-performance lighting
- High-efficiency heating and cooling systems
- Advanced controls
- High-efficiency appliances and products
- Advanced energy use feedback and monitoring technology
- Mechanical ventilation
- Solar photovoltaic systems
- Solar thermal systems

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

Any Significant Differences In Actual Pilot Program Design From Approved Pilot Program Design: No significant differences in the actual pilot program design from the approved pilot program design.

How The Program Administrator Measured Achievement Of The Pilot Program's Stated Goal: Final evaluation and Building America Test Program in process.

Identify the Department docket (and exhibit within the docket) where the pilot program is discussed and approved: D.P.U. 09-121, Exhibit NG-1.

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	$	864,416	559,970	-35%	559,970	0%	-35%
Participants	TBD	27	7	-74%	7	0%	-74%
Program Cost / Participant	$	32,015	79,996	150%	79,996	0%	150%
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annualized	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							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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	n/a	n/a	n/a
TRC Costs	$	864,416	559,970	-35%	559,970	0%	-35%
Net Benefits	$	n/a	n/a	n/a	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a	n/a	n/a	n/a

In 2011, the pilot program participation was 74% lower than planned and program spending was 35% lower than planned. This is due to the significant upfront cost of participating in the pilot combined with the long average project duration. This in turn drove up the cost per participant.

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

b. Residential Building Practices and Demonstration Program

Description of Pilot/Specific Activities Intended to Study: The goal of the Residential Building Practices and Demonstration Program is to participate in funding for demonstration projects that apply to new or underutilized technologies. New and emerging technologies were reviewed for their potential cost effectiveness for inclusion in future energy efficiency programs. Specific technologies which have been implemented were Solar Thermal heating systems and Programmable Controllable Thermostats (PCT). A program design and evaluation plan was created for Boiler Load Controls (BLC)

Targeted Customers and Definition Of Pilot Program Participants:

- Residential customers who use natural gas as their primary heating source, specifically:
  - The PCT Pilot selected towns for residential customer participation
  - The Solar Thermal customers completed applications and qualified by installing equipment that met a program minimum equipment qualification
  - The BLC Pilot was designed for residential customers who have a non-condensing boiler

Targeted End-Uses:

- Residential natural gas heating equipment
- Advanced building shell

Delivery Mechanism: Solar Thermal was installed by contractors chosen by the customer. The systems have met specific minimum criteria requirements to receive a rebate. The rebates were issued by a third party contractor. A third party evaluation contractor is evaluating the savings levels being achieved by doing a billing analysis comparison from previous years.

PCT units were installed by a third party contractor. The systems needed to have natural gas as a primary heating source. A third party evaluation contractor is being used to evaluate the product.

BLC units are being marketed to customers within a specific geographic area to minimize installation costs. Customers sign up through a web portal by answering some questions. Customers are then selected on criteria that will allow us to evaluate the participant as an average customer in the service area based on home square footage and gas usage. A third party evaluation contractor was identified to perform the evaluation of the product.

Any Significant Differences In Actual Pilot Program Design From Approved Pilot Program Design: There were no significant differences in the actual pilot design from approved pilot design.

How The Program Administrator Measured Achievement Of The Pilot Program's Stated Goal: The Solar Thermal pilot is determining the types of applications that will allow solar thermal to be cost effective. National Grid will be able to determine what type of installations can be pursued for future installations that will be cost effective. Evaluation results will define the stated goal.

The PCT pilot is determining whether customers will interact with controllable thermostats and use the enhanced options that will result in increased gas savings. The results will determine if a greater percentage of customers utilize the programmable option. Evaluation results will determine if National Grid has met its goal.

The BLC pilot has the potential to provide better control and more efficient equipment operation for most non condensing boilers. The evaluation and customer satisfaction results will provide confirmation that the stated objective of providing gas savings is being met.

Identify the Department docket (and exhibit within the docket) where the pilot program is discussed and approved: D.P.U. 09-121, Exhibit NG-1.

Table II.A.10: Residential Building Practices and Demonstration 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	$	258,868	55,054	-79%	55,054	0%	-79%
Participants	TBD	75	59	-21%	59	0%	-21%
Program Cost / Participant	$	3,452	933	-73%	933	0%	-73%
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annualized	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							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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	n/a	n/a	n/a
TRC Costs	$	258,868	55,054	-79%	55,054	0%	-79%
Net Benefits	$	n/a	n/a	n/a	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a	n/a	n/a	n/a

During the course of 2011, the Company had below average participation in the pilot. National Grid had projected participation of 75 participants and only achieved 59 participants. The lack of participation is due mainly to the shortfall in participation levels in the Company's Solar Thermal Hot Water pilot due to the strict requirements the program had enacted to insure quality installations and contractors deviating from matched OG-300 solar systems. In addition, the Company had funds available for several new emerging technologies that were planned but were never implemented or marketed in 2011 due to readiness of the technology. Installations were completed for PCTs and 59 unique participants were enrolled.

Spending was 79% lower than planned, which is largely due to the pilots that did not launch in 2011. These pilots will be implemented and reach the market in 2012.

The following EM&V studies included in the Annual Report apply to this pilot:

Solar Hot Water Pilot Program Evaluation:

This technical evaluation of Solar Hot Water (SHW) installations was designed to quantify savings for SHW installations in Massachusetts. Savings estimates were determined based on billing data, customer surveys, site visits, and engineering reviews. The results of this study did not impact the 2011 program results, as no savings for these measures were claimed in 2011. This study is discussed in more detail in Section III, Study 15.

The pilot's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the pilot in the next three-year plan for 2013-2015. Changes to this pilot are not currently expected to result in a mid-term modification for the remainder of the current three-year plan.

c. Energy Analysis: Internet Audit Program

Description of Pilot/Specific Activities Intended to Study: The goal of the Internet Audit Program is to educate customers on how their energy usage compares to similar residential customers.

Targeted Customers and Definition Of Pilot Program Participants: All residential gas customers in Massachusetts.

Targeted End-Uses: All household end uses and shell measures.

Delivery Mechanism: Free online energy analysis service that makes customized energy efficiency recommendations based on a customer's energy consumption profile.

Any Significant Differences In Actual Pilot Program Design From Approved Pilot Program Design: No significant differences in the actual pilot program design from the approved pilot program design.

Docket Number And Exhibit Where Program Is Discussed And Approved: D.P.U. 09-121, Exhibit NG-1.

Table II.A.11: Energy Analysis: Internet Audit 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	$	316,876			203,081		-36%
Participants	TBD	11,830			11,830		0%
Program Cost / Participant	$	27			17		-36%
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annualized	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							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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	$	316,876			203,081		-36%
Net Benefits	$	n/a			n/a		n/a
BCR	n/a	n/a			n/a		n/a

The Company spent 36% less than anticipated.

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

The pilot's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the pilot in the next three-year plan for 2013-2015. Changes to

this pilot are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this pilot in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

d. Community-Based Pilots

Description of Pilot/Specific Activities Intended to Study: The term "Community-Based Pilots" encompassed a number of unique partnerships in 2011 between the PAs and local communities designed to harness the power of community-based outreach to achieve broader participation in the Commonwealth's energy efficiency programs. National Grid's Community Mobilization Initiatives included efforts in three locations – Chinatown, Chelsea and Lynn, MA.

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

Targeted Customers: The PAs 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 60 and 120% of median household income in their community.

Definition of Pilot Program Participant: Any residential customer who participated in the MassSAVE HES program in the three pilot locations would have been considered a pilot participant.

Targeted End-Uses: The end-uses targeted by the community based pilots included the same end-uses addressed under the Company's existing MassSAVE HES program.

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: As stated in the 2010 annual report, the CMI pilots were designed to include the Direct Install Program, but after months of negotiation, the measure installation pricing submitted by the sub-contractor was still 3-6 times higher than existing prices on the electric side, so Direct Install was removed from the pilot. The CMIs proceeded on a residential basis only.

How Achievement of the Pilot's Stated Goal was Measured: A multi-year evaluation of community based pilots was conducted to assess the effectiveness of these pilots and determine their potential for replication. This process evaluation is included with this Annual Report as Appendix C, Study 30.

Docket/Exhibit where the Program is Discussed and Approved: D.P.U. 09-116, Exhibit NG-1.

Table II.A.12: Community Based Pilots							
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	$	147,916			155,650		5%
Participants	TBD	104			51		-51%
Program Cost / Participant	$	1,422			-		-100%
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annualized	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							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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	$	147,916			155,650		5%
Net Benefits	$	n/a			n/a		n/a
BCR	n/a	n/a			n/a		n/a

The Gas Community Based Pilot spend was 5% more than planned in 2011. Administrative, Evaluation and Marketing fees were higher than anticipated with three gas CMIs taking place in 2011 in Chinatown, Chelsea and Lynn. The incentive budget used for the Davis-Bacon weatherization differential was lower than anticipated since much of the CMI weatherization work started in 2010 and was ultimately completed in 2012.

In 2011, the Community Based Pilots facilitated a total of 51 projects including 42 single-family weatherization jobs and 9 projects at multifamily facilities. The intended plan for the Community Based Pilots was to conduct 50 single family weatherization jobs and projects at 4 multifamily facilities over the duration of the pilot.

The following EM&V studies included in the Annual Report apply to this pilot:

Community-Based Partnerships 2011 Evaluation Final Report:

The evaluation of community-based partnerships was intended to assess the effectiveness of such partnerships and determine the potential for replication and/or full-scale implementation of this type of pilot. The report builds upon an interim report issued in 2011 and presents the findings of the evaluation research conducted to date. This evaluation had no impact on the 2011 evaluated results. The study is discussed in more detail in Section III, Study 30.

The pilot's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the pilot in the next three-year plan for 2013-2015. Changes to this pilot are not currently expected to result in a mid-term modification for the remainder of the current three-year plan.

B. Low-Income Sector Programs

1. Summary

During 2011 the Company implemented the following low-income programs[3]:

- Low-Income MultiFamily Retrofit
- Low-Income Multi-Family Retrofit

Tables II.B.1 and II.B.2 provide summary information on the performance of the low-income programs at the sector and program levels, respectively. Section II.B.2 provides detailed information on the performance of each low-income program.

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	$	15,045,041			11,272,187		-25%
Performance Incentive	$	360,709			505,461		40%
Savings & Benefits							
Gas							
Lifetime	therms	9,451,088	11,211,619	19%	14,829,919	32%	57%
Annualized	therms	496,203	629,018	27%	809,933	29%	63%
Electric							
Annualized Energy	kWh	167,970	177,178	5%	474,548	168%	183%
Annualized Demand							
Summer	kW	1	1	6%	54	7978%	8430%
Winter	kW	21	22	6%	93	317%	340%
Non-Gas Non-Electric Resources (Lifetime)	$	12,885,608	17,532,263	36%	13,899,409	-21%	8%
Cost-Effectiveness							
TRC Benefits	$	24,011,468			32,876,356		37%
TRC Costs	$	15,020,452			11,777,648		-22%
Net Benefits	$	8,991,016			21,098,708		135%
BCR	n/a	1.60			2.79		75%

In 2011, the Low-Income gas programs spent 75% of the planned budget while achieving 157% of the planned lifetime savings. Both programs had a significant variance by under spending Total Program Costs.

3 The Company did not offer any pilot programs in the low-income sector during 2011.

Table II.B.2: Low-Income Program Summary				
Program / Performance Category	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
Low-Income Single Family Retrofit				
TRC Benefits	$	16,769,331	17,079,685	2%
TRC Costs	$	9,430,954	6,931,955	-26%
Net Benefits	$	7,338,377	10,147,730	38%
BCR	n/a	1.78	2.46	39%
Low-Income MuiltiFamily Retrofit				
TRC Benefits	$	7,242,137	15,796,671	118%
TRC Costs	$	5,589,498	4,498,829	-20%
Net Benefits	$	1,652,639	11,297,842	584%
BCR	n/a	1.30	3.51	171%
TOTAL				
TRC Benefits	$	24,011,468	32,876,356	37%
TRC Costs	$	15,020,452	11,777,648	-22%
Net Benefits	$	8,991,016	21,098,708	135%
BCR	n/a	1.60	2.79	75%

Low-Income Sector Performance Highlights

During 2011, the PAs continued to leverage all applicable revenue streams available and built on the current Department of Housing and Community Development low-income energy efficiency program to deepen efficiency penetration consistent with a comprehensive, whole house/building approach. The program was able to leverage American Recovery and Reinvestment Act ("ARRA") funds slated for Public Housing Authority heating system replacements by providing minimal co-payments toward upgrades. This allowed PAs to not only achieve significant savings at a lower cost, but also enabled ARRA funding to stretch further with the replacement of more units. Some of the PAs were close to their goal in terms of therm/kWh savings as well as spending. However, some PAs were notably under in production and spending as a result of the extensive use of available ARRA funding instead of PA funds. Additionally, spending was affected by the composition of customers in each PA's service area, particularly the proportion of low-income customers in the territory.

2. Low-Income Programs

a. Low-Income Single-Family Retrofit

Purpose/Goal: The purpose of the Low-Income Single-Family Retrofit program 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.

Targeted Customers: This program targeted residential gas customers living in one- to four-unit dwellings who are at or below 60% of the state median income level and who are qualified to receive fuel assistance and/or utility-discounted rates. For two- to four- unit dwellings, 50% of the occupants must qualify as low-income.

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

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"). 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: D.P.U. 09-121, Exhibit NG-1.

Table II.B.3: Low-Income Single 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	$	9,180,197			6,681,069		-27%
Performance Incentive	$	250,747			250,886		0%
Participants	Jobs	1,505			1,633		9%
Program Cost / Participant	$	6,100			4,091		-33%
Savings & Benefits							
Gas							
Lifetime	therms	3,848,980	4,322,320	12%	7,940,620	84%	106%
Annualized	therms	198,610	216,116	9%	397,031	84%	100%
Average Measure Life	yrs	19	20	3%	20	0%	3%
Electric							
Annualized Energy	kWh	167,970	177,178	5%	474,548	168%	183%
Annualized Demand							
Summer	kW	1	1	6%	54	7978%	8430%
Winter	kW	21	22	6%	93	317%	340%
Non-Gas Non-Electric Resources (Lifetime)	$	11,743,114	12,768,966	9%	6,272,938	-51%	-47%
Cost-Effectiveness							
TRC Benefits	$	16,769,331			17,079,685		2%
TRC Costs	$	9,430,954			6,931,955		-26%
Net Benefits	$	7,338,377			10,147,730		38%
BCR	n/a	1.78			2.46		39%

Total Program Costs were 27% lower than planned. The variance is due to under-spending in non-incentive cost categories such as Program Planning & Administration, Marketing & Advertising and Evaluation. Budgeting assumptions for these cost categories were revised in the Company's 2012 MTM to reflect the information learned in the 2011 program year.

Evaluated therm savings are 84% higher than preliminary year-end estimates, evaluated electric savings are 168% higher than preliminary and summer and winter kW savings are 7,978% and 317% higher than preliminary. These increases are due to the combined effects of the impact evaluations described below. It should be noted that the electric savings presented here are unique to any electric savings presented in the Low-Income Single Family Retrofit program in the 2011 Electric Energy Efficiency Annual Report.

Evaluated Non-Gas Non-Electric Benefits are 51% lower than preliminary year-end estimates. This decrease is primarily due to the results of The Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) study, which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.

The following EM&V studies included in the Annual Report apply to this program:

Massachusetts 2011 Low Income Program Process Evaluation:
This study assessed program processes with a particular focus on identifying similarities and differences in the perspectives and assumptions of program staff, implementation staff, and customers regarding program goals, design and implementation across the PAs. The study produced recommended improvements for process-related issues, identified areas where the program changed in 2011, and followed up on topics initially researched in 2010. This evaluation has no impact on 2011 evaluated results. This study is discussed in more detail in Section III, Study 16.

Low Income Single Family Program Impact Evaluation:
This impact evaluation quantified the gross per-unit savings generated by each Low Income measure. The results of this study were applied to 2011 program results and were determined by utilizing both billing and engineering analyses. The impact of this study varied for each PA based on planning assumptions and measure mix. The 2011 evaluated results had a net increase for the Company due to this study. This study is discussed in more detail in Section III, Study 17.

Additional Non-Energy Impacts for Low Income Programs:
This additional research clarified and expanded the research performed in the Residential and Low-Income Non-Energy Impacts Evaluation. Values were updated for certain additional Non-Energy Impacts. Savings were not impacted by this research; however, there was a net increase to benefits for the Company. The additional research is discussed in more detail in Section III, Study 28.

Demand Impact Model User Manual:
The Demand Impact Model User Manual was updated to reflect new load shape data, per-unit measure energy savings, and ISO-NE definitions of peak periods. The results of this study were applied to 2011 study results with the overall effect varying by PA. The Company saw a net increase in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 9.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The Low-Income Single-Family retrofit program is cost-effective with a BCR of 2.46.

b. Low-Income Multi-Family Retrofit

Purpose/Goal: The purpose of the Low-Income Multi-Family Retrofit program 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 program targeted public housing authorities, non-profit housing developers, landlords, property managers, and residential customers at, or below, 60% of median income living in multi-family properties consisting of five or more units.

Definition of Program Participant: Depending on the PA, a participant is considered either a dwelling unit or a unique gas account number served in a facility with five or more units.

Targeted End-Uses:
- Heating
- Hot water
- Envelope

Delivery Mechanism: The PAs used a lead vendor and/or worked closely with their respective CAP agencies on all aspects of the program design and implementation. All PAs worked in conjunction with 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, as well as 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: D.P.U. 09-121, Exhibit NG-1.

Table III.B.4: Low-Income MultiFamily 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	$	5,479,531			4,244,253		-23%
Performance Incentive	$	109,962			254,575		132%
Participants	Units	1,558			2,370		52%
Program Cost / Participant	$	3,517			1,791		-49%
Savings & Benefits							
Gas							
Lifetime	therms	5,602,108	6,889,299	23%	6,889,299	0%	23%
Annualized	therms	297,593	412,902	39%	412,902	0%	39%
Average Measure Life	yrs	19	17	-11%	17	0%	-11%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	1,142,494	4,763,297	317%	7,626,471	60%	568%
Cost-Effectiveness							
TRC Benefits	$	7,242,137			15,796,671		118%
TRC Costs	$	5,589,498			4,498,829		-20%
Net Benefits	$	1,652,639			11,297,842		584%
BCR	n/a	1.30			3.51		171%

The Company spent 23% less than planned for this program. The variance between planned and evaluated costs is due to a change in the types of measures that the Company rebated. The majority of planned savings were attributed to insulation and air sealing measures. However, in 2011, the Company worked with LEAN to leverage ARRA dollars in order to offer heating systems, which were not initially accounted for in the plan in terms of savings or budget. Savings from these heating systems accounted for 18% of preliminary annual therm savings. The Company paid $500 per heating system, which represented a portion of the total cost of the heating system. The rest of the cost of the system was funded by ARRA dollars. Therefore, the Company was able to achieve its planned savings without using its total planned program cost due to the subsidization of these heating systems.

Evaluated therm savings are the same as preliminary year-end estimates.

Evaluated Non-Gas Non-Electric Benefits are 60% higher than preliminary year-end estimates. This increase is primarily due to the results of The Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) study, which was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.

The following EM&V studies included in the Annual Report apply to this program:

Massachusetts Multifamily Market Characterization and Potential Study:
The primary objective of this market characterization study was to assess the potential energy efficiency savings available in multifamily buildings within Massachusetts. The results of this study did not impact the 2011 evaluated results but is being used to inform ongoing planning and program design. This study is discussed in more detail in Section III, Study 5.

Massachusetts 2011 Low Income Program Process Evaluation:
This study assessed program processes with a particular focus on identifying similarities and differences in the perspectives and assumptions of program staff, implementation staff, and customers regarding program goals, design and implementation across the PAs. The study produced recommended improvements for process-related issues, identified areas where the program changed in 2011, and followed up on topics initially researched in 2010. This evaluation has no impact on 2011 evaluated results. This study is discussed in more detail in Section III, Study 16.

Additional Non-Energy Impacts for Low Income Program:
This additional research clarified and expanded the research performed in the Residential and Low-Income Non-Energy Impacts Evaluation. Values were updated for certain additional Non-Energy Impacts. Savings were not impacted by this research; however, there was a net increase to benefits for the Company. The additional research is discussed in more detail in Section III, Study 28.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The Low-Income Multifamily retrofit program is cost-effective with a BCR of 3.51.

C. Commercial & Industrial Sector Programs

1. Summary

During 2011 the Company implemented the following C&I programs and C&I pilots:

C&I Programs:

- C&I New Construction and Major Renovation
- C&I Retrofit
- C&I Direct Install

C&I Pilot Programs:

- Deep Energy Retrofit

Tables II.C.1 and II.C.2 provide summary information on the performance of the C&I programs at the sector and program levels respectively. Section III.B.2 and III.B.3 provide detailed information on the performance of each C&I program.

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	$	17,636,649			15,587,883		-12%
Performance Incentive	$	977,072			607,231		-38%
Savings & Benefits							
Gas							
Lifetime	therms	73,998,304	82,772,191	12%	51,370,419	-38%	-31%
Annualized	therms	5,283,894	5,645,658	7%	3,582,634	-37%	-32%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	3,423,748	7,112,327	108%	6,846,967	-4%	100%
Cost-Effectiveness							
TRC Benefits	$	84,843,126			62,248,851		-27%
TRC Costs	$	44,406,788			36,417,141		-18%
Net Benefits	$	40,436,338			25,831,710		-36%
BCR	n/a	1.91			1.71		-11%

Table II.C.2: C&I Program Summary				
Program / Performance Category	Units	Planned Value	Evaluated Results	
			Value	% Change from Planned
C&I New Construction & Major Renovation				
TRC Benefits	$	27,240,950	26,719,435	-2%
TRC Costs	$	11,167,623	14,884,053	33%
Net Benefits	$	16,073,327	11,835,382	-26%
BCR	n/a	2.44	1.80	-26%
C&I Retrofit				
TRC Benefits	$	53,979,609	30,754,695	-43%
TRC Costs	$	32,638,294	20,372,345	-38%
Net Benefits	$	21,341,315	10,382,350	-51%
BCR	n/a	1.65	1.51	-9%
C&I Direct Install				
TRC Benefits	$	3,622,567	4,774,720	32%
TRC Costs	$	600,871	484,444	-19%
Net Benefits	$	3,021,696	4,290,276	42%
BCR	n/a	6.03	9.86	63%
Workforce Development				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	20,000	5,776	-71%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
Business Energy Analyzer				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	234,495	86,678	-63%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
Deep Energy Retrofit				
TRC Benefits	$	n/a	n/a	n/a
TRC Costs	$	350,318	39,149	-89%
Net Benefits	$	n/a	n/a	n/a
BCR	n/a	n/a	n/a	n/a
TOTAL				
TRC Benefits	$	84,843,126	62,248,851	-27%
TRC Costs	$	44,406,788	36,417,141	-18%
Net Benefits	$	40,436,338	25,831,710	-36%
BCR	n/a	1.91	1.71	-11%

C&I Sector Performance Highlights

During 2011, the Company built upon existing C&I programs and significantly expanded initiatives to increase participation in all C&I programs. Building on the transition which took place in 2010, gas and electric integration continued to grow and run smoothly as the gas and electric PAs became more comfortable identifying leads and sharing them with their counterparts in the same service territory. Innovative agreements with large C&I customers, which focus on long-term energy savings, continued to expand across the Commonwealth and were adopted by a greater number of customers.

Responding to the maturity of the Large Retrofit program, the PAs began to adopt a new strategy which focused on specific niche sectors of customers and offered an expanded variety of cost-effective solutions. Many of these solutions involved deeper measures that, in addition to energy savings, provided additional customer benefits.

As higher energy costs generally motivate customers to invest in energy conservation, 2011 proved to be a challenging year given the relatively low cost of gas. Customer acquisition under these circumstances was, therefore, more costly, although the PAs worked diligently to serve more customers and acquire more therms savings than in 2010.

In response to customer acquisition concerns, specifically for large, time sensitive capital gas projects unique to the New Construction & Major Renovation program, the PAs agreed to support a community initiative in the cities of Northampton and Pittsfield. The purpose of this initiative is to test the hypothesis that cities building on relationships with their constituents could, with the assistance of a customer concierge service, help the PAs identify more comprehensive gas energy efficiency projects. This year-long initiative, rolled out in August of 2011, was designed with specific metrics and will undergo an evaluation by the PAs to determine its effectiveness in meeting its objectives.

Building on the integration of gas into the electric Small Retrofit program in 2010, the PAs realized increased savings and participation in this program as vendors became more comfortable identifying and installing both electric and gas 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 PAs 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 – 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.

Targeted End-Uses: End uses targeted by the program included:

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

Delivery Mechanism: The PAs worked together to market and implement the program as a uniform 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: D.P.U. 09-121, Exhibit NG-1.

Table II.C.3 C&I 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	$	5,988,576			6,411,825		7%
Performance Incentive	$	325,383			242,486		-25%
Participants	Accounts	1,582			565		-64%
Program Cost / Participant	$	3,785			11,348		200%
Savings & Benefits							
Gas							
Lifetime	therms	25,131,372	39,442,138	57%	24,861,870	-37%	-1%
Annualized	therms	1,340,722	1,989,793	48%	1,242,383	-38%	-7%
Average Measure Life	yrs	19	20	6%	20	1%	7%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	-	-	0%	-	0%	0%
Cost-Effectiveness							
TRC Benefits	$	27,240,950			26,719,435		-2%
TRC Costs	$	11,167,623			14,884,053		33%
Net Benefits	$	16,073,327			11,835,382		-26%
BCR	n/a	2.44			1.80		-26%

Total program costs were slightly higher than anticipated and costs per participant were significantly higher than anticipated, since there were substantially fewer participants than planned.

Preliminary year-end lifetime gas savings were 57% higher than planned results due to the fact that more savings were brought in through fewer custom new construction projects than anticipated.

Conversely, evaluated savings decreased from preliminary year-end estimates by 37% for lifetime results due to the application of the evaluation results of impact studies described below. Evaluated savings were only slightly different than planned values, since the increase due to the savings per project was offset by the decrease due to evaluation results.

The following EM&V studies included in the Annual Report apply to this program:

Massachusetts Large Commercial & Industrial Process Evaluation:
The study examines key process topics identified by the EEAC, PAs and the DOER including how to improve integration and coordination, concerns about the adequacy of staffing levels, how to achieve deeper savings, whether medium-sized C&I customers are being adequately served by the programs, the adequacy of program tracking databases, and program satisfaction. The results of this study did not impact the 2011 evaluated results. The study is discussed in more detail in Section III, Study 22.

HVAC Market Characterization and Penetration Analysis:
This study estimates the market penetration of energy-efficient equipment in the Massachusetts commercial HVAC market, gauges the level of large C&I program influence on market penetration, and characterizes the market for emergency replacement. The results of this study did not impact the 2011 evaluated results. The study is discussed in more detail in Section III, Study 23.

Prescriptive Gas Final Program Evaluation Report:
This study produced retrospective and prospective estimates of annual therm savings for those prescriptive gas projects in the condensing boiler, condensing furnace, infrared heating and indirect water heating measure categories. The net effect on each PA's program is dependent on the difference between the new savings estimate and the previous savings estimate incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to increase energy savings for this program. The study is discussed in more detail in Section III, Study 24.

Impact Evaluation of 2010 Custom Gas Projects:
This study produced realization rates for annual therms for custom gas projects. The net effect on each PA's program is dependent on the difference between the new realization rate and the previous realization rate incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to slightly decrease energy savings for this program. The study is discussed in more detail in Section III, Study 25.

C&I Gas Net-to-Gross Study, 2011 Projects:
This study quantified the net impacts of the commercial and industrial natural gas programs by estimating the extent of free-ridership and spillover. As results were PA-specific, the results of this study on the program differed for each PA. For the Company, the study increased savings overall. The study is discussed in more detail in Section III, Study 29.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan.

The C&I New Construction & Major Renovation program is cost-effective with a BCR of 1.80.

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.

Targeted End-Uses:

- Lighting
- Motors and Drives
- HVAC
- Compressed Air and Processes
- Envelope
- Water Heating

Delivery Mechanism: PA 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: D.P.U. 09-121, Exhibit NG-1.

Table II.C.4 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	$	10,032,640			8,146,439		-19%
Performance Incentive	$	566,776			254,957		-55%
Participants	Accounts	1,139			1,244		9%
Program Cost / Participant	$	8,808			6,549		-26%
Savings & Benefits							
Gas							
Lifetime	therms	47,515,581	41,176,553	-13%	24,611,315	-40%	-48%
Annualized	therms	3,692,922	3,388,603	-8%	2,104,792	-38%	-43%
Average Measure Life	yrs	13	12	-6%	12	-4%	-9%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	1,125,175	4,545,922	304%	4,004,958	-12%	256%
Cost-Effectiveness							
TRC Benefits	$	53,979,609			30,754,695		-43%
TRC Costs	$	32,638,294			20,372,345		-38%
Net Benefits	$	21,341,315			10,382,350		-51%
BCR	n/a	1.65			1.51		-9%

Total program costs were significantly lower than anticipated, as were costs per participant, while there were 9% more participants than the planning estimate.

Preliminary year-end lifetime therm savings were 13% lower than planned results. This is due to a shortfall in the average retrofit project savings in relation to the planning estimate.

Evaluated savings decreased from preliminary year-end estimates by 40% for lifetime results due to the application of evaluation results of impact studies described below. Evaluated savings were substantially different than planned values, and represented a 48% reduction in therm savings values.

Non-Gas Non-Electric Resources are substantially higher than planned due to a much larger number of spray valves being installed than anticipated, resulting in higher water and sewer savings.

The following EM&V studies included in the Annual Report apply to this program:

Massachusetts Large Commercial & Industrial Process Evaluation:
The study examines key process topics identified by the EEAC, PAs and the DOER including how to improve integration and coordination, concerns about the adequacy of staffing levels, how to achieve deeper savings, whether medium-sized C&I customers are being adequately served by the programs, the adequacy of program tracking databases, and program satisfaction. The results of this study did not impact the 2011 evaluated results. The study is discussed in more detail in Section III, Study 22.

HVAC Market Characterization and Penetration Analysis:
This study estimates the market penetration of energy-efficient equipment in the Massachusetts commercial HVAC market, gauges the level of large C&I program influence on market penetration, and characterizes the market for emergency replacement. The results of this study did not impact the 2011 evaluated results. The study is discussed in more detail in Section III, Study 23.

Prescriptive Gas Final Program Evaluation Report:
This study produced retrospective and prospective estimates of annual therm savings for those prescriptive gas projects in the condensing boiler, condensing furnace, infrared heating and indirect water heating measure categories. The net effect on each PA's program is dependent on the difference between the new savings estimate and the previous savings estimate incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to increase energy savings for this program. The study is discussed in more detail in Section III, Study 24.

Impact Evaluation of 2010 Custom Gas Projects:
This study produced realization rates for annual therms for custom gas projects. The net effect on each PA's program is dependent on the difference between the new realization rate and the previous realization rate incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to slightly decrease energy savings for this program. The study is discussed in more detail in Section III, Study 25.

C&I Gas Net-to-Gross Study, 2011 Projects:
This study quantified the net impacts of the commercial and industrial natural gas programs by estimating the extent of free-ridership and spillover. As results were PA-specific, the results of this study on the program differed for each PA. For the Company, the study increased savings overall. The study is discussed in more detail in Section III, Study 29.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the remainder of the current three-year plan.

The C&I Retrofit program is cost-effective with a BCR of 1.51.

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.

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 PAs on a regular basis.

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

Docket/Exhibit where Program is Discussed and Approved: D.P.U. 09-121, Exhibit NG-1.

Table II.C.5 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	$	515,954			353,320		-32%
Performance Incentive	$	84,913			109,788		29%
Participants	Accounts	845			613		-27%
Program Cost / Participant	$	611			576		-6%
Savings & Benefits							
Gas							
Lifetime	therms	1,351,350	2,153,500	59%	1,897,233	-12%	40%
Annualized	therms	250,250	267,263	7%	235,459	-12%	-6%
Average Measure Life	yrs	5	8	49%	8	0%	49%
Electric							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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)	$	2,298,573	2,566,404	12%	2,842,009	11%	24%
Cost-Effectiveness							
TRC Benefits	$	3,622,567			4,774,720		32%
TRC Costs	$	600,871			484,444		-19%
Net Benefits	$	3,021,696			4,290,276		42%
BCR	n/a	6.03			9.86		63%

Preliminary year-end lifetime gas savings (therms) were 59% higher than planned values. Due to the gas Direct Install program being relatively new in 2011, the Company planned conservatively. The majority of planned savings came from just two measures: spray valves and thermostats. Preliminary results show that the Company achieved savings through a different measure mix than originally planned. In addition to spray valves and thermostats, the Company installed a significant amount of pipe insulation, faucet aerators and some boiler resets. The installation of these additional measures is the main driver of the variance between planned and preliminary values.

Total program costs were significantly lower than anticipated, as were costs per participant, while there were 27% fewer participants than the planning estimate.

Evaluated savings decreased from preliminary year-end estimates by 12% for lifetime results due to the application of evaluation results of impact studies described below. Evaluated savings were substantially different than planned values, and represented a 40% increase in savings values.

The following EM&V studies included in the Annual Report apply to this program:

C&I Gas Net-to-Gross Study, 2011 Projects:
This study quantified the net impacts of the commercial and industrial natural gas programs by estimating the extent of free-ridership and spillover. As results were PA-specific, the results of this study on the program differed for each PA. For the Company, the study increased savings. The study is discussed in more detail in Section III, Study 29.

The program's performance and the results of the impact evaluations described above will be used to adjust the planning estimates for the program in the next three-year plan for 2013-2015. Changes to this program are not currently expected to result in a mid-term modification for the

remainder of the current three-year plan. A mid-term modification was submitted for this program in the Company's 2012 Mid-Term Modification filed with the Department on October 28, 2011 in Boston Gas Company and Colonial Gas Company d/b/a National Grid's Proposed 2012 Mid-Term Modifications, D.P.U. 11-109.

The C&I Direct Install program is cost-effective with a BCR of 9.86.

3. C&I Pilots

The following section describes the Company's C&I pilot program activities for 2011:

a. Deep Energy Retrofit

Description of Pilot/Specific Activities Intended to Study: The Deep Energy Retrofit pilot was implemented to investigate the potential for energy savings of at least 50% of total on-site energy use through deep retrofits of existing commercial buildings and to identify 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 PAs to study a new approach to achieving energy savings. The PAs analyze the information gathered from the pilot to determine market viability, cost-effectiveness, and, if applicable, adoption rates. Following completion of the pilot, the PAs 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 commercial customers 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 Pilot Program Participant: A participant is defined as a commercial building with a target of 50% reduction in energy usage.

Targeted End-Uses:
- HVAC
- Envelope
- Process
- End-Use Behavior

Delivery Mechanism: Project design details and assistance were provided to the Deep Energy Retrofit contractors performing the work. The projects were handled through technical contractors and/or utilizing ARRA 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 prohibitive costs and project complexities are barriers to deep energy retrofit participation. Ultimately, achievement of this goal is measured by the pilot's cost-effectiveness. It was determined that this pilot is not cost-effective and therefore is no longer being offered in 2012.

Docket/Exhibit where the Program is Discussed and Approved: D.P.U. 09-121, Exhibit NG-1.

Table II.C.8: 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	$	350,318			39,149		-89%
Participants	TBD	1			-		-100%
Program Cost / Participant	$	350,318			-		-100%
Savings & Benefits							
Gas							
Lifetime	therms	n/a	n/a	n/a	n/a	n/a	n/a
Annualized	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							
Annualized Energy	kWh	n/a	n/a	n/a	n/a	n/a	n/a
Annualized 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	$	350,318			39,149		-89%
Net Benefits	$	n/a			n/a		n/a
BCR	n/a	n/a			n/a		n/a

National Grid was unable to find projects to participate in the C&I multifamily DER pilot. Large multifamily project frequently have a 3-5 year lead time. In order to participate in the DER pilot, it is critical that National Grid's building science technical support is involved in the design phase of the project, which meant that no potential project would be complete within the DER pilot three year duration. This pilot was limited to commercial master metered gas heat projects. This requirement also acted as a limitation. Many multifamily projects contain a mix of residential and commercial meters for different areas and end-uses within the project.

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

D. Hard to Measure Initiatives

The Hard to Measure initiatives, which are key components of the program such as marketing and education, do not lend themselves to direct allocations to specific savings estimates but do incur costs. The initiatives include:

- Low Income Energy Affordability Network
- C&I Workforce Development
- Statewide Marketing & Education
- Energy Analysis: Internet Audit Program
- Business Energy Analyzer
- EEAC Consultants
- DOER Assessments
- Sponsorships and Subscriptions

The costs for these initiatives are located in Table II.A.2 for residential programs; Table II.B.2 for low-income programs and Table II.C.2 for C&I programs.

III. Evaluation Measurement and Verification Activities

A. Summary

The Massachusetts PAs completed thirty evaluation studies for the 2011 Annual Report. The following is a statewide summary of the subset of these evaluation studies that had significant impact on the final evaluated data.

The studies that had the most significant impact for gas PAs were:

- Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation and Additional Non-Energy Impacts for Low Income Programs
- Low Income Single Family Program Impact Evaluation
- The 2011 C&I Natural Gas Programs Free-ridership and Spillover Study
- The Large C&I Custom Gas Measures Impact Evaluation

In the Massachusetts Special and Cross-Sector Studies area, *the Residential and Low Income Non-Energy Impacts (NEI) study* had a large impact on overall residential and low income sector benefits based on the previously filed study in National Grid Gas, D.P.U. 11-109. The supplemental research on non-energy impacts for low-income programs includes additional low income benefits that clarifies and expands the prior research performed in the *Residential and Low-Income Non-Energy Impacts Evaluation*. The additional information focused on lighting quality, refrigerator recycling, price hedging, and economic development, and the results have a significant positive impact on the benefits attributable to low-income programs. Additional information on the updated non energy benefit values for the low-income program can be found in Appendix C, Study 28.

The Low Income Single Family Program Impact Evaluation quantified the gross per-unit savings generated by each low-income measure through billing and engineering analyses. Depending on planning assumptions and measure mix, this study had a different impact on each of the PAs because the results varied by measure. This study is discussed in more detail in Appendix C, Study 17.

The 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study quantified the net impacts of the commercial and industrial natural gas energy efficiency programs by estimating the extent of program free-ridership, early participant spillover, and nonparticipant spillover. The final statewide NTG ratio was 78.7. Between individual PAs, the rate varied from 59.7 to 108. This study is discussed in more detail in Appendix C, Study 29.

The Large C&I Custom Gas Measures Impact Evaluation determined realization rates at the PA level and statewide level. Evaluation activities included visual inspection of the installed measures, acquisition of nameplate data, spot measurements of boiler efficiencies, interviews with knowledgeable site staff, review of plans, and placement of logger equipment. Depending upon the measure under evaluation, loggers were placed to calculate a variety of custom measures. Overall, the statewide realization rate of 67.6 decreased the savings for custom gas

measures. The specific results of the realization rate impact vary by PA such that if a PA had been carrying a higher realization rate than was produced in this study, the affected program's savings would decrease once the new realization rate was incorporated. This study is discussed in more detail in Appendix C, Study 26.

Table III.A summarizes the EM&V studies included in the Annual Report that have not been included in previous Annual Reports.

Studies	Location of Complete Study in Annual Report	Docket & Exhibit Approving Planned Evaluation Studies	Implemented as Approved? (yes/no)
Residential Program Studies			
Massachusetts Residential New Construction Home Buyer Survey	App. C, Study 1	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	All studies are implemented as planned
Massachusetts Residential New Construction Focus Groups with Participant Builders	App. C, Study 2	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	
Massachusetts Mini Baseline Study of Homes Built at the End of the 2006 IECC Cycle	App. C, Study 3	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	
Home Energy Services Net-to-Gross Evaluation	App. C, Study 4	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	
Massachusetts Multifamily Market Characterization and Potential Study	App. C, Study 5	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	
Massachusetts Multifamily Program Process Evaluation	App. C, Study 6	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	

Studies	Location of Complete Study in Annual Report	Docket & Exhibit Approving Planned Evaluation Studies	Implemented as Approved? (yes/no)
Massachusetts Multifamily Program Impact Analysis	App. C, Study 7	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	
Demand Impact Model User Manual	App. C, Study 9	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	
Residential Pilot Studies			
Major Renovations Pilot Evaluation	App. C, Study 11	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	All studies are implemented as planned
Massachusetts Residential New Construction Four to Eight Story Multifamily Pilot Interview Findings	App. C, Study 12	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	
Home Energy Services Packaged Measure Pilot Evaluation	App. C, Study 13	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	
Heat Pump Water Heaters Evaluation of Field Installed Performance	App. C, Study 14	Study is planned but not yet submitted for approval	
Low-Income Program Studies			
Massachusetts 2011 Low Income Program Process Evaluation	App. C, Study 16	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	All studies are implemented as planned
Low Income Single Family Program Impact Evaluation	App. C, Study 17	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	

Studies	Location of Complete Study in Annual Report	Docket & Exhibit Approving Planned Evaluation Studies	Implemented as Approved? (yes/no)
Commercial & Industrial Program Studies			
Process Evaluation of the Large Commercial and Industrial Energy Efficiency Programs	App. C, Study 22	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	All studies are implemented as planned
Large C&I - Prescriptive Gas Measures Impact Evaluation	App. C, Study 24	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	
Large C&I - Custom Gas Measures Impact Evaluation	App. C, Study 25	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	
Special & Cross Sector Studies			
Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report	App. C, Study 26	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	All studies are implemented as planned
Massachusetts Umbrella Marketing Evaluation Report	App. C, Study 27	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	
Additional Non-Energy Impacts for Low Income Programs	App. C, Study 28	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	
C&I Gas Net-to-Gross Study 2011 Projects	App. C, Study 29	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	
Community-Based Partnerships 2011 Evaluation Final Report	App. C, Study 30	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	

B. Residential Program Studies

1. Massachusetts Residential New Construction Home Buyer Survey

Type of Study: Market Assessment

Objective of the Study: Examine what buyers look for in a new home, awareness of ENERGY STAR homes, the role of ENERGY STAR certification in new home shopping, perceptions of ENERGY STAR homes, and reactions to recent changes in the program. The study also provides updates of similar surveys conducted in 2002, 2003, 2004, and 2006.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study: There are no recommendations. This study was informational, conducted to assess the role of energy efficiency in shopping for a newly constructed home as well as awareness and perceptions about the program.

#	Finding
1	The importance of getting a more efficient home with lower energy bills has steadily risen for all buyers of new homes from 2002 to 2010 with the mean ranking, using a scale from 0 to 10 where 0 is one of the least important factors and 10 is one of the most important factors, rising from 7.2 in 2002 to 9.0 in 2010.
2	Close to three out of five buyers of new homes are now aware of the ENERGY STAR label on new homes; this is more than twice the percentage who were aware at the time of the first Massachusetts home buyer survey in 2002; most of the increase in awareness occurred between 2006 and 2010.
3	Home buyers in 2010 are significantly more likely to discuss the energy efficiency of the new home, how much it would cost to heat and cool the home, and green building while shopping for or building a new home than they were in 2006. The percentage discussing energy efficiency in 2010 is 60% up from 37%; heating and cooling costs is 53% up from 25%; and green building is 26% up from 9%.
4	More than seven out of ten (72%) home buyers aware of ENERGY STAR homes believe they provide a little or a lot more value for the money, up from just over one-half (53%) in 2006.
5	Overall satisfaction with the program has remained high with nearly three-quarters of buyers of new ENERGY STAR homes who know they have ENERGY STAR homes saying they are 'satisfied' or 'extremely satisfied'. Asked to rate the importance of going through the Massachusetts program, after changes that do not require ENERGY STAR certification, three out of ten (30%) respondents say that going through the program would be very important if they were building or buying a new home today and an additional one-third (34%) believe program participation would be somewhat important.

How the Study Came to the Recommended Conclusions: Findings are based on telephone surveys of recent buyers of newly constructed homes in Massachusetts that were conducted from June through September of 2011. Surveys were completed with 100 households who had bought ENERGY STAR certified homes and 118 households who had bought homes that did not participate in the program.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: Though there were no specific recommendations from this study, the Findings indicate a positive trend. This upward trend in the growing importance of energy efficiency in new home purchases is communicated through mid stream actors such as real estate agents and mortgage bankers/brokers about long term affordability. The program continues to tap into the strong ally relationships it has formed with the Real Estate and Mortgage industry to continue to provide trainings and marketing assistance on the importance of energy efficient new construction.

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

2. Massachusetts Residential New Construction Focus Groups with Participant Builders

Type of Study: Market Assessment

Objective of the Study: The objective of the study was to assess the participating builders' experience with the program and their reactions to changes made in 2011 and changes which may be forthcoming in 2012.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study:

#	Recommendation
1	Capitalize on the theme that the program differentiates home builders in a positive manner throughout the marketplace. – On-going task
2	Continue to educate home buying consumers on the characteristics of energy-efficient homes and potential savings associated with living in an energy-efficient home. – Working with Real Estate market – mid stream marketing.
3	If program Tiers and HERS rating scores are mentioned at all in marketing materials to the home-buying consumer, provide simple and clear explanations of their significance.
4	Incorporate additional educational information into marketing materials for program participants. Further outreach is necessary to raise the awareness of participant builders with respect to changes in the program.
5	If the shift to an open HERS rater market occurs, provide clear marketing materials to builders emphasizing the advantages offered by HERS raters. Builders should also be made aware that HERS raters operate in a competitive market, charging varying fees and offering different services.

How the Study Came to the Recommended Conclusions: Findings are based on two focus groups conducted in June of 2011 with home builders who participated in the program before 2011.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: The program has incorporated the above recommendations as follows:

- By leveraging the National EPA ENERGY STAR Homes program websites Builder Partner Resource Center and Massachusetts specific builder marketing support, the program continues to assist and provide builder partners resources to stand out from their competitors. This is done through online support, marketing materials and through technical and sales trainings.

- Through the utilization of mid stream allies such as real estate professionals and mortgage brokers the program continues to educate the new residential home buying market on the benefits of purchasing an energy efficient new home. Value added benefits such as long term affordability, comfort and durability are discussed.

- Currently the program does not provide HERS Rating or Tier achievement directly to home buying consumers, however individual Raters may provide this information as part of their services, but this is decided outside of the programs requirements. All homes do receive a sticker indicating that it has participated in the program along with the final HERS Index and if it achieved ENERGY STAR.

- The program continues to provide several channels to distribute marketing materials, educational opportunities and programmatic updates. In 2011 the program launched a Massachusetts specific HERS Rater Website and Portal. The Portal allows program Raters to download the most recent program documentation, upload applications and incentive worksheets, report completions, view upcoming events and trainings and it also allows for the exchange of best practices and technical assistance on its message board. The program still also communicates information through email and fax blasts.

- Although the program currently provides Raters with an incentive to participate, the builder is made aware of this amount when they receive their participation confirmation letter. This shows not only the incentive the rater is receiving; it helps to establish a value and cost associated with the services provided. This will be beneficial in the upcoming years as the program moves towards decreasing Rater incentives.

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

3. Massachusetts Mini Baseline Study of Homes Built at the End of the 2006 IECC Cycle

Type of Study: Impact Evaluation

Objective of the Study: Homes were inspected between April and June of 2011 with three primary tasks in mind:

- Conducting a full HERS rating using REM/Rate software
- Filling out the 2006 IECC checklist developed by PNNL
- Providing program Sponsors with a mini baseline study of 50 non-ENERGY STAR-qualified homes completed at the end of the 2006 IECC code cycle

Programs to which the Results of the Study Apply:

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

Results of the Study and How the Study Determined those Results: This study was conducted in partnership with DOER to assess compliance with basic building code prescriptive path requirements at the end of the 2006 International Energy Conservation Code ("IECC") code cycle, provide a preliminary assessment of how current new single-family residential building characteristics compare to current User Defined Reference Home ("UDRH") inputs, and conduct audits of energy efficient lighting and appliances within the homes. The study also compared building practices, equipment efficiencies, and other characteristics in custom versus spec built homes.

#	Finding
1	Some current UDRH inputs may underestimate and others overestimate the energy efficiency of current building practices or equipment. Heating system efficiency inputs—the average efficiencies of gas (natural gas and propane) furnaces and boilers in inspected homes are higher than the current UDRH inputs, but wall, floor and ceiling insulation levels are lower.
2	The 2006 IECC prescriptive path insulation requirements for wood-frame walls, floors over unconditioned space and ceilings are, respectively, R-19, R-30 or cavity filled (minimum R-19), and R-38 with an allowance for R-30 in up to 500 feet of cathedral ceiling area. (*Note that a home failing to meet one or more 2006 prescriptive path requirements does not mean the home failed to comply with building code—the home may have complied under a performance-based compliance path that allows trade—offs.*) Most homes with wood framed walls (84%) had R-19 or higher insulation, 28% of homes with floors over unconditioned basements met the 2006 IECC prescriptive insulation requirement, 22% of homes with flat ceilings had R-38 or higher insulation, and no cathedral ceilings had R-38 insulation. However, 67% of homes with cathedral ceilings met the 2006 IECC prescriptive insulation requirement by having a total of 500 square feet or less of cathedral ceiling area insulated to R-30.
3	Twenty-one percent of the total number of bulbs counted in the non- ENERGY STAR Homes were energy efficient.
4	The majority of refrigerators and dishwashers installed in the non-ENERGY STAR homes were ENERGY STAR (73% and 89% respectively).

In most cases the difference between custom and spec homes is minimal. Custom homes tend to have higher R-value conditioned/ambient wall and flat ceiling insulation, while spec homes tend to have higher R-value floor and foundation wall insulation. Custom homes have slightly more efficient heating systems and spec homes have slightly more efficient water heating systems. Spec homes have lower duct leakage and air infiltration. Custom homes have more energy-efficient light bulbs and slightly higher percentages of ENERGY STAR refrigerators and dishwashers. As an overall indicator of a home's energy efficiency, the HERS ratings conducted on the 50 inspected homes suggest there is little difference between the energy efficiency of custom homes (average HERS 85) and spec homes (average HERS 83); this difference is not statistically significant at the 90% confidence level.

How the Results of the Study Impact each Identified Program's Savings: Due to the penetration rate of energy efficient bulbs and appliances program savings from these measures are reduced accordingly.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): The penetration rates are incorporated into the savings calculations as free-ridership, accordingly the appropriate formula is as follows:

kWh savings = (1 – Free-ridership + Spillover)

kW savings = (1 – Free-ridership + Spillover)

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: References to energy characteristics were not incorporated into the UDRH as this study looked at homes built under the 2006 IECC; the current code in Massachusetts is the 2009 IECC. The UDRH will be updated with results from the Full Baseline study, which looked at homes built under the 2009 IECC and will be completed during the summer of 2012.

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

4. 2011 Home Energy Services Net-to-Gross Evaluation

Type of Study: Impact Evaluation

Objective of the Study: To determine measure-specific and program-level NTG values for several of the measures installed in the HES program using information gathered from program tracking systems, participant surveys, and non-participant surveys.

Programs to which the Results of the Study Apply:

- MassSAVE (Electric)
- Weatherization (Gas)

Results of the Study and How the Study Determined those Results:

Measure Category	Measure	Participant Free-ridership	Participant Spillover	Non-participant Spillover	NTG
Direct Installs	CFL	29%	2.5%	N/R	73%
	Air Sealing	8%	8%	28%	129 %
Measures for which an Incentive was Offered	Insulation	25%	20%	28%	123 %
	Refrigerator	14%	N/R	N/A*	86%
Overall					113 %

Note: N/R = Not Reported, N/A = Not Available

The evaluation findings are based on results from an array of data collection activities and evaluation tasks, including participant and non-participant surveys and self-report and discrete choice (DC)-based assessments of measure-level NTG ratios.

How the Results of the Study Impact each Identified Program's Savings: The results of this study will be used to derive net energy savings by multiplying the gross reported savings by the NTG factors.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s):

$$NTG = 1 - FR + PS + NPS$$

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: The results of the study are adopted with the following exception. The NTG factors for CFLs were also based on this study but modified by agreement with the EEAC consultants on July 2, 2012 to account for the potential of participants who would have bought CFLs outside of the HES program but through the Upstream Lighting program, which was estimated to be 5%.

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

5. Massachusetts Multi-Family Market Characterization and Potential Study

Type of Study: Market Characterization

Objective of the Study: The objective of this study was to assess the potential energy efficiency savings available in multi-family buildings within Massachusetts. The results of this study will be used to inform ongoing energy efficiency planning and program design by identifying the quantity of available potential and determining how it is distributed across end uses in multi-family buildings.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study: There are no recommendations from this study as the main purpose was to derive potential savings from multi-family buildings within Massachusetts.

How the Study Came to the Recommended Conclusions: Not Applicable.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: Not Applicable.

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

6. Massachusetts Multi-Family Retrofit Program Process Evaluation

Type of Study: Process Evaluation

Objective of the Study: The objective of this study was to assess program processes and identify similarities and differences between the perspectives and assumptions of program staff, implementation staff, and customers regarding program goals, design, and implementation.

Primary activities for this study were: (1) report the opinions and perspectives gathered through the interview process; (2) draw conclusions based on the information obtained; and (3) offer specific, actionable recommendations for future program improvement.

Programs to which the Results of the Study Apply:

- Multi-Family Retrofit (Electric & Gas)

Recommendations Derived from the Study:

#	Recommendations
1	Develop a comprehensive statewide Multi-family program marketing and outreach plan that leverages a range of channels to make initial contact with both property managers and tenants and condo owners.
2	Continue to simplify the process for property managers. Via the MassSAVE and/or PA Multi-family websites, provide prospective participants with more detail on exactly how the program works, what measures could be included, the incentive levels, and sample proposals, in advance of calling the MMI.
3	Consider the costs, benefits, and appropriate incentives for additional standard program measures.
4	With each thermostat, leave behind easy to understand programming instructions in multiple languages.
5	Research and test program design and financing options with the aim of both increasing program participation and increasing savings from each property.
6	Provide materials (technical specifications, instructions) and websites for program participants to obtain technical information on measures and ensure that participants understand that they can contact the MMI for technical support.
7	Track program participation with unique identifiers for the building/facility (facility ID) and participating tenant units (unit #s and/or electric and gas account numbers for individually metered units).

How the Study Came to the Recommended Conclusions: The process evaluation focused on two key activities: (1) Assessing program processes; and (2) Identifying similarities in and differences between the perspectives and assumptions of program staff, implementation staff, and customers regarding program goals, design, and implementation.

The focus of this study was to report the opinions and various perspectives gathered through interviews with program stakeholders. Conclusions and recommendations were developed based on diverse opinions and perspectives.

Evaluation Task	Details
PA Program Manager Interviews (n=6)	Provided insight into PA's perspective of the Multi-family program in 2011, the overall process of participation in the program, any changes that occurred over the last year, any issues or key topics that emerged, and the current status of the program.
Implementer and Multi-family Market Integrator Interviews (n=4)	Provided insight into program implementation, the data collection and reporting process, and statewide program collaboration.
Literature Review / Benchmarking	Explored common industry practices and innovative approaches that are being undertaken by MF programs throughout North America.
Property Manager Survey (n=64)	Provided insight into satisfaction at the property management level, program delivery (in process), measure verification and persistence, and freeridership and spillover.
Tenant / Condo-owner Survey (n=73)	Provided insight into satisfaction at the individual tenant level, program delivery, verification and persistence of measures installed in tenant spaces, freeridership of tenant space CFLs, and spillover.
Property Manager Focus Group (n=9)	Provided additional insight into the validity of and rationales behind the measure verification, persistence, and NTG results from the survey, as well as further discussion of key topics and testing alternative program design strategies identified during the literature review/benchmarking task.
Program Database and Audit Data Review	Conducted a thorough review of program tracking databases, and a related review of program audit data not contained in the program tracking databases to determine what data are collected, understand the data details, determine the appropriate baseline for estimating measure-specific savings generated, and to determine the best way to aggregate and analyze the program data. The data review informed the subsequent engineering review (results of the engineering review are provided in a separate report.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: 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. Recommendations will be considered for implementation consistent with the 2013-2015 Three-Year Energy Efficiency Plan.

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

7. Massachusetts Multi-Family Retrofit Program Impact Analysis

Type of Study: Impact Analysis

Objective of the Study: This impact analysis has two primary objectives. First, the impact work aimed to provide a set of savings approaches (i.e., algorithms and deemed values) that can be used by all PAs (statewide) in future program years. Second, the analysis collected information to inform program attribution, including the measurement of installation rates, persistence, free-ridership, and spillover.

Programs to which the Results of the Study Apply:

- Multi-Family Retrofit Program (Gas and Electric)

Results of the Study and How the Study Determined those Results:

Measure	PA Data Source	Installation Rate	Persistence Rate	FR (Weighted)	FR (n)
Common Area CFLs	All (except NSTAR)	91%	100%	31%	9
Dwelling CFLs	All (except NSTAR)	98%	99%	12%	3[1]
Dwelling CFLs	All (except NSTAR)	98%	99%	51%	49
Other CFLs	NSTAR	89%	100%	27%	6
Common Area Lighting Fixtures	All PAs	100%[2]	99%	20%	27
Dwelling Lighting Fixtures	All PAs	99%	100%	16%	31
Total Lighting (except CFLs in units where the occupant pays the electric bill)		**96%**	**100%[3]**	**18%**	**63**
Insulation/Air Sealing	All PAs	100%	100%	19%	22
Showerheads	Showerheads and aerators combined	100%	93%	15%	15
Aerators	Showerheads and aerators combined	100%	96%	15%	15
Programmable Thermostats	All PAs	100%	69%[4]	24%	20
Total (All)		**97%**	**100%[3]**	**18%**	**63**

1. For property managers that pay for dwelling electricity;
2. One respondent reported installing more measures than PA participant tracking data, 100% assumes respondent recall was inaccurate;
3. PM and Tenant combination;
4. Installed and programmed.

	Based on PM Survey Responses
	Based on Tenant/Condo Owner Survey Responses

Summary of Proposed Savings Approaches

Measure Category	Primary Algorithm	Alternative Approach
Lighting – CFLs	$\Delta kWh = \frac{N \times (Watts_{pre} - Watts_{post}) \times Hrs}{1000} \times ISR$	$\Delta kWh = \frac{N * (Watts_{post}) \times \Delta WattsMult \times}{1000}$
Lighting – Linear Fluorescents	$\Delta kWh = \frac{(QNL_{pre} * Watts_{pre}) - (QN_{post} * Watts_{post}) \times Hrs}{1000}$	Same algorithm, but deemed values are provided for baseline wattage and operational hours.
Lighting – LED Exit Signs	$\Delta kWh = \frac{n \times (Watts_{pre} - Watts_{post}) \times Hrs}{1000}$	Same algorithm but, some deemed input values are provided.
Lighting – Metal Halides	$\Delta kWh = \frac{(QNL_{pre} * Watts_{pre}) - (QN_{post} * Watts_{post}) \times Hrs}{1,000}$	Same algorithm, but deemed values are provided for baseline wattage and operational hours.
Lighting – Occupancy Sensors	$\Delta kWh = \frac{(Watts_{controlled}) \times Hrs \times svg}{1000}$	Same algorithm, but some deemed input values are provided.
Refrigerators	*Refrigerator Recycling* $\Delta kWh = \left[\left((kWh_{pre} - kWh_{std})\right) \times \frac{12 - \#}{12} + \left((kWh_{std} - kWh_{ss}\right.\right.$ *No Recycling* $\Delta kWh = (kWh_{std} - kWh_{ee}) \times F_{ee}$	Same algorithm, but some deemed input values are provided.
Attic Insulation Basement Insulation Wall Insulation (gas)	$MMBtu_{annual} = \frac{\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) \times HDD \times 24 \times Area}{1,000,000 \times \eta_{heat}}$	Same algorithm, but some deemed input values are provided.
Attic Insulation Basement Insulation Wall Insulation (electric)	*Air Conditioning Savings:* $kWh_{annual} \frac{\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) \times CDH \times DOA \times Area}{1,000 \frac{Btu}{kBtu} \times \eta_{cool}}$ *Electric Heating Savings:* $kWh_{annual} \frac{\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) \times HDD \times 24 \times Area}{1,000,000 \times \eta_{heat}} \times 293.1$	Same algorithm, but some deemed input values are provided.

Measure Category	Primary Algorithm	Alternative Approach
Other Insulation (electric)	Deemed annual kWh savings = 137 kWh.	
Other Insulation (gas)	Deemed annual MMBtu savings = 1.2 MMBtu.	
Air sealing (electric)	$\Delta kWh = \frac{Vol \times \Delta ACH \times 0.018 \times HDD \times \frac{24}{\eta_{heating}}}{3413}$	Same algorithm producing a deemed savings approach per 1000 ft^2 based on zip code and heating type
Air Sealing (gas)	$\Delta MMBtu = \frac{Vol \times \Delta ACH \times 0.018 \times HDD \times \frac{24}{\eta_{heating}}}{1,000,000}$	Same algorithm producing a deemed savings approach per 1000 ft^2 based on zip code and heating type
Thermostats (electric)	Deemed annual kWh savings = 282 kWh.	
Thermostats (gas)	Deemed annual MMBtu savings = 2.4 MMBtu.	
Heat pump tune-up	$kWh = tons \times 12 \frac{kBtuh}{ton} \times \left(\frac{1}{SEER} \times Hours_{cooling} + \frac{1}{HSPF} \times Hours_{heating}\right)$ $kWh = kBtuh \times \left(\frac{1}{SEER} \times Hours_{cooling} + \frac{1}{HSPF} \times Hours_{heating}\right) \times \%$	ΔkWhdwelling = 180 kWh ΔkWhCommonArea = 325 kWh
Aerators (electric)	Deemed annual kWh savings = 41.7 kWh.	
Aerators (gas)	Deemed annual MMBtu savings = 0.36 MMBtu.	
Showerheads (electric)	Deemed annual kWh savings = 55.6 kWh.	
Showerheads (gas)	Deemed annual MMBtu savings = 0.48 MMBtu.	
Pipe Wrap (electric)	Deemed annual kWh savings = 55.6 kWh	
Pipe Wrap (gas)	Deemed annual MMBtu savings = 0.48 MMBtu.	
Tank Wrap (electric)	$\Delta kWh = kWh_{base} \times \left(\frac{EF_{new} - EF_{base}}{EF_{new}}\right)$	Deemed savings per wrap = 31.5 kWh

These results were determined by reviewing program audit data and also reviewing the measure-specific engineering savings estimates contained in each PA's program tracking database, and their relationships to the per unit values in PA Benefit-Cost Ratio (BCR) models and to the methods described in the Technical Reference Manual (TRM). Also, a review of third party algorithms from other Technical Resource Manuals or from recent studies to get another

perspective of how various jurisdictions calculate savings for similar measures was conducted. These reviews included both local sources (within Massachusetts or New England utilities), as well as outside sources like the Database for Energy Efficient Resources (DEER), the Ohio TRM, and the New York TRMs.

How the Results of the Study Impact each Identified Program's Savings:
The results of this study were used to derive net energy savings by multiplying the gross reported savings by the NTG factors. The impact of this study was a decrease in the reported net savings.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): The report includes all required algorithms and calculations to interpret and verify results.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: The NTG results were adopted. The proposed savings approaches will be used in 3-year planning.

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

8. Brushless Fan Motors Impact Evaluation

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

9. Demand Impact Model Update User Manual

Type of Study: Impact

Objective of the Study: Update the existing residential demand impact model originally created by Quantec in 2001 with an improved interface and more recent Massachusetts- or New England-specific load shape data.

Programs to which the Results of the Study Apply:

- Residential New Construction & Major Renovation (Electric and Gas)
- Low-Income Residential New Construction (Electric)
- Residential Cooling & Heating Equipment (Electric)
- Multi-Family Retrofit (Electric Only)
- MassSAVE (Electric)
- Behavior/Feedback Program (Electric Only)
- ENERGY STAR® Lighting (Electric)
- ENERGY STAR® Appliances (Electric)
- Low-Income Single Family Retrofit (Electric and Gas)
- Low-Income Multi Family Retrofit (Electric Only)

Results of the Study and How the Study Determined those Results: The updated model utilizes the best available load shape data, per-unit measure energy savings, and ISO-NE definitions of peak period to allow PAs to dynamically calculate demand impacts.

How the Results of the Study Impact each Identified Program's Savings: The model can be used to assess demand impacts for any of the residential or Low-Income programs. This model will be utilized where demand impacts are not calculated in a typical impact evaluation. The results of this study only affect demand and energy calculations, not savings. Gas programs are minimally impacted by the outcome of this study.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): Not Applicable.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: The results of the study are adopted.

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

10. Massachusetts Residential Retail ENERGY STAR® Lighting Evaluation

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

C. Residential Pilot Studies

11. Memo: Major Renovations Pilot Evaluation

Type of Study: Process Evaluation

Objective of the Study: As follow up to the preliminary report on non-participant interviews issued in 2011, this memo briefly summarizes findings from interviews with homeowners, architects and builders involved with projects completed by the end of 2011. The memo focuses on satisfaction with the Pilot and suggestions for how the Pilot could be improved or made more user-friendly. In addition, it summarizes a discussion with a HERS rater who worked with 5 of the 11 completed projects.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study:

#	Recommendation
1	Make requirements for participating in the Pilot clearer.
2	Encourage further energy-efficiency upgrades and address smaller projects.
3	Make clear what programs a project qualifies for and if it can participate in multiple programs.
4	Speed up the administration process—minimize delays in issuing incentives.

How the Study Came to the Recommended Conclusions: Recommendations are based on findings from discussion with a HERS rater who worked with five of the eleven completed projects and in-depth interviews conducted with eight homeowners, three architects and three builders. In most cases the interviewees played more than one role on the projects they were involved in. For example, the owner may have been the architect and/or been the one who applied to participate in the Pilot. The builder may have been hired by the applicant or submitted the application for the project to participate in the Pilot. The architect may have also been the general contractor or builder and may have submitted the application for the project to participate in the Pilot. All interviewees were asked to provide suggestions for how the Pilot could be improved or made more user-friendly.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: The Major Renovations pilot went through an update in early 2012 to make adjustments based on lessons-learned and to address the findings from interviews with homeowners, architects and builders.

One adjustment was that the pilot became a contractor-focused program rather than a homeowner-focused program. The change was made in response to homeowner comments that the pilot requirements were unclear. Homeowners were struggling to understand and manage the technical requirements of the pilot, while a contractor should have greater familiarity with the requirements.

Another adjustment was that the eligibility requirements changed to allow major renovations of any size to participate. This change ensured there would not be a gap between the HES program and the Major Renovations pilot, where people would not qualify for either program.

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

12. Massachusetts Residential New Construction Four to Eight Story Multi-family Pilot Interview Findings

Type of Study: Process Evaluation

Objective of the Study: Assess the strengths and areas in need of improvement of the three year pilot that was introduced to serve smaller, four to eight story buildings that do not qualify for ENERGY STAR certification but are too small for commercial programs. The report focuses on the lessons learned from the pilot about addressing the energy efficiency potential of the mid-rise multi-family new construction market.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study:

#	Recommendation
1	Offer a performance-based program for the mid-rise multi-family new construction market, or possibly the entire multi-family market over three stories.
2	The pilot's verification of ventilation and infiltration rates for individual units through the High Performance Building Adder is a positive innovation. Given that quality installation of insulation and air sealing have shown to be important in single family structures, multi-family programs should continue to fund and encourage these measures.
3	Offer a long-term program. Ideally, a program would run for a longer period of time and be renewed annually, so that prospective participants know that the program will be in place when their projects complete. With a longer-term program, implementers should focus their efforts on reaching projects at the earliest stage possible.
4	Try to identify and recruit more projects with less of an energy efficiency or green building tilt. Expanding relationship-based marketing focused on the design community would enable programs to reach more projects and provide the assistance they need to incorporate higher levels of energy efficiency.
5	Consider offering assistance and support for the design team, especially as more projects with less of a green tilt are recruited.
6	Consider efforts to address market concerns and misperceptions about energy-efficient building practices. Participant interviews identified a number of concerns particular to this market, notably that more efficient systems need more sophisticated staffs and training for building operation and that it would be more difficult to obtain replacement parts.

How the Study Came to the Recommended Conclusions: Recommendations are based on findings from fourteen interviews conducted with the pilot's sponsors (three interviews), implementer (two interviews), and participants with completed projects (nine interviews representing fourteen projects). The interviews examined the pilot's goals and objectives, the process of signing up and completing verification, outreach and the timing of projects served, the measures covered, the measures installed, barriers to energy efficient multi-family new construction, and satisfaction.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: With the goal of transitioning the current Massachusetts Multi-family New Construction Pilot to a full program, the following program design features which incorporate the above recommendations are being explored. The proposed program will continue to provide a single point of contact for the participants and provide service for all fuel sources and meter configurations. To address the issue of long development timelines, a suite of program offerings will provide a stepped enrollment mechanism for pre-bid and post-bid projects. (The bid process is the project milestone after which efforts to influence energy efficiency are no longer possible.) The first offering will include a simple prescriptive application to service post-bid projects. The goal will be to maximize the capture of energy savings from established designs with a focus on residentially metered electric savings.

In tandem with this simple prescriptive offering, a whole building prescriptive program and an interactive savings tool are being developed for pre-bid projects. Third party verification and commissioning activities will continue to be incentivized. In total, these approaches will be capable of servicing multi-family projects from 4 stories and up. These combinations of measures, in conjunction with the transition mechanism, will allow the program to offer cost-effective incentives that will move projects to achieve higher levels of energy efficiency and pave the way to recruit and educate more first-time program participants.

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

13. 2011 Home Energy Services Packaged Measure Pilot Evaluation

Type of Study: Pilot Evaluation

Objective of the Study: The evaluation was a review to determine whether the additional customer incentives offered in an effort to achieve deeper savings at one time in the HES program made a difference in the customer's willingness to move forward with installation of energy efficient measures, meeting the pilot's stated goal, as well as assessing the delivery of the pilot itself.

Programs to which the Results of the Study Apply:

- MassSAVE (Electric)
- Weatherization (Gas)

Recommendations Derived from the Study:

#	Recommendation
1	The Cadmus Team suggests that if the PAs reissue the pilot, they consider additional package combinations, such as an all-insulation package. PAs might also consider a package option without the heating system requirement, which is the highest cost item.
2	The Cadmus Team suggests that the PAs and vendors market the pilot and continue to encourage the HES auditors to explain fully the benefits of the pilot when conducting HES audits.

How the Study Came to the Recommended Conclusions: The recommendations are based on PA program manager interviews, program vendor staff interviews, participant and nonparticipant customer surveys, and a review of pilot and historical program data.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why:

1	If the PAs decide to reissue the pilot, additional package combinations will be discussed for appropriateness and cost effectiveness.
2	The PAs will look into the best approach for handling this recommendation if the pilot is reissued.

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

14. Heat Pump Water Heaters Evaluation of Field Installed Performance

Type of Study: Technology Evaluation

Objective of the Study: The objective of this study was to quantify the in-situ performance of three types of heat pump water heaters ("HPWH"). The study was also meant to answer questions on the efficiency, reliability, and performance of the three types of HPWHs.

Programs to which the Results of the Study Apply: This is a new pilot measure that will not directly affect savings from any program during this annual report year. Going forward, this is likely to affect only electric programs.

Results of the Study: This study did not have recommendations per se, but rather quantified the results of HPWH use that can be used in the analysis of potential HPWH measures.

	Small Tank (50-60 gal)	Large Tank (80 gal)
Measure Life	10 years	10 years
Incremental Cost	$1,510	$2,610
Mean Annual kWh Saved over ERWH	1,687	2,670
Annual Energy Usage		
HPWH; Monitored (kWh)	734-4,035 [1643][1]	1,200-2,040 [1579][1]
ERWH; EF=0.91 (kWh)	1,898-5,813 [3330][1]	3,110-6,078 [4249][1]
Gas, Oil, or Propane; EF=0.56 (MMBTU)	1,289-3,105 [1950][1]	1,880-3,226 [2410][1]
Gas, Oil, or Propane; EF=0.67 (MMBTU)	9,57-2,664 [1577][1]	1,510-2,757 [1987][1]
Mean Winter Peak Demand Reduction over ERWH[2]	374.1 W	
Mean Summer Peak Demand Reduction over ERWH[3]	174.8 W	

[1] Minimum – Maximum [Mean]
[2] June-August, Weekdays, 1pm-5pm
[3] December – January, Weekdays, 5pm-7pm

How the Study Determined Those Results: The study came to its conclusions through evaluating the in-situ performance of three types of HPWH products. Fourteen units were monitored for over one year.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: There are not any strict recommendations to adopt from this study but the PAs will use the results from this study in future analysis of HPWH measures.

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

15. Solar Hot Water Program Pilot Evaluation

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

D. Low-Income Program Studies

16. Massachusetts 2011 Low Income Program Process Evaluation

Type of Study: Process Evaluation

Objective of the Study: The focus for this process evaluation was to report the opinions and various perspectives gathered through interviews with program stakeholders. The key objectives for the 2011 program process evaluation were as follows:

- Follow up on topics discussed during the 2010 process evaluation, such as progress in standardization goals, internal and external QA/QC processes, and participant waitlists;
- Identify and discuss areas where the program changed in 2011 and reason(s) for the changes; and
- Recommend improvements for process-related issues and suggest ways to standardize or streamline processes between agencies/PAs.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study:

Low Income Single-family Retrofit Program Process Evaluation Recommendations:

#	Recommendation
1	If not already, all PAs should provide savings goals to their lead agencies to improve transparency between PAs and program implementers. Lead vendors should then provide all sub-agencies information about annual savings goals, especially in cases where it is a challenge to meet the PAs' savings goals. Furthermore, it may prove beneficial for all agencies to track certain savings performance indicators in a manner similar to that of how they track budgets and spending. If indicators for savings performance currently do not exist, this should be a topic for discussion in the Best Practices working group meetings.
2	The PAs should establish an approval system that does not cause significant delays the PAs ability to provide program budgets to implementers. The process should be set up in a way that PAs can provide contracts and budget information to the agencies in advance of program [start date] year, to provide services to customers in a timely and effective manner and ensure agencies can plan effectively. Multi-year contracts and budgets should be implemented, when possible, with any subsequent revisions negotiated in advance of existing contract expiration dates.
3	Through the Best Practices working group, standardize a streamlined approval process for repairs that works for the agencies and PAs.
4	Through the Best Practices working group (including the PAs), develop, document and put into practice both (a) a standardized definition of the waitlist; and (b) standardized methods for tracking and reporting this information. One suggested definition for wait list is the number of eligible low income customers who have completed all the necessary paperwork to participate and are awaiting an audit.
5	Coordinated and developed through the Best Practices working group, PAs should investigate funding a statewide energy education curriculum, including leave-behind materials and energy saving tips. This effort should aim to increase the depth of energy savings resulting from behavior change, and provide thorough and consistent energy conservation messages to participants.

6	An assessment of necessary or recommended trainings should be discussed through the Best Practices Group to ensure quality auditors and contractors while also maintaining cost-effectiveness.
7	Through the Best Practices working group (or sub-committee) including CRI and DHCD, discuss ways to further streamline the QA/QC process so it serves the needs of the PA-funded program while minimizing participant intrusion. The objectives of the discussion should be: • Clearly articulate the objectives of multiple QA/QC visits to a participant's home. • Establish the value of agencies conducting 100% post inspections versus redirecting resources to serve more homes. • Determine where the objectives of the DHCD and CRI inspections align and identify if there are opportunities for collaboration and coordination. • Assess how changes in federal funding levels are expected to affect DHCD inspections and what affect that has on collaboration or coordination opportunities. Findings from this discussion should be clearly documented and action items to improve QA/QC process should be adopted.

Low Income Multi-family Retrofit Program Process Evaluation Recommendations:

#	Recommendation
1	The LIMF Advisory Committee should encourage more standardization across PAs by developing standardized project screening criteria or a tool to determine savings and cost effectiveness for both gas and electric projects.
2	Identify one single representative program to remain involved with during the entire participation process with building managers. Consider looking to the Multi-family Market Integrator used in the market rate multi-family program as a model.
3	Update program materials, including the Program Guide, and clarify the role of each PA's branded benchmarking software tool. To ensure continued participation and energy savings into the future, plan for the need to increase participation in the LIMF program by raising awareness among potential participants of their eligibility and the existence of the program. Facilitate this effort by developing marketing collateral, such as leave-behind materials, that help to clarify and differentiate the LIMF program eligibility and requirements from other potential funding sources that may commonly be offered to participants.
4	Develop data formats to track program savings and administer the program more consistently. To prepare for any future audit or evaluation efforts, all implementers should collect and store building manager contact information as part of the program tracking data, then share those details with the PAs.

How the Study Came to the Recommended Conclusions: The recommendations were developed through 77 interviews with program stakeholders.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why:

Low Income Single-Family Program Process Evaluation Recommendations Responses:

#	PA Response
1	PAs have been and will continue to provide savings goals to lead vendors to the best of their ability. Often, lead vendors not only manage the overall spend of the program between the various agencies implementing the program but also their performance as it relates to savings goals for PA's territory.
2	The PAs are always willing to work with the Department to establish a regulatory approval system that does not cause significant delays in program delivery.
3	This recommendation is 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.
4	This recommendation is 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.
5	PAs are in process of reviewing current marketing collateral and energy education materials that is used by the PAs and/or agencies. Once the analysis of what is currently available is complete, the PAs will determine if the recommendation for the development and/or utilization of statewide materials should be adopted.
6	This recommendation is 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.
7	This recommendation is 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.

Low Income Multi-family Retrofit Program Process Evaluation Recommendations Responses:

#	PA Response
1	This recommendation is 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.
2	This recommendation is 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.
3	PAs are in process of reviewing current marketing collateral and energy education materials that is used by the PAs and/or agencies. Once the analysis of what is currently available is complete, the PAs will determine if the recommendation for the development and/or utilization of statewide materials should be adopted.
4	This recommendation is 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.

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

17. Low Income Single Family Program Impact Evaluation

Type of Study: Impact Evaluation

Objective of the Study: The objective of the study was to determine gross per-unit savings generated by each Low Income program measure.

Programs to which the Results of the Study Apply:

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

Results of the Study and How the Study Determined those Results: The PA-weighted Massachusetts-wide per-unit gross *ex post* energy savings (by measure and primary fuel type of treated homes) are summarized below.

Category	Measure	Natural Gas (Therms/year)	Electric (kWh/year)	Oil (MMBTUs/year)
Insulation and Air Sealing	Insulation and Air Sealing (overall)	263*	1,616	28.1
	Air Sealing	105	501	9.9
	Attic Insulation	83	1,071	11.6
	Wall Insulation	115	824	11.2
	Basement Ceiling Insulation	15	30	2.9
	Basement Wall Insulation	13	37	0.2
	Furnace Fan (due to weatherization)	206 (kWh)	--	224 (kWh)
	Cooling (due to weatherization)	138 (kWh)	--	153 (kWh)
Heating System	Heating System Replacement	199*	--	18.4
	Boiler Reset Controls	--	--	4.4
	Programmable Thermostat	--	--	3.1
	Furnace Fan (due to furnace replacement)	172 (kWh)	--	132 (kWh)
Appliances	Refrigerator Replacement	--	762	--
	Second Refrigerator Removal	--	1,180	--
	Freezer Replacement	--	239	--
	Window AC Replacement	--	204	--
Lighting	CFLs	--	45	--
	Torchieres	--	211	--
	Fixtures	--	140	--
Domestic Hot Water	Domestic Hot Water (overall)	5	128	0.7
	Low-Flow Showerhead	9	188	1.1
	Faucet Aerator	2	40	0.2
	Pipe Wrap	4	41	0.4
Distribution	Duct Insulation	55	--	4.3
	Duct Sealing	33	--	3.3
Other	Baseload (TLC Kits)	--	25**	--

* Indicates this number is based on billing analysis. All other measure results through engineering analysis (simulation or algorithms).
** Reflects MA-wide average based on each PA's kit contents and participation.

How the Results of the Study Impact each Identified Program's Savings: Please refer to the table in Section II.B.5

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): A complete set of measure-specific engineering algorithms are provided in the appendix of the report.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: The results of the study are adopted.

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

E. C&I Program Studies

18. Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

19. 2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

20. Impact Evaluation of 2010 Custom Process and Compressed Air Installations

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

21. Impact Evaluation of 2010 Custom Lighting Installations

This study applies to electric energy efficiency programs only and is, therefore, not included in National Grid's Gas Company's Annual Report.

22. Massachusetts Large Commercial & Industrial Process Evaluation

Type of Study: Process Evaluation

Objective of the Study: The study is a process evaluation of the Massachusetts Large C&I energy efficiency programs. The study examines key process topics identified by the EEAC, PAs and the DOER including how to improve integration and coordination, concerns about the adequacy of staffing levels, how to achieve deeper savings, whether medium-sized C&I customers are being adequately served by the programs, the adequacy or program tracking databases, and program satisfaction. This study was conducted on behalf of the PAs and the EEAC.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study:

#	Recommendation
1	Target participants with more sophisticated audits and technical assistance.
2	PAs should be more proactive in reaching out to the trade allies.
3	The PAs need to simplify paperwork and accelerate rebate processing.
4	Reach out to trade ally organizations to disseminate program information and identify contractors who would promote the programs.
5	A standard lifecycle cost tool would probably be well-received.
6	Market the reduced interest financing option to dormant participants.
7	The vendor interviews reaffirmed previous process evaluation findings that PAs need to work closely with architects and engineers who specify the new construction and major renovation projects.
8	The PAs should implement a means of combining small jobs into a bigger pool.
9	The program needs to do a better job of warning program vendors about changes in program funding.
10	In order to clearly identify projects by end-use, the PARIS categories should be adopted, and data entry constrained to the following values.
11	Measure Categories should be used to indicate how projects are treated within these end-uses, according to the list of measures in the TRM.
12	A set of core data should be collected for all projects and included in tracking systems.
13	All data that is collected on customer application forms should be captured in tracking systems so that it is available for analysis.
14	Create or populate a field with consistent business type names.
15	Define Custom vs. Prescriptive projects based on savings calculation
16	Define C&I customer size categories by rate class instead of program.
17	Enter data project data or create queries that extract files in such a way that each record represents a single customer site, project and type of measure.
18	Save the queries or code used to produce extract files from one year to the next.
19	Develop a statewide security policy and practice to allow all project and customer data to be delivered at once.

#	Recommendation
20	Build the capability to link gas and electric customer projects.
21	Provide a mechanism for linking billing and tracking data.
22	Add quality control through rule-based data entry screens that prevent invalid combinations of program, end use and measure category.
23	Calculate savings through lookup tables, wherever possible.
24	Provide premise number instead of account number where available.

How the Study Came to the Recommended Conclusions: The study draws on multiple sources of information including: In-depth interviews with EEAC consultants, C&I program managers and staff, participating and nonparticipating trade allies, trade association representatives, and participating customers; Focus group discussions with participating customers; Computer-Aid Telephone Interview ("CATI") surveys with hundreds of participants including both recent (2010-2011) participants and "dormant" participants who have not participated in the C&I programs since 2008-2009; and an examination of the various PA program tracking databases.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: As this report was recently issued, the recommendations are currently under consideration.

A copy of the complete study can be found in Appendix C, Study 22.

23. HVAC Market Characterization and Penetration Analysis – Final Report

Type of Study: Process Evaluation

Objective of the Study: The objective of the study was to estimate the market penetration of energy-efficient equipment in the Massachusetts commercial HVAC market, gauge the level of large C&I program influence on market penetration, and characterize the market for emergency replacement.

Programs to which the Results of the Study Apply:

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

Recommendations Derived from the Study:

#	Recommendation
1	Consider raising efficiency levels for condensing gas boilers. Given the high market penetration for high-efficiency condensing gas boilers reported by both participating contractors (84%-90%) and non-participants (90%-100%), it appears that the program could benefit from raising efficiency levels.
2	Consider offering stocking incentives to distributors. One-half of respondents believe that availability is an important factor in selecting new equipment in emergency replacement situations. In order to ensure the wide availability of high-efficiency models, consider offering stocking incentives to distributors to maintain an inventory of high-efficiency equipment.

How the Study Came to the Recommended Conclusions: The evaluation included telephone interviews with commercial HVAC contractors and distributors in Massachusetts. The evaluation had a goal of completing 80 interviews, however only 51 were completed. Each respondent was asked to estimate the market penetration for their firm. This figure was then rolled up to estimate market penetration for the entire market.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: As this report was recently issued, the recommendations are currently under consideration.

A copy of the complete study can be found in Appendix C, Study 23.

24. Prescriptive Gas Final Program Evaluation Report

Type of Study: Impact Evaluation

Objective of the Study: The study's objective was to produce revised annual therm savings estimates for program administrators' condensing boiler, condensing furnace, infrared heater and indirect water heater prescriptive gas projects for both prospective and retrospective savings. An 80% confidence interval was set in the sample design. Therm savings were to be produced at the individual PA level and also at the statewide level.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Gas Only)
- C&I Retrofit (Gas Only)

Results of the Study and How the Study Determined those Results:

Recommended Condensing Boiler Savings:

Size Category	Revised Capacity (MBtu)	AFUE	EFLH	Original Savings (ΔMMBtu/Unit/yr)	Evaluated (Retrospective) Savings (ΔMMBtu/Unit/yr)	Recommended Prospective Savings (ΔMMBtu/Unit/yr)
Capacity ≤ 300	209.6	88.9%	1400	22.1	29.8	29.4
300 < Capacity < 500	400	88.9%	1400	42.3	56.9	56.1
500 ≤ Capacity < 1000	735	88.9%	1400	77.1	104.6	103.0
1000 ≤ Capacity ≤ 1700	1350	88.9%	1400	142.6	192.1	189.2
1700 < Capacity	2363	88.9%	1400	249.0	336.2	331.2

Recommended Condensing Furnace Savings:

Furnace Efficiency	Original Savings (ΔMMBtu/Unit/yr)	Evaluated (Retrospective) Savings (ΔMMBtu/Unit/yr)	Recommended Prospective Savings (ΔMMBtu/Unit/yr)
Furnace AFUE =>92%	21.1	5.9	13.5
Furnace AFUE =>92% w/ECM	19.6	5.5	12.5
Furnace AFUE =>94% w/ECM	23.6	6.2	14.9

Recommended Infrared Heater Savings:

Measure Type	Original Savings (ΔMMBtu/Unit/yr)	Evaluated (Retrospective) Savings (ΔMMBtu/Unit/yr)	Recommended Prospective Savings (ΔMMBtu/Unit/yr)
Infrared Heater	74.4	22.3	48.3

Recommended Indirect Water Heater Savings:

Measure Type	Original Savings (ΔMMBtu/Unit/yr)	Evaluated (Retrospective) Savings (ΔMMBtu/Unit/yr)	Recommended Prospective Savings (ΔMMBtu/Unit/yr)
Indirect Water Heater	30.4	20.7	20.7

The study determined therm savings estimates at the statewide level. The evaluation consisted 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 approximately

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 early February 2012 and recovery was completed during the second week of April 2012. 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.

How the Results of the Study Impact each Identified Program's Savings: How the results impact each program's savings is a function of the previous realization rates that were being incorporated into each PA's savings models. For instance, if a PA had been carrying a higher realization rate than was produced in this study, the affected program's savings would decrease once the new realization rate was incorporated.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): Net Savings = Gross Savings x Gross Realization Rate[4] x (1 – Freeridership Rate + Spillover Rate). Further information can be found in the Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures 2011 Program Year – Report Version.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: N/A – This study has been adopted by all PAs.

A copy of the complete study can be found in Appendix C, Study 24.

[4] Realization rate determined by this study.

25. Impact Evaluation of 2010 Custom Gas Installations

Type of Study: Impact Evaluation

Objective of the Study: The study's objective was to produce annual therm savings realization rates for program administrators' custom gas projects. An 80% confidence interval was set in the sample design. Realization rates were to be produced at the individual PA level and also at the statewide level.

Programs to which the Results of the Study Apply:

- C&I New Construction and Major Renovation (Gas Only)
- C&I Retrofit (Gas Only)

Results of the Study and How the Study Determined those Results:

Statistic	Annual Therms
All Program Administrators	
Total Tracking Savings	4,427,361
Total Measured Savings	2,991,776
Realization Rate	67.6%
Relative Precision at 80% Confidence	±9.0%
Error Bound at 80% Confidence	268,703
Sample Size	48
Error Ratio	0.50

PA	Annual Therms	PA	Annual Therms
Berkshire Gas		**National Grid**	
Total Tracking Savings	89,684	Total Tracking Savings	1,710,500
Total Measured Savings	34,660	Total Measured Savings	1,172,176
Realization Rate	38.6%	Realization Rate	68.5%
Relative Precision at 80% Confidence	±0.8%	Relative Precision at 80% Confidence	±17.4%
Error Bound at 80% Confidence	276	Error Bound at 80% Confidence	203,593
Sample Size	2	Sample Size	17
Error Ratio	0.02	Error Ratio	0.62
Columbia Gas		**NSTAR**	
Total Tracking Savings	1,553,740	Total Tracking Savings	938,625
Total Measured Savings	1,293,037	Total Measured Savings	444,200
Realization Rate	83.2%	Realization Rate	47.3%
Relative Precision at 80% Confidence	±12.9%	Relative Precision at 80% Confidence	±11.2%
Error Bound at 80% Confidence	167,329	Error Bound at 80% Confidence	49,693
Sample Size	13	Sample Size	13
Error Ratio	0.42	Error Ratio	0.39
New England Gas		**Unitil**	
Total Tracking Savings	23,400	Total Tracking Savings	111,412
Total Measured Savings	12,902	Total Measured Savings	34,801
Realization Rate	55.1%	Realization Rate	31.2%
Relative Precision at 80% Confidence	±0.0%	Relative Precision at 80% Confidence	±48.3%
Error Bound at 80% Confidence	-	Error Bound at 80% Confidence	16,807
Sample Size	1	Sample Size	2
Error Ratio	0.00	Error Ratio	0.86

The study determined realization rates at the PA level and statewide level. Evaluation activities included visual inspection of the installed measures, acquisition of nameplate data, spot measurements of boiler efficiencies, interviews with knowledgeable site staff, review of plans, and placement of logger equipment. Depending upon the measure under evaluation, loggers were placed to measure parameters such as supply air temperatures, return and supply water temperatures, and motor runtime profiles. The study design provided for a longer than normal two week logging period. Loggers were left in place for a minimum of a week and for as much as eight weeks. When possible, trend data was secured from the building automation system. Capturing distribution company billing data for all the affected meters at a site was a goal as well. The engineer selected from a variety of analytical techniques as appropriate for the measure including eQuest building simulation models and bin temperature models. Customer gas bills were used to calibrate bills, corroborate savings, and in some cases used as the primary means of determining savings impacts.

PAs represented in the study sample were Berkshire Gas, Columbia Gas, New England Gas, National Grid, NSTAR and Unitil. The study produced statewide results that are reliable (±9.0%) at 80% confidence. In addition, the precision levels for several PAs (National Grid: ±17.4%, Columbia Gas: ±12.9%, and NSTAR: ±11.2%) are sufficient to warrant application of the three individual PA realization results to the 2011 results according to the protocol established in the November 2010 Protocol memo, which stated that individual realization rates may be applied for those PAs with more than ten sites and a final precision better than ±9.0%.

How the Results of the Study Impact each Identified Program's Savings: How the results impact each program's savings is a function of the previous realization rates that were being incorporated into each PA's savings models. For instance, if a PA had been carrying a higher realization rate than was produced in this study, the affected program's savings would decrease once the new realization rate was incorporated.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): Net Savings = Gross Savings x Gross Realization Rate[5] x (1 – Freeridership Rate + Spillover Rate). Further information can be found in the Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures 2011 Program Year – Report Version.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: N/A – This study has been adopted by all PAs.

A copy of the complete study can be found in Appendix C, Study 25.

[5] Realization rate determined by this study.

F. Special and Cross Sector Studies

26. Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report

Type of Study: Impact and Process Evaluation

Objective of the Study: This report provides the findings from the 2011 annual impact and process evaluation of the Massachusetts Behavioral programs. This represents the second formal report of the three-year evaluation under the Massachusetts Cross-Cutting evaluation area. This report covers two of three behavior programs or pilots implemented between 2009 and 2011: the Behavior/Feedback programs administered by National Grid and NSTAR which are both implemented by OPOWER, and the Behavior/Feedback pilot administered by WMECo, called Western Mass Saves and implemented by C3.

The study evaluates the savings impacts of the two behavior programs or pilots during the 2011 program year. The report also includes a demographic analysis of the savings for the Behavior/Feedback program administered by National Grid. The report also includes a process evaluation of the Behavior/Feedback pilot administered by WMECo, which included a customer survey and web statistics.

Additionally, the report investigates a number of research questions related to behavior programs, such as: How do savings differ by opt-in or opt-out programs? Will the savings persist with or without treatment? Do these programs lead to additional participation in other programs and what are the associated energy savings? Are there specific population characteristics that lead to greater savings?

Programs to which the Impact Results of the Study Apply:

- Behavior/Feedback (Electric & Gas)

Results of the Study and How the Study Determined those Results:

Behavior/Feedback Gas Results:

PA	Cohort or Measure Name	Program Year	Base Usage	Annualized Net Savings per HH	Net Savings %	Total Evaluated Participants
National Grid	2009	PY2	137.2 MMBTUs	1.72 MMBTU	1.25%	23,685
National Grid	2010	PY1	139.9 MMBTUs	1.69 MMBTU	1.21%	74,138
National Grid	2011	PY1	102.7 MMBTUs	1.02 MMBTU	0.99%	87,691

Complete results of the impact evaluation can be found in Section 5 of "Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report."

Net program savings were determined by conducting billing analysis to estimate annual electric and therm savings. Average annual net savings attributable to the behavioral program were determined using a linear fixed effects regression analysis of customer billing data that included billing data from behavioral program participants (who received the Home Energy Reports), and a matched comparison group of residential customers. The billing analysis approach is described in Section 3.4 of "Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report."

In addition, net program savings were also determined by conducting a channeling analysis where net program savings determined by billing analysis were adjusted by factoring out deemed savings values counted in other programs. Therefore, the savings values cited here reflect only those program savings directly obtained by the Behavior/Feedback program, factoring out savings jointly attributable to the Behavior/Feedback program *and* other energy efficiency programs. This adjustment is described in Section 3.3 of "Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report."

How the Results of the Study Impact each Identified Program's Savings: Please see Table II.A.08 in National Grid's and Western Massachusetts Electric Company's 2011 Energy Efficiency Annual Reports and Table II.A.9 in NSTAR Gas Company's 2011 Energy Efficiency Annual Report.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): Please see the Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures 2011 Program Year – Report Version.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why:

Impact results for the Behavior/Feedback programs are being adopted.

Programs to which the *Process* Results of the Study Apply:

- Behavior/Feedback Pilots (Electric Only)
- Behavior/Feedback Programs(Electric & Gas)

Recommendations Derived from the Study: The process evaluation identified recommendations in two areas: (1) program design and evaluation for opt-in programs, (2) evaluating persistence.

#	Recommendation
1	Program design and evaluation for opt-in programs: • Waitlisted or delayed treatment participants should be used whenever possible to establish a comparison group. • In the absence of a waitlist or delayed treatment, Variability in Adoption ("VIA") designs are the most appropriate for quasi-experiments. • Ensure that the "treatment effects" do not occur prior to treatment, indicating a pre-existing saving trajectory (no treatment effects seem to occur prior to treatment). • Employ surveys and other qualitative research techniques to assess what customers would have done in the absence of the program. • Evaluation must also consider the effects of feedback in keeping customers on a trajectory. • Consider adjusting the impact models to account for self-selection bias.
2	Evaluating persistence: • Persistence should be examined in two ways: (1) with program treatment, and (2) without program treatment. • All behavioral programs should be continually evaluated for persistence; however opt-in models have little data to date that document persistence beyond one year. • Evaluating/measuring participants' and non-participants' attitudes and intentions using a tested conceptual model can provide confidence in interpreting statistical results.

How the Study Came to the Recommended Conclusions: The study developed the recommendations by researching and citing best practices for evaluating quasi-experimental design and persistence in behavior programs.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: The Company will adopt the recommendations from the study because they will help maintain evaluation best practices.

A copy of the complete study can be found in Appendix C, Study 26.

27. Massachusetts Umbrella Marketing Evaluation Report

Type of Study: Process Evaluation

Objective of the Study: The objective of this study was to establish baseline campaign awareness in advance of the 2012 marketing campaign. The report also builds on an interim evaluation of the 2010 Massachusetts Umbrella MassSAVE Statewide Marketing Campaign, which focused on documenting the campaign's organizational structure and initial strategy.

Programs to which the Results of the Study Apply:

- Residential New Construction & Major Renovation (Electric and Gas)
- Residential Cooling & Heating Equipment (Electric)
- Multi-Family Retrofit (Electric and Gas)
- MassSAVE (Electric and Gas)
- Behavior/Feedback Program (Electric and Gas)
- ENERGY STAR® Lighting (Electric)
- ENERGY STAR® Appliances (Electric)
- Residential Heating and Water Heating (Gas)
- Weatherization Program (Gas)
- C&I New Construction & Major Renovation (Electric and Gas)
- C&I Retrofit (Electric and Gas)

Recommendations Derived from the Study: There are no recommendations from this report as it was designed to establish baseline campaign awareness.

How the Study Came to the Recommended Conclusions: Not Applicable

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: Not Applicable

A copy of the complete study can be found in Appendix C, Study 27.

28. Additional Non-Energy Impacts for Low Income Programs

Type of Study: Impact

Objective of the Study: This study includes additional investigation that clarifies and expands the research performed in the Residential and Low-Income Non-Energy Impacts Evaluation. The additional information focused on refrigerator recycling, lighting quality, price hedging, and economic development.

Programs to which the Results of the Study Apply:

- Low-Income Single Family Retrofit (Electric and Gas)
- Low-Income Multi Family Retrofit (Electric and Gas)

Results of the Study and How the Study Determined those Results: The results have a positive impact on the benefits attributable to low income programs. The results were arrived at through a process of meeting and building consensus among PAs, LEAN, and the EEAC.

Lighting Quality:

Item	NEI
Increased Lighting Quality	$56/participant

Refrigerator Recycling:

Item	NEI
Avoided Landfill Space	$1.06
Plastics & Glass Recycling	$1.25
Incineration Insulating Foam	$170.22

Price Hedging:

Item	NEI
Hedge against volatile prices	$0.76/MMBTU of gas
	$0.005/kWh

Economic Development:

Massachusetts – Gas Estimate					
Increase in GSP (Billion $) (1)	Savings (Tbtu) (2)	Savings (therms) (3)	Economic output per therm (4)	11% for low income (5)	Inflated from 2008 to 2011$ (6)
28	664	6,640,000,000	$4.22	$0.46	$0.486
(1) Energy Efficiency: Engine of Economic Growth; ENE; October 2009; page 49.					
(2) Energy Efficiency in Massachusetts: Engine of Economic Growth; ENE; October 2009; page 2.					
(3) Tbtu times 10,000,000					
(4) Calculated as Increase in GSP/Savings (therms)					
(5) Multiply economic output per therm by 11%; assumes 11% inures to the benefit of low-income (the low-income fraction of population).					
(6) Uses an inflation rate of 1.85% from BCR models.					

How the Results of the Study Impact each Identified Program's Savings: This additional research will result in an increase in benefits in the Low-Income Programs.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): Not Applicable.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why: The results of the study are adopted.

A copy of the complete study can be found in Appendix C, Study 28.

29. 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study

Type of Study: Impact Evaluation

Objective of the Study: The primary objective of the 2011 program year Free-ridership and Spillover Study was to assist the Massachusetts PAs in quantifying the net impacts of their commercial and industrial natural gas energy efficiency programs by estimating the extent of Program free-ridership, Early participant "like" and "unlike" spillover, and Nonparticipant "like" spillover.

Programs to which the Results of the Study Apply:

- C&I New Construction & Lost Opportunity (Gas Only)
- C&I Retrofit (Gas Only)
- C&I Direct Install (Gas Only)

Results of the Study and How the Study Determined those Results:

PA	Program Type	Sur-veyed	Pop-ulation	Population Savings	Free-ridership Rate	90% Margin Error (±)	Participant "Like" Spillover Rate	90% Margin Error (±)	Non-participant Spillover Rate	N R
Berkshire Gas	Custom	11	30	99,832	3.5%	7.2%	13.6%	13.5%	0.0%	110
	Prescriptive	24	74	41,089	46.9%	13.8%	49.4%	13.8%	0.2%	102
	Total	**35**	**104**	**140,921**	**16.1%**	**8.3%**	**24.0%**	**9.7%**	**0.1%**	**108**
Columbia Gas	Custom	27	147	1,081,175	7.8%	7.7%	1.7%	3.6%	0.4%	94.2
	Prescriptive	41	205	55,642	24.0%	9.8%	0.2%	0.9%	1.1%	77.2
	Total	**68**	**352**	**1,136,817**	**8.6%**	**5.0%**	**1.6%**	**2.2%**	**0.4%**	**93.4**
National Grid	Custom	47	254	3,361,773	27.9%	9.7%	9.6%	6.4%	1.0%	82.7
	Prescriptive	287	1,886	960,498	19.5%	3.5%	7.4%	2.3%	0.2%	88.2
	Total	**334**	**2,140**	**4,322,271**	**25.7%**	**3.6%**	**9.0%**	**2.4%**	**0.8%**	**84.1**
New England Gas	Custom	0	2	95,831	NA	NA	NA	NA	3.1%	NA
	Prescriptive	12	30	22,417	23.0%	15.5%	0.0%	0.0%	0.5%	77.5
	Total	**12**	**32**	**118,248**	**23.0%**	**15.8%**	**0.0%**	**0.0%**	**2.6%**	**79.6**
NSTAR	Custom	23	89	2,050,931	57.5%	14.6%	11.4%	9.4%	0.8%	54.7
	Prescriptive	88	755	425,092	16.0%	6.0%	3.9%	3.2%	0.3%	88.2
	Total	**111**	**844**	**2,476,023**	**51.3%**	**7.3%**	**10.3%**	**4.4%**	**0.7%**	**59.7**
Unitil	Custom	0	2	32,377	NA	NA	NA	NA	0.0%	NA
	Prescriptive	16	33	47,610	24.5%	12.7%	0.0%	0.0%	0.2%	75.7
	Total	**16**	**35**	**79,987**	**24.5%**	**13.0%**	**0.0%**	**0.0%**	**0.2%**	**75.7**
Statewide	Custom	108	524	6,721,919	33.1%	6.6%	8.8%	4.0%	0.8%	76.5
	Prescriptive	468	2,983	1,552,349	19.8%	2.8%	7.4%	1.8%	0.3%	88.0
	Total	**576**	**3,507**	**8,274,268**	**30.5%**	**2.9%**	**8.5%**	**1.7%**	**0.7%**	**78.7**

The methodology used for this study follows the standardized methodology developed in 2010 and 2011 for the Massachusetts PAs[7] for use in situations where end-users are able to report on program impacts via self-report methods. Telephone surveys were conducted with 2011 program participants in each of the PA's C&I natural gas programs and with design professionals and equipment vendors involved in these 2011 installations.

How the Results of the Study Impact each Identified Program's Savings: As this study produced PA-specific results, each PA will see a different impact for the study. Each identified programs used NTG rates of 100% for planning values in 2011, so most PAs saw a decrease in

[6] NTG Rate is calculated as (1-Free-ridership Rate) + Participant "Like" Spillover Rate.

[7] "Cross-Cutting C&I Free-Ridership and Spillover Methodology Study Final Report", prepared for the Massachusetts Program Administrators by Tetra Tech, KEMA, and NMR, May 20, 2011.

program savings due to this study however, one PA (Berkshire Gas), saw an increase as their NTG rate is greater than 100%.

Formulas Necessary to Understand the Impact of the Study on the PA's Program(s): Gross Savings * Realization Rate * NTG Rate = Net Program Savings. This study updated the NTG Rate for all Gas PAs.

If the Results of the Study Are Not Adopted by the PA, Fully Explain Why:

N/A – This study has been adopted by all PAs.

A copy of the complete study can be found in Appendix C, Study 29.

30. Community Based Partnership Interim Process Evaluation

Type of Study: Process

Objective of the Study: The overall objective of this evaluation is to assess the effectiveness of each community-based partnership that falls within the scope of the evaluation and determine its potential for replication and/or full-scale implementation.

The *Community-Based Partnerships 2011 Evaluation Final Report* provides an overview of each effort's structure and performance against the goals, presents findings from the research activities conducted with a goal of providing feedback and identifying areas for program improvement. The report also presents comparative analysis of community-based efforts under evaluation with the goal of developing best practices for design and implementation of such efforts.

Programs to which the Results of the Study Apply:

- Renew Boston (Electric and Gas)
- New Bedford Community Mobilization Initiative (Electric and Gas)

Recommendations Derived from the Study:

#	Finding
1	Determine the goals of each community-based effort (and how it complements the overall portfolio) upfront.
2	Be strategic with the selection of communities.
3	Understand the targeted population and barriers that might prevent the achievement of goals. Clearly document how the community-based initiative seeks to intervene prior to launch.
4	Establish metrics before launching the effort, and track metrics consistently across community-based initiatives.
5	Consider most efficient and cost-effective delivery structure that would align with the effort's goals.
6	Require that all costs and resources required for support be clearly documented and tracked.
7	For future evaluation efforts explicitly evaluate participation trends; marketing efforts and conversion rates; and the full costs of these partnerships, including resources expended by the PAs, implementers and community groups.

How the Study Came to the Recommended Conclusions: The findings presented in the study were developed through analysis of program materials and tracking databases, in-depth interviews with the PA staff, in-depth interviews with program stakeholders and community groups, historical participation analysis (for one effort), and participant interviews. As part of the research, the evaluation team has also conducted a literature review of community-based programs implemented across the United States, and developed both partnership-specific logic models and an overarching theory of change for community-based partnerships.

Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why: These findings are targeted at future efforts, and will be considered by the PAs and interested stakeholders as additional efforts are launched.

A copy of the complete study can be found in Appendix C, Study 30.

G. Future Studies

Table III.B details the studies in each of the six research areas that are either ongoing or planned for the next evaluation cycle. The list is not finalized, as discussions in each of the six research areas are still underway.

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		
RNC Net Impact Study	Study is planned but not yet submitted for approval	Yes
RNC Incremental Cost Study	Study is planned but not yet submitted for approval	Yes
RNC Baseline Study/Code Compliance Assessment*	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	Yes
Home Energy Services: Contractor Charettes in Support of Lost Opportunity Metric*	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	Yes
Net-to-Gross study on Residential Cooling & Heating Equipment (Cool Smart)*	Study is pending approval of the 2010 AR, D.P.U. 11-63 through D.P.U. 11-73 and D.P.U. 11-126	Yes
NTG study of the High Efficiency Heating Equipment (HEHE) program*	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	Yes
Home Energy Services: Impact Evaluation*	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	Yes
Residential Pilot Studies		
Process and Impact Evaluation of the WI FI Thermostat Pilot*	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	Yes
Electronically Commutated Motor (ECM) Circulator Pump Pilot Program*	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	Yes
Impact Evaluation of the 2011-2012 Boiler Reset Control Pilot Program*	Study is planned but not yet submitted for approval	Yes

Table III.B: Evaluation Studies in Next Annual Report		
Studies	Docket & Exhibit Approving Planned Evaluation Studies	Expected to be Implemented as Approved? (yes/no)
Commercial & Industrial Studies		
Small C&I Billing Analysis	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	Yes
Large C&I - Potential Study to assess the mid-sized C&I customers	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	Yes
Large C&I - 2011 Custom Gas Impact Evaluation	Study is planned but not yet submitted for approval	Yes
Large C&I - 2011 Prescriptive Gas Impact Evaluation	Study is planned but not yet submitted for approval	Yes
Large C&I - C&I Customer Profile	Study is planned but not yet submitted for approval	Yes
Large C&I - Existing Building Market Characterization	Study is planned but not yet submitted for approval	Yes
Large C&I - Whole System Approach Assessment	Study is planned but not yet submitted for approval	Yes
Large C&I - New Construction Market Characterization	Study is planned but not yet submitted for approval	Yes
Large C&I - New Construction Baseline Code Compliance Study*	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	Yes
Special & Cross-Cutting Studies		
Non-Energy Impacts 2011 - C&I*	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	Yes
Education Program Process (Literature Review)*	Study is planned but not yet submitted for approval	Yes
Residential Smart Energy Monitoring Pilot Impact Evaluation (CLC)	Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150	Yes
Community-Based Inititative: Northampton/Pittsfield	Study is planned but not yet submitted for approval	Yes

Table III.B: Evaluation Studies in Next Annual Report		
Studies	Docket & Exhibit Approving Planned Evaluation Studies	Expected to be Implemented as Approved? (yes/no)
Umbrella Marketing Post-Campaign Study	Study is planned but not yet submitted for approval	Yes
Job Creation Study*	Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116	Yes
*The PAs anticipate filing these studies with the 2013-15 Three Year Plan		

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 VI.A through VI.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

The most significant factor in the PA approach to minimizing administrative costs in 2011 was the statewide collaborative process, which was used by the PAs 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 PA individually, resulted in economies of scale that reduced the cost for each PA. For example, the joint release of many RFPs lead to minimization of administrative costs in that the costs for preparation and release of the RFPs were shared by the PAs. The PAs also minimized 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 was necessary and appropriate for all PAs 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 PAs sought 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 2010-2012 Three-Year Energy Efficiency Plan.

While the economies of scale and other steps taken by the PAs to minimize costs in 2011 were effective, and administrative costs incurred by the PAs are transparent and are presented in each PA's narrative and supporting tables (see Appendix B), 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 PAs' energy efficiency 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 PAs sought to minimize costs at all available opportunities, and not just from one point in time to another.

Table IV.A: Program Planning and Administration Costs						
Customer Sector / Program	Planned		Actual		Change from Planned to Actual	
	Value ($)	% of Total Program Costs	Value ($)	% of Total Program Costs	Value ($)	% of Total Program Costs
Residential						
Residential New Construction & Major Renovations	251,366	11%	188,306	7%	(63,060)	-4%
Residential Heating and Water Heating	488,123	6%	731,276	5%	243,153	-1%
MassSAVE	295,042	12%	111,624	4%	(183,417)	-8%
Weatherization Program	481,115	4%	413,989	6%	(67,126)	1%
Multifamily Retrofit	281,319	13%	184,281	8%	(97,038)	-5%
Behavior/Feedback Program	214,338	9%	135,244	5%	(79,094)	-4%
Deep Energy Retrofit	120,147	14%	192,934	34%	72,787	21%
Residential Building Practices and Demonstration Program	36,623	14%	5,994	11%	(30,629)	-3%
Energy Analysis: Internet Audit Program	188,373	59%	5,972	3%	(182,401)	-57%
Community based pilots	52,216	35%	36,635	24%	(15,581)	-12%
Workforce Development	-	0%	-	0%	-	0%
Statewide Marketing & Education	-	0%	-	0%	-	0%
EEAC Consultants	346,166	100%	154,301	100%	(191,865)	0%
DOER Assessment	208,124	100%	204,105	100%	(4,019)	0%
Sponsorships & Subscriptions	158,818	100%	-	0%	(158,818)	-100%
Residential Total	**3,121,770**	**10%**	**2,364,663**	**7%**	**(757,107)**	**-3%**
Low-Income						
Low-Income Single Family Retrofit	1,605,467	17%	378,956	6%	(1,226,511)	-12%
Low-Income MultiFamily Retrofit	362,669	7%	212,457	5%	(150,212)	-2%
Statewide Marketing & Education	-	0%	0	0%	0	0%
Low Income Energy Affordability Network Funding	243,941	100%	229,560	100%	(14,381)	0%
Low Income DOER Assessment	89,196	100%	73,565	100%	(15,631)	0%
Low-Income Total	**2,301,273**	**15%**	**894,537**	**8%**	**(1,406,736)**	**-7%**
Commercial & Industrial						
C&I New Construction & Major Renovation	660,367	11%	814,826	13%	154,458	2%
C&I Retrofit	927,059	9%	1,182,005	15%	254,946	5%
C&I Direct Install	141,259	27%	142,177	40%	918	13%
Workforce Development	20,000	100%	5,745	99%	(14,255)	-1%
Business Energy Analyzer	-	0%	4,622	5%	4,622	5%
Deep Energy Retrofit	39,855	11%	28,499	73%	(11,355)	61%
Statewide Marketing & Education	-	0%	(0)	0%	(0)	0%
EEAC Consultants	287,865	100%	182,464	100%	(105,401)	0%
DOER Assessment	247,474	100%	171,651	100%	(75,823)	0%
Sponsorships & Subscriptions	40,828	100%	-	0%	(40,828)	-100%
C&I Total	**2,364,707**	**13%**	**2,531,989**	**16%**	**167,281**	**3%**
GRAND TOTAL	**7,787,750**	**12%**	**5,791,188**	**9%**	**(1,996,561)**	**-3%**

The change from Planned to Actual percent of Total Program Costs was calculated as the difference of the other two percentages in the table above. The same calculation was performed at the sector level. No sector showed a variance greater than 10% between planned and actual PP&A as a percent of total program costs.

C. Competitive Procurement

Table IV.B: Outsourced & Competitively Procured Services									
Customer Sector	In-House Activities		Outsourced Activities						TOTAL Activities
			Competitively Procured		Non-Competitively Procured		Total Outsourced Activities		
	$	% of Total Activities	$	% of Total Outsourced	$	% of Total Outsourced	$	% of Total Activities	$
Residential									
Planned	2,669,090	31%	4,217,065	71%	1,758,796	29%	5,975,861	69%	8,644,951
Actual	2,892,286	36%	3,446,885	66%	1,876,179	36%	5,236,492	64%	8,128,778
% Difference from Planned to Actual	8%	-140%	-18%	148%	7%	-54%	-12%	-5%	-6%
Low-Income									
Planned	642,004	12%	862,463	18%	3,846,804	82%	4,709,267	88%	5,351,271
Actual	933,148	29%	634,237	0%	1,651,310	100%	2,285,547	71%	3,218,696
% Difference from Planned to Actual	45%	17%	-26%	-18%	-57%	18%	-51%	-17%	-40%
Commercial & Industrial									
Planned	3,171,207	49%	1,618,204	48%	1,727,187	52%	3,345,391	51%	6,516,598
Actual	3,199,685	140%	765,179	4%	1,208,085	96%	1,129,912	49%	2,283,658
% Difference from Planned to Actual	1%	91%	-53%	-45%	-30%	45%	-66%	-2%	-65%
TOTAL									
Planned	6,482,300	32%	6,697,732	48%	7,332,787	52%	14,030,519	68%	20,512,820
Actual	7,025,119	136%	4,846,301	246%	4,735,573	240%	1,973,264	38%	5,172,948
% Difference from Planned to Actual	8%	104%	-28%	198%	-35%	188%	-86%	-30%	-75%

As shown in the right hand column in Table IV.B, "Total Activities," overall spending on combined PP&A, sales, technical assistance and training, evaluation and marketing services were less than planned in each sector in 2011. The Company was able to perform these services and deliver energy savings while spending less than budgeted amounts. The difference from planned to actual spending on Total Outsource Activities and Total In House Activities generally tracked the difference in the spending on Total Activities for the same reason, with the exception of the Low Income sector, due to the unique characteristics of that program's administration.

D. Low Income Spending

Table IV.C: Customer Sector Budget Allocation						
Customer Sector	Planned		Actual		Change from Planned to Actual	
	Total Sector Program Costs	% of Total Program Costs	Total Sector Program Costs	% of Total Program Costs	Value	% Change
Residential	$ 31,152,066	49%	$ 31,013,276	54%	$ (138,790)	5%
Low-Income	$ 15,045,041	24%	$ 11,272,187	19%	$ (3,772,854)	-4%
Commercial & Industrial	$ 17,636,649	28%	$ 15,587,883	27%	$ (2,048,766)	-1%
TOTAL	**$ 63,833,756**	**100%**	**$ 57,873,345**	**100%**	**$ (5,960,411)**	**0%**

National Grid's actual low-income spending in 2011 was 19% of the overall budget. This value is within a reasonable variance of the planned budget.

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 VII summarizes the performance incentives earned by the Company by component for its successful delivery of energy efficiency programs in 2011.

Table VII summarizes the performance incentives earned by the Company for its successful delivery of energy efficiency programs in 2011.

Table VII: Performance Incentives Summary				
Incentive Components	**Threshold**	**Design**	**Exemplary**	**Actual Incentive**
Savings Mechanism	$ 816,567	$ 1,088,757	$ 1,360,946	$ 1,188,035
Value Mechanism	$ 401,988	$ 535,984	$ 669,980	$ 669,980
Performance Metrics	$ 421,157	$ 561,543	$ 701,929	$ 457,096
Total Incentive (before-tax)	$ 1,639,713	$ 2,186,284	$ 2,732,854	$ 2,315,111
Total Incentive (after-tax)	$ 996,535	$ 1,328,714	$ 1,660,892	$ 1,407,009

The planned values referenced in the Performance Incentives Summary Table above were originally filed in the performance incentives model set forth at Attachment B to the Memorandum of Agreement filed with the Department on April 15, 2011 in Boston Gas Company and ColonialGas Company d/b/a National Grid, D.P.U. 10-140 ("2011 MOA"). The tax rate used to calculate the before-tax total incentive is 60.775 percent.

All supporting documentation for each performance incentive component, including detailed information one the Company's clear and distinct role in achieving the performance metrics, can be found in Appendix D. Evaluation results for all sectors required the EM&V impact bandwidth of 25% of preliminary results to be applied. Residential sector evaluated results were 158% of preliminary results but were capped at 125% of preliminary results. Low income sector evaluated results were 68% of preliminary results but were limited to 75% of preliminary results. C&I sector evaluated results were 63% of preliminary results but were limited to 75% of preliminary results.

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 2011 MOA, using the post-evaluation benefits and taking into account the 25% EM&V impact bandwidth. The Company achieved 109% of its planned benefits and 127% of its planned net benefits at the portfolio level, surpassing the 75% threshold required in order to earn both the savings and value mechanisms of the performance incentive. Net benefits were capped at 125% of planned benefits at the portfolio level. Using evaluated results (subject to the +/- 25% impact bandwidth), the Company calculated the lifetime benefits and net benefits that each program achieved. The benefits were multiplied by the savings payout rate of $0.00609 and the net benefits were multiplied by the value payout rate of $0.00639, per the 2011 MOA. 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 2011 MOA. A model illustrating the calculation of the performance incentives in accordance with this methodology is included as Appendix D, Section 1.

A summary of the Company's performance for each Performance Metric is set forth below. Additional supporting documentation related to performance metrics is included as Appendix D, Section 2.

The table below shows a summary of the Company's performance for each Performance Metric.

National Grid 2011 Gas Performance Metrics Summary[1]

	Achievement Level	Actual Units/Task Achieved	Pre Tax Incentive
Residential			
RES #1 MassSAVE/Weatherization: Deeper Savings	Increase in # of Customers: **Exemplary**	**469%**	$ 50,539
	Increase in Savings: **None**	**n/a**	$ -
Outreach	**Exemplary**	**Produced Report**	$ 101,078
Low Income			
Low Income #1. Hard to Reach Landlords	**Exemplary**	**See Low Income Metric 1**	$ 52,411
Low Income #2. New Measures	**Exemplary**	**See Low Income Metric 2**	$ 52,411
Low Income #3. Multi-family Building Inventory	**Exemplary**	**See Low Income Metric 3**	$ 52,411
Commercial and Industrial			
C&I #1 Retrofit Depth of Savings	**None**	**n/a**	$ -
C&I #2 N/C Comprehensiveness and Depth of Savings	**None**	**n/a**	$ -
C&I #3 Direct Install Electric and Gas Integration	**Exemplary**	**20%**	$ 50,539
C&I #4 Combined Heat & Power (CHP)	**None**	**n/a**	$ -
All Sector			
Other Financing Capital	**None**	**n/a**	$ -
Cost Efficiency	**Design**	**116%**	$ 97,708
Total			**$ 457,096**

1. See Appendix D, Section 3 for performance metric details and supporting documentation for reported acheivement levels.

Appendix D, Section 3 contains documentation supporting the Company's performance, including a description of its role in each performance metric, especially for those designed on a statewide basis, and explain why the PA should earn the incentive associated with such metric.

VI. Audits

Other than the Navigant Consulting, Inc. audit filed with the Company's 2010 Gas Energy Efficiency Annual Report, there were no other audits performed.

Appendix A:
Glossary of Terms and Abbreviations

Appendix A, Section 1:

Types of Costs in Each Budget Category

Types of Costs in each Budget Category

Please see the following descriptions of budget cost categories. The categories described below are generally consistent among all Program Administrators, 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 the PP&A, Marketing-Advertising, Sales, Technical Assistance & Training, and Evaluation & Market Research categories, depending on the employee's responsibility.

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.

Costs that cannot be assigned directly to a program are allocated among relevant programs on an appropriate basis and tracked accordingly.

Planning and Administration include costs associated with developing program plans, including market transformation plans, research and development (excluding R&D assigned to Evaluation & 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 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 includes 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 as rebates or in other forms.

Sales, Technical Assistance & Training are administration, sales technical assistance and training costs to motivate (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) manufactures to make energy efficiency products; and (5) vendor services and supplies that demonstrate benefits of energy efficiency.

Evaluation and Market Research include costs associated with evaluation activities, including costs related to cost-effectiveness evaluation, market research (e.g., baseline studies, market assessments, surveys), impact and process evaluation reports, tracking and reporting program inputs and outputs, funding studies, and other costs clearly associated with evaluating the program.

Performance Incentives are funds earned by a Program Administrator based on its performance in implementing its Energy Efficiency Programs and shall be determined pursuant to § 3.6 of the Department's Energy Efficiency Guidelines.

Appendix A, Section 2:
Glossary of Defined Terms

GLOSSARY OF TERMS AND ABBREVIATIONS	
Annual kWh Reduction	Expected net annual energy savings after all impact factors have been taken into consideration.
AAP	Accelerated Application Process
AMP	Appliance Management Program
BBRS	Board of Building Regulations and Standards
BFM	Brushless Fan Motor
CAP	Community Action Program
CBO	Community Based Organization
CEE	Consortium for Energy Efficiency
CFL	Compact Fluorescent Lamps
C&I	Commercial and Industrial
Coincident Peak Demand	Demand for electricity at the time of the Company's peak demand.
Customer Incentive	Direct rebates to customers, upstream incentives paid to retailers and wholesalers, and rebates paid to vendors to reduce participant costs (see description of participant costs).
Delta Watts	The difference in the watts between pre-existing or baseline lighting equipment and energy efficient lighting equipment.
Demand	The amount of electric energy used by a customer or piece of equipment at a specific time, expressed in kilowatts.
Demand Adjustment Factor	This factor is a combination of one or more evaluation impact parameters applied to gross demand savings in the calculation of net demand savings.
Department	Massachusetts Department of Public Utilities
Diversity Factor	Percent of savings available at the time of the Company's peak demand.
DOE	Department of Energy
DOER	Massachusetts Department of Energy Resources

D&R	D&R International, the contractor to DOE and EPA that monitors sales of ENERGY STAR® appliances.
DRIPE	Demand Response Induced Price Effect – the impact of efficiency and demand response programs on market prices. It is based on the economic theory that programs will reduce energy quantities in the future, resulting in lower prices for electric energy and capacity markets.
DSM	Demand Side Management
D.T.E.	Massachusetts Department of Telecommunications and Energy
D.P.U.	Massachusetts Department of Public Utilities
EFLH	Equivalent Full Load Hours
Energy Adjustment Factor	A factor made up of one or more evaluation impact parameters applied to gross kWh savings in the calculation of net kWh savings.
EPA	Environmental Protection Agency
EPACT	Energy Policy Act
ENERGY STAR®	Brand name for the voluntary energy efficiency labeling initiative sponsored by the U.S. Environmental Protection Agency and Department of Energy.
Evaluation	Monies allocated for performing evaluation studies of projects, markets, etc., and the internal labor and expenses for staff that work within this category.
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.
FCM	Forward Capacity Market – ISO NE forecasts demand for the next three years and then conducts auctions, where both generation and demand resources may participate, to purchase sufficient capacity for reliable system operation at competitive prices.
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.
GSHP	Ground Source Heat Pump
GWh	Gigawatt-hour – a measure of electricity usage over time equal to 1,000 megawatt-hours or 1,000,000 kilowatt-hours.
HEM	Home Energy Management
HERS	Home Energy Rating System
Hours of Use Realization Rate	Ratio of actual metered hours of use data to estimated hours of use data.
Hp	Horsepower
HVAC	Heating Ventilation and Air Conditioning
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.
ISO NE	Independent System Operator New England
ISOS	Industrial Systems Optimization Service
JMC	The Joint Management Committee of utility and non-utility parties that manages the ENERGY STAR® Homes Program.
kWh	Kilowatt-hour – The basic unit of electric energy usage over time. One kWh is equal to one kW of power supplied to a circuit for a period of one hour.
kW	Kilowatt-A measure of electric demand - 1000 watts.
kW- Years	See: Lifetime kW
Lifetime	The expected length of time, in years, that an installed measure will be in service and producing savings.
Lifetime kW	The expected demand savings over the lifetime of an installed measure, calculated by multiplying the annual peak kW reduction associated with a measure by the expected lifetime of that measure. It is expressed in units of kW-years.

Lifetime MWh	The expected energy savings over the lifetime of an installed measure, calculated by multiplying the annual MWh reduction associated with a measure by the expected lifetime of that measure.
LIHEAP	Low-income Heating Assistance Program
Lost Base Revenue (LBR)	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.
Marketing	Internal marketing and advertising costs, including labor and expenses for staff. External media costs for television, radio, billboards, brochures, telemarketing, web-sites, and mailings, as well as marketing association fees.
Maximum Annual kW Savings	Peak annual demand savings of a measure. At the program level, this equals the sum of the annual peak demand savings across all measures.
Measure	Specific technology or practice that produces energy and/or demand savings for which the Company provides financial incentives.
MOU	Memorandum of Understanding
MPER	Multi-Year Program Evaluation and Market Progress Reporting, or Market Progress and Evaluation Report, developed for various residential programs.
MW	Megawatt – a measure of electric demand equal to 1,000 kilowatts.
MWh	Megawatt-hour – a measure of energy use over time equal to 1,000 kilowatt-hours.
NATE	North American Technician Excellence Program
NEEP	Northeast Energy Efficiency Partnerships
NCP	Negotiated Cooperative Promotions
Net to Gross Ratio	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.
O&M	Operation and Maintenance

Off-Peak energy kWh	The kWh reduction that occurs during the Company's off-peak hours for energy (Monday-Friday, 9 p.m. to 8 a.m. and all day on weekends and holidays).
On-Peak Energy kWh	The kWh reduction that occurs during the Company's on-peak hours for energy (Monday-Friday, 8 a.m. to 9 p.m., except holidays).
Participant Cost	Is the total cost of a project or measure less the customer incentive.
PAs	Program Administrators. The electric Program Administrators include Cape Light Compact, Fitchburg Electric, National Grid, NSTAR Electric, and Western Massachusetts Electric Company. The gas Program Administrators include Berkshire Gas, Columbia Gas, Fitchburg Gas, National Grid, NSTAR Gas, and New England Gas
Persistence Rate	Percentage of first year energy or demand savings expected to persist over the life of the installed energy efficiency equipment; developed by conducting surveys of installed equipment several years after installation to determine presence and operational capability of the equipment.
PMR	Performance Measurement Report
PRISM	Princeton scorekeeping Method- tool that analyzes DSM savings for large samples of buildings or homes.
Program Planning & Administration (PP&A)	Day to day administration of programs including: employee labor, benefits, expenses, materials, supplies, taxes, overhead, and internal administrative and general expenses. Also included are external expenses such as consultant fees, legal activities, and external administrative and general expenses.
RCS	Residential Conservation Services. Formerly Energy Conservation Service or ECS.
Sales Technical Assistance & Training (STAT)	Internal labor and expenses for field personnel delivering programs, vendor administration fees, vendor sales costs (rebate processing fees, contractor installation fees), technical assessment study costs paid to vendors for engineering studies of potential energy efficiency projects.
SBS	Small Business Services program, formerly known as Small Commercial and Industrial Program.

Seasonal (Winter/Summer) kW	The net demand reduction during either the Winter or Summer seasons.
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.
VSD	Variable Speed Drive
WAP	Weatherization Assistance Program
Watt	The basic electrical unit of power.

Appendix B, Section 1:
DPU 08-50
Support Tables

IV.C. Gas PA Budgets
1. Summary Table

Program Administrator Budget, Planned (1)								
Customer Sector / Program	Program Costs						Performance Incentive (2,3)	TOTAL PA Budget (4)
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs		
Residential (total)	**$3,121,770**	**$992,263**	**$22,507,115**	**$3,163,554**	**$1,367,364**	**$31,152,066**	**$848,502**	**$32,000,588**
Residential New Construction & Major Renovations	$251,366	$83,592	$1,617,400	$340,040	$44,038	$2,336,436	$25,193	$2,361,629
Residential Heating and Water Heating	$488,123	$371,425	$6,572,750	$453,580	$455,653	$8,341,531	$409,545	$8,751,083
MassSAVE	$295,042	$100,917	$350,000	$1,546,650	$254,220	$2,546,829	$0	$2,546,829
Weatherization Program	$481,115	$93,025	$9,627,700	$282,659	$293,039	$10,777,538	$268,109	$11,045,656
Multifamily Retrofit	$281,319	$41,300	$1,301,265	$421,975	$149,832	$2,195,691	$119,171	$2,314,864
Behavior/Feedback Program	$214,338	$20,650	$2,213,250	$20,000	$46,794	$2,515,032	$26,485	$2,541,517
Deep Energy Retrofit	$120,147	$19,000	$561,000	$78,000	$86,269	$864,416	$0	$864,416
Residential Building Practices and Demonstration Program	$36,623	$0	$200,000	$10,000	$12,244	$258,868	$0	$258,868
Energy Analysis: Internet Audit Program	$188,373	$113,529	$0	$0	$14,975	$316,876	$0	$316,876
Community Based Pilots	$52,216	$11,000	$63,750	$10,650	$10,300	$147,916	$0	$147,916
Workforce Development	$0	$0	$0	$0	$0	$0	$0	$0
Statewide Marketing & Education	$0	$137,825	$0	$0	$0	$137,825	$0	$137,825
EEAC Consultants	$346,166	$0	$0	$0	$0	$346,166	$0	$346,166
DOER Assessment	$208,124	$0	$0	$0	$0	$208,124	$0	$208,124
Sponsorships & Subscriptions	$158,818	$0	$0	$0	$0	$158,818	$0	$158,818
Low Income (total)	**$2,301,273**	**$273,657**	**$9,693,770**	**$2,434,575**	**$341,766**	**$15,045,041**	**$360,709**	**$15,405,765**
Low-Income Single Family Retrofit	$1,605,467	$186,417	$5,229,875	$1,919,005	$239,433	$9,180,197	$250,747	$9,430,954
Low-Income MultiFamily Retrofit	$362,669	$35,064	$4,463,895	$515,570	$102,333	$5,479,531	$109,962	$5,589,498
Statewide Marketing & Education	$0	$52,176	$0	$0	$0	$52,176	$0	$52,176
Low Income Energy Affordability Network Funding	$243,941	$0	$0	$0	$0	$243,941	$0	$243,941
Low Income DOER Assessment	$89,196	$0	$0	$0	$0	$89,196	$0	$89,196
Commercial & Industrial (total)	**$2,364,707**	**$686,995**	**$11,120,051**	**$2,327,718**	**$1,137,178**	**$17,636,649**	**$977,072**	**$18,613,741**
C&I New Construction & Major Renovation	$660,367	$236,363	$3,591,211	$1,145,582	$355,053	$5,988,576	$325,383	$6,313,964
C&I Retrofit	$927,059	$236,363	$7,044,590	$1,121,766	$702,862	$10,032,640	$566,776	$10,599,426
C&I Direct Install	$141,259	$47,275	$250,250	$30,000	$47,170	$515,954	$84,913	$600,871
Workforce Development	$20,000	$0	$0	$0	$0	$20,000	$0	$20,000
Business Energy Analyzer	$0	$0	$0	$0	$0	$0	$0	$0
Deep Energy Retrofit	$39,855	$14,000	$234,000	$30,370	$32,093	$350,318	$0	$350,318
Statewide Marketing & Education	$0	$152,995	$0	$0	$0	$152,995	$0	$152,995
EEAC Consultants	$287,865	$0	$0	$0	$0	$287,865	$0	$287,865
DOER Assessment	$247,474	$0	$0	$0	$0	$247,474	$0	$247,474
Sponsorships & Subscriptions	$40,828	$0	$0	$0	$0	$40,828	$0	$40,828
GRAND TOTAL	**$7,787,750**	**$1,952,915**	**$43,320,936**	**$7,925,847**	**$2,846,308**	**$63,833,756**	**$2,186,284**	**$66,020,093**

Program Administrator Budget, Actual (1), (5)								
Customer Sector / Program	Program Costs						Performance Incentive (2,3)	TOTAL PA Budget (4)
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs		
Residential (total)	**$2,364,663**	**$933,058**	**$25,986,235**	**$4,050,485**	**$780,572**	**$34,115,014**	**$1,202,419**	**$35,317,433**
Residential New Construction & Major Renovations	$188,306	$44,503	$2,152,842	$306,473	$113,337	$2,805,461	$112,862	$2,918,323
Residential Heating and Water Heating	$731,276	$434,534	$12,787,918	$405,593	$97,965	$14,457,286	$553,697	$15,010,983
MassSAVE	$111,624	$100,669	$720,248	$2,116,531	$52,666	$3,101,738	$0	$3,101,738
Weatherization Program	$413,989	$67,406	$6,018,170	$598,798	$194,859	$7,293,222	$401,676	$7,694,897
Multifamily Retrofit	$184,281	$42,533	$1,486,573	$380,246	$174,242	$2,267,876	$107,104	$2,374,980
Behavior/Feedback Program	$135,244	$9,464	$2,517,589	-$1,722	$63,991	$2,724,566	$27,080	$2,751,645
Deep Energy Retrofit	$192,934	$7,601	$276,368	$48,995	$34,072	$559,970	$0	$559,970
Residential Building Practices and Demonstration Program	$5,994	$2,906	$24,985	$21,110	$59	$55,054	$0	$55,054
Energy Analysis: Internet Audit Program	$5,972	$58,242	$0	$138,903	-$36	$203,081	$0	$203,081
Community Based Pilots	$36,635	$46,748	$1,540	$35,559	$35,167	$155,650	$0	$155,650
Workforce Development	$0	$0	$0	$0	$0	$0	$0	$0
Statewide Marketing & Education	$0	$118,451	$0	-$1	$14,252	$132,703	$0	$132,703
EEAC Consultants	$154,301	$0	$0	$0	$0	$154,301	$0	$154,301
DOER Assessment	$204,105	$0	$0	$0	$0	$204,105	$0	$204,105
Sponsorships & Subscriptions	$0	$0	$0	$0	$0	$0	$0	$0
Low Income (total)	**$894,537**	**$62,874**	**$8,219,135**	**$1,932,448**	**$163,192**	**$11,272,187**	**$505,461**	**$11,777,648**
Low-Income Single Family Retrofit	$378,956	$4,870	$4,882,131	$1,316,798	$98,314	$6,681,069	$250,886	$6,931,955
Low-Income MultiFamily Retrofit	$212,457	$14,264	$3,337,004	$615,650	$64,879	$4,244,253	$254,575	$4,498,829
Statewide Marketing & Education	$0	$43,740	$0	$0	$0	$43,740	$0	$43,740
Low Income Energy Affordability Network Funding	$229,560	$0	$0	$0	$0	$229,560	$0	$229,560
Low Income DOER Assessment	$73,565	$0	$0	$0	$0	$73,565	$0	$73,565
Commercial & Industrial (total)	**$2,531,989**	**$407,446**	**$10,414,934**	**$1,599,650**	**$633,864**	**$15,587,883**	**$607,231**	**$16,195,113**
C&I New Construction & Major Renovation	$814,826	$104,409	$4,894,391	$410,321	$187,879	$6,411,825	$242,486	$6,654,311
C&I Retrofit	$1,182,005	$77,064	$5,356,119	$1,121,820	$409,431	$8,146,439	$254,957	$8,401,396
C&I Direct Install	$142,177	$19,793	$164,424	$795	$26,130	$353,320	$109,788	$463,107
Workforce Development	$5,745	$18	$0	$13	-$1	$5,776	$0	$5,776
Business Energy Analyzer	$4,622	$15,459	$0	$66,613	-$15	$86,678	$0	$86,678
Deep Energy Retrofit	$28,499	$122	$0	$88	$10,441	$39,149	$0	$39,149
Statewide Marketing & Education	$0	$190,580	$0	$0	$0	$190,580	$0	$190,580
EEAC Consultants	$182,464	$0	$0	$0	$0	$182,464	$0	$182,464
DOER Assessment	$171,651	$0	$0	$0	$0	$171,651	$0	$171,651
Sponsorships & Subscriptions	$0	$0	$0	$0	$0	$0	$0	$0
GRAND TOTAL	**$5,791,188**	**$1,403,378**	**$44,620,304**	**$7,582,583**	**$1,577,629**	**$60,975,083**	**$2,315,111**	**$63,290,194**

Program Administrator Budget, Percent Variance (1)								
Customer Sector / Program	Program Costs						Performance Incentive (2,3)	TOTAL PA Budget (4)
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs		
Residential (total)	**-24%**	**-6%**	**15%**	**28%**	**-43%**	**10%**	**42%**	**10%**
Residential New Construction & Major Renovations	-25%	-47%	33%	-10%	157%	20%	348%	24%
Residential Heating and Water Heating	50%	17%	95%	-11%	-79%	73%	35%	72%
MassSAVE	-62%	0%	106%	37%	-79%	22%	0%	22%
Weatherization Program	-14%	-28%	-37%	112%	-34%	-32%	50%	-30%
Multifamily Retrofit	-34%	3%	14%	-10%	16%	3%	-10%	3%
Behavior/Feedback Program	-37%	-54%	14%	-109%	37%	8%	2%	8%
Deep Energy Retrofit	61%	-60%	-51%	-37%	-61%	-35%	0%	-35%
Residential Building Practices and Demonstration Program	-84%	0%	-88%	111%	-100%	-79%	0%	-79%
Energy Analysis: Internet Audit Program	-97%	-49%	0%	0%	-100%	-36%	0%	-36%
Community Based Pilots	-30%	325%	-98%	234%	241%	5%	0%	5%
Workforce Development	0%	0%	0%	0%	0%	0%	0%	0%
Statewide Marketing & Education	0%	-14%	0%	0%	0%	-4%	0%	-4%
EEAC Consultants	-55%	0%	0%	0%	0%	-55%	0%	-55%
DOER Assessment	-2%	0%	0%	0%	0%	-2%	0%	-2%
Sponsorships & Subscriptions	-100%	0%	0%	0%	0%	-100%	0%	-100%
Low Income (total)	**-61%**	**-77%**	**-15%**	**-21%**	**-52%**	**-25%**	**40%**	**-24%**
Low-Income Single Family Retrofit	-76%	-97%	-7%	-31%	-59%	-27%	0%	-26%
Low-Income MultiFamily Retrofit	-41%	-59%	-25%	19%	-37%	-23%	132%	-20%
Statewide Marketing & Education	0%	-16%	0%	0%	0%	-16%	0%	-16%
Low Income Energy Affordability Network Funding	-6%	0%	0%	0%	0%	-6%	0%	-6%
Low Income DOER Assessment	-18%	0%	0%	0%	0%	-18%	0%	-18%
Commercial & Industrial (total)	**7%**	**-41%**	**-6%**	**-31%**	**-44%**	**-12%**	**-38%**	**-13%**
C&I New Construction & Major Renovation	23%	-56%	36%	-64%	-47%	7%	-25%	5%
C&I Retrofit	28%	-67%	-24%	0%	-42%	-19%	-55%	-21%
C&I Direct Install	1%	-58%	-34%	-97%	-45%	-32%	29%	-23%
Workforce Development	-71%	0%	0%	0%	0%	-71%	0%	-71%
Business Energy Analyzer	0%	0%	0%	0%	0%	0%	0%	0%
Deep Energy Retrofit	-28%	-99%	-100%	-100%	-67%	-89%	0%	-89%
Statewide Marketing & Education	0%	25%	0%	0%	0%	25%	0%	25%
EEAC Consultants	-37%	0%	0%	0%	0%	-37%	0%	-37%
DOER Assessment	-31%	0%	0%	0%	0%	-31%	0%	-31%
Sponsorships & Subscriptions	-100%	0%	0%	0%	0%	-100%	0%	-100%
GRAND TOTAL	**-26%**	**-28%**	**3%**	**-4%**	**-45%**	**-4%**	**6%**	**-4%**

Notes:

(1) All parties would refer to common definitions (in Appendix) for allocation of costs.

(2) Values listed in this table represent pre-tax performance incentive amounts. See Section IV.H. Shareholder Performance Incentives for supporting calculations.

(3) The source of the planned performance incentive values is the Performance Incentive Model filed with the DPU as Attachment B to the Memorandum of Agreement dated 4/15/11

(4) The Total PA Budget is the sum of Total Program Costs and Performance Incentives.

(5) Any negative amounts shown in the "Program Administrator Budget, Actual" table represent prior period adjustments

IV.D. Cost Effectiveness

1. Summary Table

Total Resource Cost Test, Planned				
Customer Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs (1)**
Residential	**1.93**	**$ 33,689,741**	**$ 69,808,222**	**$ 36,118,481**
Residential New Construction & Major Renovations	1.32	$ 758,346	$ 3,120,210	$ 2,361,864
Residential Heating and Water Heating	3.30	$ 22,984,779	$ 32,962,261	$ 9,977,482
MassSAVE	0.00	$ (2,546,829)	$ -	$ 2,546,829
Weatherization Program	1.57	$ 7,508,183	$ 20,738,239	$ 13,230,056
Multifamily Retrofit	3.20	$ 6,654,166	$ 9,675,890	$ 3,021,724
Behavior/Feedback Program	1.30	$ 770,105	$ 3,311,622	$ 2,541,517
Deep Energy Retrofit	n/a	n/a	$ -	$ 864,416
Residential Building Practices and Demonstration Program	n/a	n/a	$ -	$ 258,868
Energy Analysis: Internet Audit Program	n/a	n/a	$ -	$ 316,876
Community based pilots	n/a	n/a	$ -	$ 147,916
Workforce Development	n/a	n/a	$ -	$ -
Statewide Marketing & Education	n/a	n/a	$ -	$ 137,825
EEAC Consultants	n/a	n/a	$ -	$ 346,166
DOER Assessment	n/a	n/a	$ -	$ 208,124
Sponsorships & Subscriptions	n/a	n/a	$ -	$ 158,818
Low Income	**1.56**	**$ 8,605,703**	**$ 24,011,468**	**$ 15,405,765**
Low-Income Single Family Retrofit	1.78	$ 7,338,377	$ 16,769,331	$ 9,430,954
Low-Income MultiFamily Retrofit	1.30	$ 1,652,639	$ 7,242,137	$ 5,589,498
Statewide Marketing & Education	n/a	n/a	$ -	$ 52,176
Low Income Energy Affordability Network Funding	n/a	n/a	$ -	$ 243,941
Low Income DOER Assessment	n/a	n/a	$ -	$ 89,196
Commercial & Industrial	**1.86**	**$ 39,336,859**	**$ 84,843,126**	**$ 45,506,268**
C&I New Construction & Major Renovation	2.44	$ 16,073,327	$ 27,240,950	$ 11,167,623
C&I Retrofit	1.65	$ 21,341,315	$ 53,979,609	$ 32,638,294
C&I Direct Install	6.03	$ 3,021,696	$ 3,622,567	$ 600,871
Workforce Development	n/a	n/a	$ -	$ 20,000
Business Energy Analyzer	n/a	n/a	$ -	$ -
Deep Energy Retrofit	n/a	n/a	$ -	$ 350,318
Statewide Marketing & Education	n/a	n/a	$ -	$ 152,995
EEAC Consultants	n/a	n/a	$ -	$ 287,865
DOER Assessment	n/a	n/a	$ -	$ 247,474
Sponsorships & Subscriptions	n/a	n/a	$ -	$ 40,828
GRAND TOTAL	**1.84**	**$ 81,632,303**	**$ 178,662,816**	**$ 97,030,514**

Total Resource Cost Test, Evaluated				
Customer Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs (1)**
Residential	**2.49**	**$ 64,089,185**	**$ 107,140,870**	**$ 43,051,685**
Residential New Construction & Major Renovations	3.42	$ 7,072,220	$ 9,990,544	$ 2,918,323
Residential Heating and Water Heating	2.68	$ 32,584,971	$ 51,952,297	$ 19,367,326
MassSAVE	0.00	$ (3,101,738)	$ -	$ 3,101,738
Weatherization Program	3.04	$ 21,502,291	$ 32,051,597	$ 10,549,306
Multifamily Retrofit	3.30	$ 6,657,946	$ 9,556,427	$ 2,898,481
Behavior/Feedback Program	1.30	$ 838,360	$ 3,590,006	$ 2,751,645
Deep Energy Retrofit	n/a	n/a	n/a	$ 559,970
Residential Building Practices and Demonstration Program	n/a	n/a	n/a	$ 55,054
Energy Analysis: Internet Audit Program	n/a	n/a	n/a	$ 203,081
Community based pilots	n/a	n/a	n/a	$ 155,650
Workforce Development	n/a	n/a	n/a	$ -
Statewide Marketing & Education	n/a	n/a	n/a	$ 132,703
EEAC Consultants	n/a	n/a	n/a	$ 154,301
DOER Assessment	n/a	n/a	n/a	$ 204,105
Sponsorships & Subscriptions	n/a	n/a	n/a	$ -
Low Income	**2.79**	**$ 21,098,708**	**$ 32,876,356**	**$ 11,777,648**
Low-Income Single Family Retrofit	2.46	$ 10,147,730	$ 17,079,685	$ 6,931,955
Low-Income MultiFamily Retrofit	3.51	$ 11,297,842	$ 15,796,671	$ 4,498,829
Statewide Marketing & Education	n/a	n/a	n/a	$ 43,740
Low Income Energy Affordability Network Funding	n/a	n/a	n/a	$ 229,560
DOER Assessment	n/a	n/a	n/a	$ 73,565
Commercial & Industrial	**1.71**	**$ 25,831,710**	**$ 62,248,851**	**$ 36,417,141**
C&I New Construction & Major Renovation	1.80	$ 11,835,382	$ 26,719,435	$ 14,884,053
C&I Retrofit	1.51	$ 10,382,350	$ 30,754,695	$ 20,372,345
C&I Direct Install	9.86	$ 4,290,276	$ 4,774,720	$ 484,444
Workforce Development	n/a	n/a	n/a	$ 5,776
Business Energy Analyzer	n/a	n/a	n/a	$ 86,678
Deep Energy Retrofit	n/a	n/a	n/a	$ 39,149
Statewide Marketing & Education	n/a	n/a	n/a	$ 190,580
EEAC Consultants	n/a	n/a	n/a	$ 182,464
DOER Assessment	n/a	n/a	n/a	$ 171,651
Sponsorships & Subscriptions	n/a	n/a	n/a	$ -
GRAND TOTAL	**2.22**	**$ 111,019,603**	**$ 202,266,076**	**$ 91,246,473**

Total Resource Cost Test, Percent Variance				
Customer Sector	**B/C Ratio**	**Net Benefits**	**Benefits**	**Costs (1)**
Residential	**29%**	**90%**	**53%**	**19%**
Residential New Construction & Major Renovations	159%	833%	220%	24%
Residential Heating and Water Heating	-19%	42%	58%	94%
MassSAVE	0%	22%	0%	22%
Weatherization Program	94%	186%	55%	-20%
Multifamily Retrofit	3%	0%	-1%	-4%
Behavior/Feedback Program	0%	9%	8%	8%
Deep Energy Retrofit	n/a	n/a	n/a	-35%
Residential Building Practices and Demonstration Program	n/a	n/a	n/a	-79%
Energy Analysis: Internet Audit Program	n/a	n/a	n/a	-36%
Community based pilots	n/a	n/a	n/a	5%
Workforce Development	n/a	n/a	n/a	0%
Statewide Marketing & Education	n/a	n/a	n/a	-4%
EEAC Consultants	n/a	n/a	n/a	-55%
DOER Assessment	n/a	n/a	n/a	-2%
Sponsorships & Subscriptions	n/a	n/a	n/a	-100%
Low Income	**79%**	**145%**	**37%**	**-24%**
Low-Income Single Family Retrofit	39%	38%	2%	-26%
Low-Income MultiFamily Retrofit	171%	584%	118%	-20%
Statewide Marketing & Education	n/a	n/a	n/a	-16%
Low Income Energy Affordability Network Funding	n/a	n/a	n/a	-6%
DOER Assessment	n/a	n/a	n/a	-18%
Commercial & Industrial	**-8%**	**-34%**	**-27%**	**-20%**
C&I New Construction & Major Renovation	-26%	-26%	-2%	33%
C&I Retrofit	-9%	-51%	-43%	-38%
C&I Direct Install	63%	42%	32%	-19%
Workforce Development	n/a	n/a	n/a	-71%
Business Energy Analyzer	n/a	n/a	n/a	0%
Deep Energy Retrofit	n/a	n/a	n/a	-89%
Statewide Marketing & Education	n/a	n/a	n/a	25%
EEAC Consultants	n/a	n/a	n/a	-37%
DOER Assessment	n/a	n/a	n/a	-31%
Sponsorships & Subscriptions	n/a	n/a	n/a	-100%
GRAND TOTAL	**20%**	**36%**	**13%**	**-6%**

Notes:
(1) See Table IV.D.2.1 Total Resource Costs Summary for more information regarding TRC Test Costs.
(2) For purpose of determining cost-effectiveness, the benefits and costs of "hard to measure programs" are taken into account at the customer sector level.
(3) For the purpose of determining cost-effectiveness, General Support costs are taken into account at the customer sector level.

IV.D. Cost Effectiveness

2.1. Cost Summary Table

TRC Costs Summary, Planned				
	Program Costs (1)	**Performance Incentive (2,3)**	**Participant Costs**	**TOTAL Resource Costs (4)**
Residential (total)	**31,152,066**	**848,502**	**4,117,893**	**36,118,481**
Residential New Construction & Major Renovations	2,336,436	25,193	235	2,361,864
Residential Heating and Water Heating	8,341,531	409,545	1,226,399	9,977,482
MassSAVE	2,546,829	-	-	2,546,829
Weatherization Program	10,777,538	268,109	2,184,400	13,230,056
Multifamily Retrofit	2,195,691	119,171	706,860	3,021,724
Behavior/Feedback Program	2,515,032	26,485	-	2,541,517
Deep Energy Retrofit	864,416	-	-	864,416
Residential Building Practices and Demonstration Program	258,868	-	-	258,868
Energy Analysis: Internet Audit Program	316,876	-	-	316,876
Community Based pilots	147,916	-	-	147,916
Workforce Development	-	-	-	-
Statewide Marketing & Education	137,825	-	-	137,825
EEAC Consultants	346,166	-	-	346,166
DOER Assessment	208,124	-	-	208,124
Sponsorships & Subscriptions	158,818	-	-	158,818
Low Income (total)	**15,045,041**	**360,709**	**-**	**15,405,765**
Low-Income Single Family Retrofit	9,180,197	250,747	-	9,430,954
Low-Income MultiFamily Retrofit	5,479,531	109,962	-	5,589,498
Statewide Marketing & Education	52,176	-	-	52,176
Low Income Energy Affordability Network Funding	243,941	-	-	243,941
DOER Assessment	89,196	-	-	89,196
Commercial & Industrial (total)	**17,636,649**	**977,072**	**26,892,527**	**45,506,268**
C&I New Construction & Major Renovation	5,988,576	325,383	4,853,658	11,167,623
C&I Retrofit	10,032,640	566,776	22,038,869	32,638,294
C&I Direct Install	515,954	84,913	-	600,871
Workforce Development	20,000	-	-	20,000
Business Energy Analyzer	-	-	-	-
Deep Energy Retrofit	350,318	-	-	350,318
Statewide Marketing & Education	152,995	-	-	152,995
EEAC Consultants	287,865	-	-	287,865
DOER Assessment	247,474	-	-	247,474
Sponsorships & Subscriptions	40,828	-	-	40,828
GRAND TOTAL	**63,833,756**	**2,186,284**	**31,010,420**	**97,030,514**

TRC Costs Summary, Actual				
	Program Costs (1)	**Performance Incentive (2)**	**Participant Costs**	**TOTAL Resource Costs (3)**
Residential (total)	**34,115,014**	**1,202,419**	**7,734,252**	**43,051,685**
Residential New Construction & Major Renovations	2,805,461	112,862	-	2,918,323
Residential Heating and Water Heating	14,457,286	553,697	4,356,343	19,367,326
MassSAVE	3,101,738	-	-	3,101,738
Weatherization Program	7,293,222	401,676	2,854,408	10,549,306
Multifamily Retrofit	2,267,876	107,104	523,501	2,898,481
Behavior/Feedback Program	2,724,566	27,080	-	2,751,645
Deep Energy Retrofit	559,970	-	-	559,970
Residential Building Practices and Demonstration Program	55,054	-	-	55,054
Energy Analysis: Internet Audit Program	203,081	-	-	203,081
Community Based pilots	155,650	-	-	155,650
Workforce Development	-	-	-	-
Statewide Marketing & Education	132,703	-	-	132,703
EEAC Consultants	154,301	-	-	154,301
DOER Assessment	204,105	-	-	204,105
Sponsorships & Subscriptions	-	-	-	-
Low Income (total)	**11,272,187**	**505,461**	**-**	**11,777,648**
Low-Income Single Family Retrofit	6,681,069	250,886	-	6,931,955
Low-Income MultiFamily Retrofit	4,244,253	254,575	-	4,498,829
Statewide Marketing & Education	43,740	-	-	43,740
Low Income Energy Affordability Network Funding	229,560	-	-	229,560
Low Income DOER Assessment	73,565	-	-	73,565
Commercial & Industrial (total)	**15,587,883**	**607,231**	**20,222,028**	**36,417,141**
C&I New Construction & Major Renovation	6,411,825	242,486	8,229,742	14,884,053
C&I Retrofit	8,146,439	254,957	11,970,949	20,372,345
C&I Direct Install	353,320	109,788	21,337	484,444
Workforce Development	5,776	-	-	5,776
Business Energy Analyzer	86,678	-	-	86,678
Deep Energy Retrofit	39,149	-	-	39,149
Statewide Marketing & Education	190,580	-	-	190,580
EEAC Consultants	182,464	-	-	182,464
DOER Assessment	171,651	-	-	171,651
Sponsorships & Subscriptions	-	-	-	-
GRAND TOTAL	**60,975,083**	**2,315,111**	**27,956,279**	**91,246,473**

TRC Costs Summary, Percent Variance				
	Program Costs (1)	**Performance Incentive (2)**	**Participant Costs**	**TOTAL Resource Costs (3)**
Residential (total)	**10%**	**42%**	**88%**	**19%**
Residential New Construction & Major Renovations	20%	348%	-100%	24%
Residential Heating and Water Heating	73%	35%	255%	94%
MassSAVE	22%	0%	0%	22%
Weatherization Program	-32%	50%	31%	-20%
Multifamily Retrofit	3%	-10%	-26%	-4%
O Power	8%	2%	0%	8%
Deep Energy Retrofit	-35%	0%	0%	-35%
Residential Building Practices and Demonstration Program	-79%	0%	0%	-79%
Energy Analysis: Internet Audit Program	-36%	0%	0%	-36%
Community Based pilots	5%	0%	0%	5%
Workforce Development	0%	0%	0%	0%
Statewide Marketing & Education	-4%	0%	0%	-4%
EEAC Consultants	-55%	0%	0%	-55%
DOER Assessment	-2%	0%	0%	-2%
Sponsorships & Subscriptions	-100%	0%	0%	-100%
Low Income (total)	**-25%**	**40%**	**0%**	**-24%**
Low-Income Single Family Retrofit	-27%	0%	0%	-26%
Low-Income MuiltiFamily Retrofit	-23%	132%	0%	-20%
Statewide Marketing & Education	-16%	0%	0%	-16%
Low Income Energy Affordability Network Funding	-6%	0%	0%	-6%
Low Income DOER Assessment	-18%	0%	0%	-18%
Commercial & Industrial (total)	**-12%**	**-38%**	**-25%**	**-20%**
C&I New Construction & Major Renovation	7%	-25%	70%	33%
C&I Retrofit	-19%	-55%	-46%	-38%
C&I Direct Install	-32%	29%	0%	-19%
Workforce Development	-71%	0%	0%	-71%
Business Energy Analyzer	0%	0%	0%	0%
Deep Energy Retrofit	-89%	0%	0%	-89%
Statewide Marketing & Education	25%	0%	0%	25%
EEAC Consultants	-37%	0%	0%	-37%
DOER Assessment	-31%	0%	0%	-31%
Sponsorships & Subscriptions	-100%	0%	0%	-100%
GRAND TOTAL	**-4%**	**6%**	**-10%**	**-6%**

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 Section IV.H. Shareholder Performance Incentives for supporting ca
(3) The source of the planned performance incentive values is the Performance Incentive Model filed with the DPU as Attachment B to the Memorandum
(4) This represents the total TRC Test costs, which does not include LBR.

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 (total)	**69,394,296**	**97,285**	**-**	**279,198**	**-**	**-**	**-**	**-**	**-**	**37,443**	**-**	**-**	**37,443**	**69,808,222**
Residential New Construction & Major Renovations	2,706,285	97,285	-	279,198	-	-	-	-	-	37,443	-	-	37,443	3,120,210
Residential Heating and Water Heating	32,962,261	-	-	-	-	-	-	-	-	-	-	-	-	32,962,261
MassSAVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	20,738,239	-	-	-	-	-	-	-	-	-	-	-	-	20,738,239
Multifamily Retrofit	9,675,890	-	-	-	-	-	-	-	-	-	-	-	-	9,675,890
Behavior/Feedback Program	3,311,622	-	-	-	-	-	-	-	-	-	-	-	-	3,311,622
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Community Based Pilots	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income (total)	**10,823,357**	**2,055**	**-**	**300,447**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**12,885,608**	**12,885,608**	**24,011,468**
Low-Income Single Family Retrofit	4,723,715	2,055	-	300,447	-	-	-	-	-	-	-	11,743,114	11,743,114	16,769,331
Low-Income MultiFamily Retrofit	6,099,643	-	-	-	-	-	-	-	-	-	-	1,142,494	1,142,494	7,242,137
Commercial & Industrial (total)	**81,419,378**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,423,748**	**-**	**-**	**3,423,748**	**84,843,126**
C&I New Construction & Major Renovation	27,240,950	-	-	-	-	-	-	-	-	-	-	-	-	27,240,950
C&I Retrofit	52,854,434	-	-	-	-	-	-	-	-	1,125,175	-	-	1,125,175	53,979,609
C&I Direct Install	1,323,995	-	-	-	-	-	-	-	-	2,298,573	-	-	2,298,573	3,622,567
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**161,637,032**	**99,340**	**-**	**579,645**	**-**	**-**	**-**	**-**	**-**	**3,461,191**	**-**	**12,885,608**	**16,346,799**	**178,662,816**

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 (total)	**66,117,018**	**242,202**	**-**	**403,694**	**-**	**-**	**-**	**-**	**-**	**1,783,838**	**-**	**38,594,118**	**40,377,956**	**107,140,870**
Residential New Construction & Major Renovations	5,379,936	242,202	-	403,694	-	-	-	-	-	4,177	-	3,960,534	3,964,711	9,990,544
Residential Heating and Water Heating	31,007,623	-	-	-	-	-	-	-	-	-	-	20,944,674	20,944,674	51,952,297
MassSAVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	22,015,824	-	-	-	-	-	-	-	-	-	-	10,035,772	10,035,772	32,051,597
Multifamily Retrofit	4,123,629	-	-	-	-	-	-	-	-	1,779,660	-	3,653,138	5,432,798	9,556,427
Behavior/Feedback Program	3,590,006	-	-	-	-	-	-	-	-	-	-	-	-	3,590,006
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Community Based Pilots	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income (total)	**17,890,944**	**187,091**	**-**	**898,912**	**-**	**-**	**-**	**-**	**-**	**2,189,524**	**-**	**11,709,885**	**13,899,409**	**32,876,356**
Low-Income Single Family Retrofit	9,720,744	187,091	-	898,912	-	-	-	-	-	-	-	6,272,938	6,272,938	17,079,685
Low-Income MultiFamily Retrofit	8,170,200	-	-	-	-	-	-	-	-	2,189,524	-	5,436,947	7,626,471	15,796,671
Commercial & Industrial (total)	**55,397,404**	**-**	**-**	**4,480**	**-**	**-**	**-**	**-**	**-**	**6,846,967**	**-**	**-**	**6,846,967**	**62,248,851**
C&I New Construction & Major Renovation	26,714,955	-	-	4,480	-	-	-	-	-	-	-	-	-	26,719,435
C&I Retrofit	26,749,738	-	-	-	-	-	-	-	-	4,004,958	-	-	4,004,958	30,754,695
C&I Direct Install	1,932,711	-	-	-	-	-	-	-	-	2,842,009	-	-	2,842,009	4,774,720
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**139,405,366**	**429,293**	**-**	**1,307,085**	**-**	**-**	**-**	**-**	**-**	**10,820,329**	**-**	**50,304,003**	**61,124,332**	**202,266,076**

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 (total)	**-5%**	**149%**	**0%**	**45%**	**0%**	**0%**	**0%**	**0%**	**0%**	**4664%**	**0%**	**0%**	**107739%**	**53%**
Residential New Construction & Major Renovations	99%	149%	0%	45%	0%	0%	0%	0%	0%	-89%	0%	0%	10489%	220%
Residential Heating and Water Heating	-6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	58%
MassSAVE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Weatherization Program	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	55%
Multifamily Retrofit	-57%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
Behavior/Feedback Program	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%
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%
Community Based Pilots	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 (total)	**65%**	**9002%**	**0%**	**199%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**-9%**	**8%**	**37%**
Low-Income Single Family Retrofit	106%	9002%	0%	199%	0%	0%	0%	0%	0%	0%	0%	-47%	-47%	2%
Low-Income MultiFamily Retrofit	34%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	376%	568%	118%
Commercial & Industrial (total)	**-32%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**100%**	**0%**	**0%**	**100%**	**-27%**
C&I New Construction & Major Renovation	-2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%
C&I Retrofit	-49%	0%	0%	0%	0%	0%	0%	0%	0%	256%	0%	0%	256%	-43%
C&I Direct Install	46%	0%	0%	0%	0%	0%	0%	0%	0%	24%	0%	0%	24%	32%
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	**-14%**	**332%**	**0%**	**125%**	**0%**	**0%**	**0%**	**0%**	**0%**	**213%**	**0%**	**290%**	**274%**	**13%**

NOTES
*where applicable
Gas PAs should footnote this table to indicate that discounting is being used to calculate lifetime dollars

IV.D. Cost Effectiveness
3.2. Savings Summary Table

Gas Savings (Annualized), Planned

Program	# of Participants	Gas Annualized Savings (MMBTU)	Gas Annualized 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 (total)	**249,904**	**539,627**	**5,396,274**	**57,500,316**	**32**	**24**	**200,934**	**-**	**-**	**-**	**-**	**-**	**-**	**378,830**	**-**
Residential New Construction & Major Renovations	881	9,701	97,008	2,289,383	32	24	200,934	-	-	-	-	-	-	378,830	-
Residential Heating and Water Heating	22,044	153,439	1,534,388	27,095,618	-	-	-	-	-	-	-	-	-	-	-
MassSAVE	7,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weatherization Program	4,730	84,508	845,079	16,945,225	-	-	-	-	-	-	-	-	-	-	-
Multifamily Retrofit	3,213	39,520	395,199	8,645,490	-	-	-	-	-	-	-	-	-	-	-
Behavior/Feedback Program	200,000	252,460	2,524,600	2,524,600	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofit	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Building Practices and Demonstration Program	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Analysis: Internet Audit Program	11,830	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Community Based Pilots	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workforce Developmen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income (total)	**3,063**	**49,620**	**496,203**	**9,451,088**	**1**	**21**	**167,970**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**12,885,608**
Low-Income Single Family Retrofit	1,505	19,861	198,610	3,848,980	1	21	167,970	-	-	-	-	-	-	-	11,743,114
Low-Income MultiFamily Retrof	1,558	29,759	297,593	5,602,108	-	-	-	-	-	-	-	-	-	-	1,142,494
Commercial & Industrial (total)	**4,067**	**528,389**	**5,283,894**	**73,998,304**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**132,709,650**	**-**
C&I New Construction & Major Renovation	1,582	134,072	1,340,722	25,131,372	-	-	-	-	-	-	-	-	-	-	-
C&I Retrofit	1,139	369,292	3,692,922	47,515,581	-	-	-	-	-	-	-	-	-	43,613,500	-
C&I Direct Install	845	25,025	250,250	1,351,350	-	-	-	-	-	-	-	-	-	89,096,150	-
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Energy Analyzer	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deep Energy Retrofi	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAND TOTAL	**257,034**	**1,117,637**	**11,176,371**	**140,949,708**	**33**	**45**	**368,904**	**-**	**-**	**-**	**-**	**-**	**-**	**133,088,480**	**12,885,608**

Gas Savings (Annualized), Evaluated

Program	# of Participants	Gas (MMBTU)	Gas (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 (total)	**268,259**	**545,014**	**5,450,135**	**54,813,162**	**78**	**73**	**398,754**	**-**	**-**	**-**	**-**	**-**	**-**	**25,104,189**	**$ 38,594,118**
Residential New Construction & Major Renovations	855	19,952	199,517	4,586,660	78	73	398,754	-	-	-	-	-	-	38,550	$ 3,960,534
Residential Heating and Water Heating	23,790	138,942	1,389,425	25,869,318	-	-	-	-	-	-	-	-	-	-	$ 20,944,674
MassSAVE	12,746	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Weatherization Program	4,302	86,679	866,793	18,185,909	-	-	-	-	-	-	-	-	-	-	$ 10,035,772
Multifamily Retrofit	5,618	25,757	257,573	3,434,448	-	-	-	-	-	-	-	-	-	25,065,640	$ 3,653,138
Behavior/Feedback Program	209,052	273,683	2,736,827	2,736,827	-	-	-	-	-	-	-	-	-	-	$ -
Deep Energy Retrofit	7	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Residential Building Practices and Demonstration Program	59	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Energy Analysis: Internet Audit Program	11,830	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Community Based Pilots	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Workforce Developmen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Low Income (total)	**4,003**	**80,993**	**809,933**	**14,829,919**	**54**	**93**	**474,548**	**-**	**-**	**-**	**-**	**-**	**-**	**30,838,368**	**$ 11,709,885**
Low-Income Single Family Retrofit	1,633	39,703	397,031	7,940,620	54	93	474,548	-	-	-	-	-	-	-	$ 6,272,938
Low-Income MultiFamily Retrof	2,370	41,290	412,902	6,889,299	-	-	-	-	-	-	-	-	-	30,838,368	$ 5,436,947
Commercial & Industrial (total)	**2,951**	**358,263**	**3,582,634**	**51,370,419**	**-**	**-**	**2,558**	**-**	**-**	**-**	**-**	**-**	**-**	**112,712,512**	**$ -**
C&I New Construction & Major Renovation	565	124,238	1,242,383	24,861,870	-	-	2,558	-	-	-	-	-	-	-	$ -
C&I Retrofit	1,244	210,479	2,104,792	24,611,315	-	-	-	-	-	-	-	-	-	77,615,457	$ -
C&I Direct Install	613	23,546	235,459	1,897,233	-	-	-	-	-	-	-	-	-	35,097,055	$ -
Workforce Development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Business Energy Analyzer	529	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Deep Energy Retrofi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
GRAND TOTAL	**275,213**	**984,270**	**9,842,702**	**121,013,500**	**132**	**166**	**875,861**	**-**	**-**	**-**	**-**	**-**	**-**	**168,655,069**	**$ 50,304,003**

Gas Savings (Annualized), Percent Variance																
Program	# of Participants	Gas (MMBTU)	Gas (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 (total)	**7%**	**1%**	**1%**	**0**	**144%**	**211%**	**98%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**6527%**	**0%**
Residential New Construction & Major Renovations	-3%	106%	106%	100%	144%	211%	98%	0%	0%	0%	0%	0%	0%		-90%	0%
Residential Heating and Water Heating	8%	-9%	-9%	-5%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
MassSAVE	82%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Weatherization Program	-9%	3%	3%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Multifamily Retrofit	75%	-35%	-35%	-60%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Behavior/Feedback Program	5%	8%	8%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Deep Energy Retrofit	-74%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Residential Building Practices and Demonstration Program	-21%	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	-100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Workforce Developmen	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Low Income (total)	**31%**	**63%**	**63%**	**57%**	**8430%**	**340%**	**183%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**0%**	**-9%**
Low-Income Single Family Retrofit	9%	100%	100%	106%	8430%	340%	183%	0%	0%	0%	0%	0%	0%		0%	-47%
Low-Income MultiFamily Retrof	52%	39%	39%	23%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	376%
Commercial & Industrial (total)	**-27%**	**-32%**	**-32%**	**-31%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**-15%**	**0%**
C&I New Construction & Major Renovation	-64%	-7%	-7%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
C&I Retrofit	9%	-43%	-43%	-48%	0%	0%	0%	0%	0%	0%	0%	0%	0%		78%	0%
C&I Direct Install	-27%	-6%	-6%	40%	0%	0%	0%	0%	0%	0%	0%	0%	0%		-61%	0%
Workforce Development	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Business Energy Analyzer	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Deep Energy Retrofi	-100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
GRAND TOTAL	**7%**	**-12%**	**-12%**	**-14%**	**305%**	**272%**	**137%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		**27%**	**290%**

NOTES
*where applicable
(1) For each program that includes non-resource benefits, identify the category of non-resource benefits and provide a complete description of the calculation used to determine the benefit amount, and include all supporting documentation

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

Outsourced Services Planned, 2011

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	$14,875	$62,942	$319,390	$38,740	$435,947
	No	$236,491	$20,650	$20,650	$5,298	$283,089
	% Outsourced	6%	75%	94%	88%	61%
Residential Heating and Water Heating	Yes	$54,829	$319,800	$401,955	$400,827	$1,177,411
	No	$433,294	$51,625	$51,625	$54,826	$591,370
	% Outsourced	11%	86%	89%	88%	67%
MassSAVE	Yes	$15,025	$80,267	$1,526,000	$223,632	$1,844,925
	No	$280,017	$20,650	$20,650	$30,588	$351,905
	% Outsourced	$0	$1	$1	$1	84%
Weatherization Program	Yes	$69,918	$41,400	$220,709	$257,780	$589,807
	No	$411,196	$51,625	$61,950	$35,259	$560,030
	% Outsourced	15%	45%	78%	88%	51%
Multifamily Retrofit	Yes	$13,608	$0	$401,325	$131,804	$546,737
	No	$267,710	$41,300	$20,650	$18,028	$347,688
	% Outsourced	5%	0%	95%	88%	61%
Behavior/Feedback Program	Yes	$46,052	$0	$20,000	$41,164	$107,216
	No	$168,285	$20,650	$0	$5,630	$194,565
	% Outsourced	21%	0%	100%	88%	36%
Deep Energy Retrofit	Yes	$14,727	$9,500	$78,000	$75,890	$178,117
	No	$105,420	$9,500	$0	$10,379	$125,299
	% Outsourced	12%	0%	100%	88%	59%
Residential Building Practices and Demonstration Program	Yes	$15,482	$0	$10,000	$12,244	$37,726
	No	$21,141	$0	$0	$0	$21,141
	% Outsourced	42%	0%	0%	100%	64%
Energy Analysis: Internet Audit Program	Yes	$170,433	$10,279	$0	$14,975	$195,687
	No	$17,940	$103,250	$0	$0	$121,190
	% Outsourced	90%	9%	0%	100%	62%
Community Based Pilots	Yes	$404	$0	$650	$10,300	$11,354
	No	$51,812	$11,000	$10,000	$0	$72,812
	% Outsourced	0%	0%	0%	0%	0%
Workforce Development	Yes	$0	$0	$0	$0	$0
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	$0	$137,825	$0	$0	$137,825
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	100%	0%	0%	100%
EEAC Consultants	Yes	$346,166	$0	$0	$0	$346,166
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
DOER Assessment	Yes	$208,124	$0	$0	$0	$208,124
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
Sponsorships & Subscriptions	Yes	158,818	0	0	0	158,818
	No	0	0	0	0	0
	% Outsourced	100%	0%	0%	0%	100%
Residential TOTAL	Yes	$969,645	$662,013	$2,978,029	$1,207,356	$5,975,861
	No	$1,993,307	$330,250	$185,525	$160,008	$2,669,090
	% Outsourced	33%	67%	94%	88%	69%
Low Income						
Low-Income Single Family Retrofit	Yes	$1,314,821	$176,092	$1,898,355	$210,624	$3,599,892
	No	$290,646	$10,325	$20,650	$28,809	$350,430
	% Outsourced	82%	94%	99%	88%	91%
Low-Income Multifamily Retrofit	Yes	$114,382	$24,739	$494,920	$90,021	$724,062
	No	$248,287	$10,325	$20,650	$12,312	$291,574
	% Outsourced	32%	71%	96%	88%	71%
Statewide Marketing & Education	Yes	$0	$52,176	$0	$0	$52,176
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	100%	0%	0%	100%
Low Income Energy Affordability Network Funding	Yes	$243,941	$0	$0	$0	$243,941
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
DOER Assessment	Yes	$89,196	$0	$0	$0	$89,196
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
Low Income TOTAL	Yes	$1,762,339	$253,007	$2,393,275	$300,645	$4,709,267
	No	$538,933	$20,650	$41,300	$41,121	$642,004
	% Outsourced	77%	92%	98%	88%	88%
Commercial & Industrial						
C&I New Construction & Major Renovation	Yes	$82,142	$186,363	$445,582	$338,935	$1,053,022
	No	$578,225	$50,000	$700,000	$16,118	$1,344,343
	% Outsourced	12%	79%	39%	95%	44%
C&I Retrofit	Yes	$150,591	$186,363	$421,766	$670,955	$1,429,674
	No	$776,468	$50,000	$700,000	$31,907	$1,558,375
	% Outsourced	16%	79%	38%	95%	48%
C&I Direct Install	Yes	$8,701	$27,275	$30,000	$45,029	$111,005
	No	$132,558	$20,000	$0	$2,141	$154,699
	% Outsourced	6%	58%	100%	95%	42%
Workforce Development	Yes	$20,000	$0	$0	$0	$20,000
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
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	$4,649	$7,000	$21,070	$30,637	$63,356
	No	$35,205	$7,000	$9,300	$1,456	$52,961
	% Outsourced	12%	0%	0%	0%	54%
Statewide Marketing & Education	Yes	$0	$152,995	$0	$0	$152,995
	No	$0	$0	$0	$0	$0
	% Outsourced	$0	$1	$0	$0	100%
EEAC Consultants	Yes	$287,865	$0	$0	$0	$287,865
	No	$0	$0	$0	$0	$0
	% Outsourced	$1	$0	$0	$0	100%
DOER Assessment	Yes	$247,474	$0	$0	$0	$247,474
	No	$0	$0	$0	$0	$0
	% Outsourced	$1	$0	$0	$0	100%
Sponsorships & Subscriptions	Yes	$0	$0	$0	$0	$0
	No	$158,818	$0	$0	$0	$158,818
	% Outsourced	$0	$0	$0	$0	0%
C&I TOTAL	Yes	$801,423	$559,995	$918,418	$1,085,556	$3,365,391
	No	$1,522,457	$127,000	$1,409,300	$51,622	$3,110,379
	% Outsourced	34%	82%	39%	95%	52%
TOTAL						
GRAND TOTAL	**Yes**	**$3,533,407**	**$1,475,015**	**$6,289,722**	**$2,593,557**	**$14,050,519**
	No	**$4,054,696**	**$477,900**	**$1,636,125**	**$252,751**	**$6,421,472**
	% Outsourced	**47%**	**76%**	**79%**	**91%**	**69%**

Outsourced Services Actual, 2011						
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	$4,664	$29,705	$252,768	$95,090	$382,227
	No	$183,643	$14,798	$53,705	$18,246	$270,392
	% Outsourced	6%	75%	94%	88%	59%
Residential Heating and Water Heating	Yes	$30,150	$337,546	$301,077	$93,172	$761,945
	No	$701,125	$96,988	$104,515	$4,793	$907,422
	% Outsourced	11%	86%	89%	88%	46%
MassSAVE	Yes	$0	$89,343	$1,893,533	$39,411	$2,022,286
	No	$111,624	$11,326	$222,998	$13,255	$359,204
	% Outsourced	$0	$1	$1	$1	85%
Weatherization Program	Yes	$16,399	$43,689	$515,865	$191,176	$767,128
	No	$397,590	$23,717	$82,933	$3,683	$507,923
	% Outsourced	15%	45%	78%	88%	60%
Multifamily Retrofit	Yes	$3,139	$35,322	$172,122	$166,546	$377,129
	No	$181,142	$7,212	$208,124	$7,697	$404,174
	% Outsourced	5%	0%	95%	88%	48%
Behavior/Feedback Program	Yes	$1,255	$800	$152	$68,567	$70,774
	No	$133,989	$8,664	-$1,874	-$4,576	$136,203
	% Outsourced	21%	0%	100%	88%	34%
Deep Energy Retrofit	Yes	$449	$5,820	$46,758	$11,836	$64,864
	No	$192,485	$1,781	$2,237	$22,235	$218,738
	% Outsourced	12%	0%	100%	88%	23%
Residential Building Practices and Demonstration Program	Yes	$464	$2,730	$0	$70	$3,264
	No	$5,530	$176	$21,110	-$10	$26,805
	% Outsourced	42%	0%	0%	100%	11%
Energy Analysis: Internet Audit Program	Yes	$0	$57,597	$138,434	$0	$196,031
	No	$5,972	$645	$469	-$36	$7,050
	% Outsourced	90%	9%	0%	100%	97%
Community based pilots	Yes	$0	$46,254	$34,931	$37,137	$118,322
	No	$36,635	$495	$629	-$1,971	$35,788
	% Outsourced	0%	0%	0%	0%	77%
Workforce Development	Yes	$0	$0	$0	$0	$0
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	$0	$99,864	$0	$14,252	$114,117
	No	$0	$18,587	-$1	$0	$18,586
	% Outsourced	0%	100%	0%	0%	86%
EEAC Consultants	Yes	$154,301	$0	$0	$0	$154,301
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
DOER Assessment	Yes	$204,106	$0	$0	$0	$204,106
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
Sponsorships & Subscriptions	Yes	$0	$0	$0	$0	0
	No	$0	$0	$0	$0	0
	% Outsourced	0%	0%	0%	0%	#DIV/0!
Residential TOTAL	Yes	$414,927	$748,669	$3,355,640	$717,256	$5,236,492
	No	$1,949,736	$184,389	$694,845	$63,316	$2,892,286
	% Outsourced	18%	80%	83%	92%	64%
Low Income						
Low-Income Single Family Retrofit	Yes	$16,683	$4,057	$1,229,927	$93,941	$1,344,608
	No	$68,604	$270	$14,170	$11,829	$94,873
	% Outsourced	82%	94%	99%	88%	93%
Low-Income Multifamily Retrofit	Yes	$4,533	$768	$600,989	$58,718	$665,007
	No	$145,450	$4,200	$24,658	$7,806	$182,115
	% Outsourced	32%	71%	96%	88%	79%
Statewide Marketing & Education	Yes	$0	$36,723	$0	$0	$36,723
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	100%	0%	0%	100%
Low Income Energy Affordability Network Funding	Yes	$0	$0	$165,644	$0	$165,644
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
DOER Assessment	Yes	$73,565	$0	$0	$0	$73,565
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
Low Income TOTAL	Yes	$94,781	$41,548	$1,996,560	$152,659	$2,285,547
	No	$214,054	$4,470	$38,828	$19,635	$276,987
	% Outsourced	31%	90%	98%	89%	89%
Commercial & Industrial						
C&I New Construction & Major Renovation	Yes	$9,842	$161,151	$112,699	$166,056	$449,749
	No	$713,471	$22,087	$250,724	$8,529	$994,810
	% Outsourced	12%	79%	39%	95%	31%
C&I Retrofit	Yes	$24,341	$64,470	$401,388	$405,948	$896,146
	No	$990,000	$16,302	$700,034	$18,586	$1,724,923
	% Outsourced	16%	79%	38%	95%	34%
C&I Direct Install	Yes	$621	$18,696	$0	$24,288	$43,605
	No	$133,420	$8,373	$0	$1,186	$142,979
	% Outsourced	6%	58%	100%	95%	23%
Workforce Development	Yes	$0	$0	$0	$0	$0
	No	$0	$18	$13	-$1	$30
	% Outsourced	100%	0%	0%	0%	0%
Business Energy Analyzer	Yes	$0	$14,673	$63,688	$0	$78,361
	No	$4,622	$15,459	$66,613	-$15	$86,678
	% Outsourced	0%	0%	0%	0%	47%
Deep Energy Retrofit	Yes	$0	$0	$0	$0	$0
	No	$25,174	$122	$88	$10,441	$35,825
	% Outsourced	12%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	$0	$151,287	$0	$0	$151,287
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	100%	0%	0%	100%
EEAC Consultants	Yes	$182,464	$0	$0	$0	$182,464
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	0%
DOER Assessment	Yes	$171,651	$0	$0	$0	$171,651
	No	$0	$0	$0	$0	$0
	% Outsourced	100%	0%	0%	0%	100%
Sponsorships & Subscriptions	Yes	$0	$0	$0	$0	$0
	No	$0	$0	$0	$0	$0
	% Outsourced	0%	0%	0%	0%	0%
C&I TOTAL	Yes	$388,920	$410,278	$577,775	$596,292	$1,973,264
	No	$1,866,687	$62,361	$1,017,472	$38,726	$2,985,245
	% Outsourced	17%	87%	36%	94%	40%
TOTAL						
GRAND TOTAL	**Yes**	**$898,627**	**$1,200,494**	**$5,929,975**	**$1,466,207**	**$9,495,303**
	No	**$4,030,477**	**$251,220**	**$1,751,145**	**$121,677**	**$6,154,519**
	% Outsourced	**18%**	**83%**	**77%**	**92%**	**61%**

Outsourced Services Percent Variance, 2011						
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	-69%	-53%	-21%	145%	-12%
	No	-22%	-28%	160%	244%	-4%
	% Outsourced	0%	0%	0%	0%	-3%
Residential Heating and Water Heating	Yes	-45%	6%	-25%	-77%	-35%
	No	62%	88%	102%	-91%	53%
	% Outsourced	0%	0%	0%	0%	-31%
MassSAVE	Yes	-100%	11%	24%	-82%	10%
	No	-60%	-45%	980%	-57%	2%
	% Outsourced	0%	0%	0%	0%	1%
Weatherization Program	Yes	-77%	6%	134%	-26%	30%
	No	-3%	-54%	34%	-90%	-9%
	% Outsourced	0%	0%	0%	0%	17%
Multifamily Retrofit	Yes	-77%	0%	-57%	26%	-31%
	No	-32%	-83%	908%	-57%	16%
	% Outsourced	0%	0%	0%	0%	-21%
Behavior/Feedback Program	Yes	-97%	0%	-99%	67%	-34%
	No	-20%	-58%	0%	-181%	-30%
	% Outsourced	0%	0%	0%	0%	-4%
Deep Energy Retrofit	Yes	-97%	-39%	-40%	-84%	-64%
	No	83%	-81%	0%	114%	75%
	% Outsourced	0%	0%	0%	0%	-61%
Residential Building Practices and Demonstration Program	Yes	-97%	0%	-100%	-99%	-91%
	No	-74%	0%	0%	0%	27%
	% Outsourced	0%	0%	0%	0%	-83%
Energy Analysis: Internet Audit Program	Yes	-100%	460%	0%	-100%	0%
	No	-67%	-99%	0%	0%	-94%
	% Outsourced	0%	0%	0%	0%	56%
Community based pilots	Yes	-100%	0%	5274%	261%	942%
	No	-29%	-96%	-94%	0%	-51%
	% Outsourced	0%	0%	0%	0%	0%
Workforce Development	Yes	0%	0%	0%	0%	0%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	0%	-28%	0%	0%	-17%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	-14%
EEAC Consultants	Yes	-55%	0%	0%	0%	-55%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
DOER Assessment	Yes	-2%	0%	0%	0%	-2%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Sponsorships & Subscriptions	Yes	-100%	0%	0%	0%	-100%
	No	0%	0%	0%	0%	0%
	% Outsourced	-100%	0%	0%	0%	0%
Residential TOTAL	Yes	-57%	13%	13%	-41%	-12%
	No	-2%	-44%	275%	-60%	8%
	% Outsourced	-46%	20%	-12%	4%	-7%
Low Income						
Low-Income Single Family Retrofit	Yes	-99%	-98%	-35%	-55%	-63%
	No	-76%	-97%	-31%	-59%	-73%
	% Outsourced	0%	0%	0%	0%	3%
Low-Income Multifamily Retrofit	Yes	-96%	-97%	21%	-35%	-8%
	No	-41%	-59%	19%	-37%	-38%
	% Outsourced	0%	0%	0%	0%	10%
Statewide Marketing & Education	Yes	0%	-100%	0%	0%	-30%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Low Income Energy Affordability Network Funding	Yes	-100%	0%	0%	0%	-32%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
DOER Assessment	Yes	-18%	0%	0%	0%	-18%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Low Income TOTAL	Yes	-95%	-84%	-17%	-49%	-51%
	No	-60%	-78%	-6%	-52%	-57%
	% Outsourced	-60%	-2%	0%	1%	1%
Commercial & Industrial						
C&I New Construction & Major Renovation	Yes	-88%	-14%	-75%	-51%	-57%
	No	23%	-56%	-64%	-47%	-26%
	% Outsourced	0%	0%	0%	0%	-29%
C&I Retrofit	Yes	-84%	-65%	-5%	-39%	-37%
	No	28%	-67%	0%	-42%	11%
	% Outsourced	0%	0%	0%	0%	-29%
C&I Direct Install	Yes	-93%	-31%	-100%	-46%	-61%
	No	1%	-58%	0%	-45%	-8%
	% Outsourced	0%	0%	0%	0%	-44%
Workforce Development	Yes	-100%	0%	0%	0%	-100%
	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	-100%	-100%	-100%	-100%	-100%
	No	-28%	-98%	-99%	617%	-32%
	% Outsourced	0%	0%	0%	0%	0%
Statewide Marketing & Education	Yes	0%	-1%	0%	0%	-1%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
EEAC Consultants	Yes	-37%	0%	0%	0%	-37%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
DOER Assessment	Yes	-31%	0%	0%	0%	-31%
	No	0%	0%	0%	0%	0%
	% Outsourced	0%	0%	0%	0%	0%
Sponsorships & Subscriptions	Yes	-100%	0%	0%	0%	-100%
	No	0%	0%	0%	0%	0%
	% Outsourced	-100%	0%	0%	0%	-100%
C&I TOTAL	Yes	-51%	-27%	-37%	-45%	-41%
	No	23%	-51%	-28%	-25%	-4%
	% Outsourced	-50%	6%	-8%	-2%	-23%
TOTAL						
GRAND TOTAL	**Yes**	**-75%**	**-19%**	**-6%**	**-43%**	**-32%**
	No	**-1%**	**-47%**	**7%**	**-52%**	**-4%**
	% Outsourced	**-61%**	**9%**	**-3%**	**1%**	**-12%**

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	66,117,018	97,285	-	279,198	37,443	-	66,530,944	32,000,568	4,117,893	36,118,461	1.84	30,412,482
Low Income	17,890,944	2,055	-	300,447	-	12,885,608	31,079,055	15,405,750	-	15,405,750	2.02	15,673,305
C&I	55,397,404	-	-	-	3,423,748	-	58,821,152	18,613,721	26,892,527	45,506,248	1.29	13,314,904
TOTAL	161,637,032	99,340	-	579,645	3,461,191	12,885,608	178,662,816	66,020,039	31,010,420	97,030,460	1.84	81,632,357
Evaluated												
Residential	66,117,018	242,202	-	403,694	1,783,838	38,594,118	107,140,870	35,317,433	7,734,252	43,051,685	2.49	64,089,185
Low Income	17,890,944	187,091	-	898,912	2,189,524	11,709,885	32,876,356	11,777,648	-	11,777,648	2.79	21,098,708
C&I	55,397,404	-	-	4,480	6,846,967	-	62,248,851	16,195,113	20,222,028	36,417,141	1.71	25,831,710
TOTAL	139,405,366	429,293	-	1,307,085	10,820,329	50,304,003	202,266,076	63,290,194	27,956,279	91,246,473	2.22	111,019,603
Perent Variance												
Residential	0%	149%	0%	45%	4664%	0%	61%	10%	88%	19%	35%	111%
Low Income	0%	9002%	0%	199%	0%	-9%	6%	-24%	0%	-24%	38%	35%
C&I	0%	0%	0%	0%	100%	0%	6%	-13%	-25%	-20%	32%	94%
TOTAL	-14%	332%	0%	125%	213%	290%	13%	-4%	-10%	-6%	20%	36%

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

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-MWh saved)	Emissions Reductions (Short Tons) (1)				Participants
	Gas (Therms)		Electric Energy (kWh)		Summer Electric Capacity (KW)		Winter Capacity (kW)		Non-gas non-elec Resources				NOx	SO2	GHG (MA Based)	GHG (Regional Based)	
	Annualized	Lifetime	Annualized	Lifetime	Annualized	Lifetime	Annualized	Lifetime	Annualized	Lifetime							
Planned																	
Residential	5,396,274	57,500,316	200,934	2,141,063	32	340	24	252	378,830	4,036,646	11	0.63	N/A	N/A	337,075	27,021,169	249,904
Low Income	496,203	9,451,088	167,970	3,199,294	1	12	21	402	-	-	19	1.63	N/A	N/A	56,929	4,457,992	3,063
C&I	5,283,894	73,998,304	-	-	-	-	-	-	132,709,650	1,858,532,475	14	0.61	N/A	N/A	432,312	34,757,985	4,067
TOTAL	11,176,371	140,949,708	368,904	5,340,357	33	352	45	654	133,088,480	1,678,432,314	13	0.69	N/A	N/A	826,317	66,237,146	257,034
Evaluated																	
Residential	5,450,135	54,813,162	398,754	4,010,356	78	782	73	738	25,104,189	252,478,131	10	0.79	N/A	N/A	322,378	25,769,898	268,259
Low Income	809,933	25,869,318	474,548	15,157,105	54	1,726	93	2,968	30,838,368	984,980,165	32	0.46	N/A	N/A	159,255	12,239,712	4,003
C&I	3,582,634	51,370,419	2,558	36,685	-	-	-	-	112,712,512	1,616,154,391	14	0.71	N/A	N/A	300,135	24,129,581	2,951
TOTAL	9,842,702	132,052,898	875,861	19,204,145	132	1,768	166	3,706	168,655,069	2,853,612,688	13	0.69	N/A	N/A	781,769	62,139,192	275,213
Perent Variance																	
Residential	1%	-5%	98%	87%	144%	130%	211%	193%	6527%	6155%	-6%	25%	N/A	N/A	-4%	-5%	7%
Low Income	63%	174%	183%	374%	8430%	14205%	340%	638%	0%	0%	68%	-72%	N/A	N/A	180%	175%	31%
C&I	-32%	-31%	0%	0%	0%	0%	0%	0%	-15%	-13%	2%	15%	N/A	N/A	-31%	-31%	-27%
TOTAL	-12%	-6%	137%	260%	305%	402%	272%	467%	27%	70%	6%	0%	N/A	N/A	-5%	-6%	7%

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

mass save
Savings through energy efficiency

Massachusetts
Technical Reference Manual

for Estimating Savings from Energy Efficiency Measures

2011 Program Year – Report Version

August 2012

berkshire gas
Unitil
nationalgrid
Western Massachusetts Electric
The Northeast Utilities System
Columbia Gas of Massachusetts
A NiSource Company
NSTAR
BLACKSTONE GAS COMPANY
New England Gas Company
Cape Light Compact

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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)
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

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Stakeholder	Responsibilities
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") 2011 TRM Plan and Report versions are described below the timeline.

OCTOBER 2010: The 2011 PY – Plan Version TRM is filed with the PAs' program plans.

The 2011 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 2010 - JUNE 2012: The 2011 Program Year TRM will be updated as needed based on evaluation studies and any other updates that will affect reported savings for PY 2011.

After the 2011 Program Year – Plan Version TRM has been filed, there may be updates to the TRM to reflect how savings are actually calculated for PY 2011. 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 2011: PAs begin to track savings based on the 2011 TRM

Beginning in January 2011, the PAs will track savings for PY 2011 based on the 2011 Program Year – Plan Version TRM.

August 2012: The 2011 Program Year – Report Version TRM will be filed with the PY 2011 Annual Reports

The 2011 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 2011 - OCTOBER 2011: The PAs prepare the 2012 Program Year – Plan Version TRM for filing with their 2012 program plans

The 2012 Program Year – Plan Version TRM will be based on previous program year versions of the TRM, updated as appropriate for the 2011 program year in preparation for filing with the 2012 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**Error! Reference source not found.**, 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	

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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.

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:

$$\Delta kW = \left(Watts_{BASE} - Watts_{EE}\right)/1000$$

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

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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.

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.

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

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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)

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$adj_gross_kW_{WP}$	=	Adjusted Gross Connected kW Savings (summer peak)
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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Lighting – CFL Bulbs (Markdown)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: This measure covers the installation of ENERGY STAR® screw-in compact fluorescent lamps (CFLs) purchased through the PAs markdown programs. 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
Market: Lost Opportunity
End Use: Lighting
Program: ENERGY STAR Lighting

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 CFL Bulb Spiral
ΔkWh	=	Average annual kWh reduction: 47 kWh
ΔkW	=	Average annual kW reduction: 0.0457 kW[2]
Hours	=	Average annual operating hours

Baseline Efficiency

The baseline efficiency case is an incandescent bulb.

High Efficiency

The high efficiency case is an ENERGY STAR® rated CFL spiral bulb.

Hours

Average annual operating hours are 1,022 hours/year (2.8 hours/day[3] * 365 days/year).

Measure Life

The measure life is 7 years for markdown bulbs and 5 years for coupon bulbs.[4]

[2] Nexus Market Research (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.
[3] Nexus Market Research, Inc., RLW Analytics (2008). *Residential Lighting Measure Life Study*. Prepared for New England Residential Lighting Program Sponsors.
[4] 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}
Screw-in Bulbs	ES Lighting	All	0.97	1.00	1.00	1.00	1.00	0.11	0.22
Screw-in Bulbs (Hard to Reach)	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22
Screw-in Bulbs (School Fundraiser)	ES Lighting	All	0.50	1.00	1.00	1.00	1.00	0.11	0.22
Screw-in Bulbs (Specialty)	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22

In-Service Rates
In-Service rates are based on Massachusetts Common Assumptions.

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
Coincidence factors are from the 2009 Lighting Markdown Study.[5]

[5] Nexus Market Research and RLW Analytics (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.

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Lighting – CFL Bulbs

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of ENERGY STAR® screw-in compact fluorescent lamps (CFLs). 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, Retrofit
End Use: Lighting
Program: Residential New Construction & Major Renovation, MassSAVE, Multi-Family Retrofit (not National Grid), 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 are deemed based on the on the following algorithms and averaged inputs:

For Residential New Construction & Major Renovation, MassSAVE, Multi-Family Retrofit and Low-Income Residential New Construction:

$$\Delta kWh = \Delta kW \times Hours$$
$$\Delta kW = \Delta kW$$

Unit = Installed CFL bulb
ΔkWh = Average annual kWh reduction: 57 kWh
ΔkW = Average reduction in connected kW: 0.0487 kW[6]
Hours = Average annual operating hours

For Low-Income 1-4 Family Retrofit:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Installed CFL bulb
ΔkWh = Average annual kWh savings per unit: 45 kWh[7]
ΔkW = Max kW reduction: 0.007 kW[8]

[6] Nexus Market Research, Inc., RLW Analytics (2004). *Impact Evaluation of the MA, RI, and VT 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.
[7] 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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For Low-Income MultiFamily Retrofit:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Installed CFL bulb
ΔkWh = Average annual kWh savings per unit: 45 kWh[9]
ΔkW = Max kW reduction: 0.011 kW[10]

Baseline Efficiency

The baseline efficiency case is an incandescent bulb.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified compact fluorescent light bulb that uses 75% less energy and lasts about 10 times longer than an incandescent bulb.

Hours

The annual operating hours are 1,168 hours/year (3.2 hours/day[11] * 365 days/year).

Measure Life

For Residential New Construction & Major Renovation, MassSAVE, Multi-Family Retrofit and Low-Income Residential New Construction installations, the measure life is 7 years.[12]

For Low-Income 1-4 Family Retrofit and Low-Income MultiFamily Retrofit installations, the measure life is 9 years.[13]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impact

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

[8] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[9] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[10] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[11] Ibid.
[12] Nexus Market Research, Inc., RLW Analytics (2008). *Residential Lighting Measure Life Study*. New England Residential Lighting Program Sponsors.
[13] Massachusetts Common Assumption: In the Low Income program there is no limit on the number of CFLs installed per home; a longer lifetime is assumed to account for the shorter hours per day.

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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}
Screw-in Bulbs	RNC, LI RNC	All	0.99	1.00	1.00	1.00	1.00	0.11	0.22
Screw-in Bulbs	MassSAVE	All	0.90	1.00	1.00	1.00	1.00	0.11	0.22
Screw-in Bulbs (piggyback)	MassSAVE	All	0.90	1.00	1.00	1.00	1.00	0.11	0.22
Screw-in Bulbs	MF Retrofit	All (not National Grid)	0.97	0.99	1.00	1.00	1.00	0.11	0.22
Common Area Fixtures	MF Retrofit	All (not National Grid)	0.97	0.99	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	0.80	1.00
CFL Bulb	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.19	1.00

In-Service Rate

- RNC, LI RNC: 2006 ENERGY STAR® Homes New Homebuyer Survey Report[14]
- MassSAVE: Impact evaluation of the MA, RI, VT 2003 Residential Lighting Programs[15]
- MF Retrofit: 2011 Residential Retrofit Multifamily Impact Analysis[16]
- LI 1-4 Retrofit, LI MF Retrofit: PAs assume 100% installation rate.

Savings Persistence Factor

All PAs use 100% savings persistence factors except for MF Retrofit where the Savings Persistence Factor is from the 2011 Residential Retrofit Multifamily Impact Analysis[17].

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

- RNC, LI RNC, MassSAVE, MF Retrofit: Coincidence factors are based on the 2009 Lighting Markdown Study.[18]
- LI MF Retrofit, LI 1-4 Retrofit: Summer and winter coincidence factors are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[19]
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[14] 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.

[15] Nexus Market Research, Inc., RLW Analytics (2004). *Impact Evaluation of the MA, RI, and VT 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.

[16] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators

[17] Ibid

[18] Nexus Market Research and RLW Analytics (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.

[19] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Lighting – CFL 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: Low Income, Residential
Market: Lost Opportunity, Retrofit
End Use: Lighting
Program: Low-Income 1-4 Family Retrofit, Low-Income MultiFamily Retrofit (not National Grid), ENERGY STAR Lighting, Residential New Construction & Major Renovation, Low-Income Residential New Construction, Multi-Family Retrofit (not National Grid)

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

For Low-Income 1-4 Family Retrofit

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Installation of CFL fixture
ΔkWh = Average annual kWh savings per unit: 140 kWh[20]
ΔkW = Max kW reduction: 0.023 kW[21]

For Low-Income MultiFamily Retrofit

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Installation of CFL fixture
ΔkWh = Average annual kWh savings per unit: 140 kWh[22]

[20] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[21] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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ΔkW = Max kW reduction: 0.036 kW[23]

For ENERGY STAR Lighting, Residential New Construction & Major Renovation, Low-Income Residential New Construction, and Multi-Family Retrofit

$$\Delta kWh = \Delta kW \times Hours$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Rebated indoor fixture
ΔkWh = Average annual kWh reduction: 44 kWh
ΔkW = Average reduction in connected kW: 0.049 kW[24]
Hours = Average annual operating hours

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[25] * 365 days/year) for ENERGY STAR Lighting, Residential New Construction & Major Renovation, Low-Income Residential New Construction, and Multi-Family Retrofit.

Measure Life

The measure life is 20 years.[26]

Secondary Energy Impact

There are no secondary energy impacts for this measure.

Non-Energy Impact

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

[22] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.* Prepared for the Electric and Gas Program Administrators of Massachusetts.
[23] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[24] Nexus Market Research, Inc., RLW Analytics (2004) *Impact Evaluation of the MA, RI, and VT 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, Table 1-8.
[25] Nexus Market Research, Inc., RLW Analytics (2004) *Impact Evaluation of the MA, RI, and VT 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.
[26] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Lighting Fixtures*. Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=LF.

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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 Fixture	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.80	1.00
CFL Fixture	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.19	1.00
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	0.99	1.00	1.00	1.00	0.11	0.22

In-Service Rates

All CFL fixture installations have 100% in service rate since all PAs programs include verification of equipment installations.

- ES Lighting: 2004 Impact Evaluation of MA, RI, VT Residential Lighting Program[27]
- RNC, LI RNC: 2006 ENERGY STAR® Homes New Homebuyer Survey Report[28]
- MF Retrofit: 2011 Residential Retrofit Multifamily Impact Analysis[29]

Savings Persistence Factor

All PAs use 100% savings persistence factors except for MF Retrofit where the Savings Persistence Factor is from the 2011 Residential Retrofit Multifamily Impact Analysis[30].

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

- 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.[31] Coincidence factors for indoor fixtures are based on the 2009 Lighting Markdown Study.[32]

[27] Nexus Market Research, Inc., RLW Analytics (2004). *Impact Evaluation of the MA, RI, and VT 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.
[28] 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 Joint Management Committee; Table 8.1
[29] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[30] Ibid
[31] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators..
[32] Nexus Market Research and RLW Analytics (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.

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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, Multifamily Retrofit (not National Grid)

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
ΔkW	=	Average connected kW reduction: 0.095 kW[33]
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 bulb.

Hours

The average annual operating hours are 1,642.5 hours/year (4.5 hours per day[34] * 365 days per year).

Measure Life

The measure life is 6 years for markdown outdoor fixtures and 5 years for coupon outdoor fixtures.[35]

[33] Nexus Market Research, Inc., RLW Analytics (2004). *Impact Evaluation of the MA, RI, and VT 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.
[34] Nexus Market Research, Inc., RLW Analytics (2004). *Impact Evaluation of the MA, RI, and VT 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

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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	0.99	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[36]
- MF Retrofit: 2011 Residential Retrofit Multifamily Impact Analysis[37]
-

Savings Persistence Factor

All PAs use 100% savings persistence factors except for MF Retrofit where the Savings Persistence Factor is from the 2011 Residential Retrofit Multifamily Impact Analysis[38].

Realization Rates

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors

- Coincidence factors are based on the 2009 Lighting Markdown Study.[39]

[35] Nexus Market Research, Inc., RLW Analytics (2008). *Residential Lighting Measure Life Study*. Prepared for New England Residential Lighting Program Sponsors; Page 1.
[36] Nexus Market Research, Inc., RLW Analytics (2004) *Impact Evaluation of the MA, RI, and VT 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.
[37] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[38] Ibid
[39] Nexus Market Research and RLW Analytics (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, MassSAVE, Multi-Family Retrofit, Low-Income 1-4 Family Retrofit, Low-Income MultiFamily Retrofit (not National Grid)

Algorithms for Calculating Primary Energy Impact

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 = Rebated ENERGY STAR® Torchiere
ΔkWh = Average annual kWh savings per unit: 211 kWh[40]
ΔkW = Max kW reduction: 0.035 kW[41]

For Low-Income MultiFamily Retrofit

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Rebated ENERGY STAR® Torchiere
ΔkWh = Average annual kWh savings per unit: 211 kWh[42]

[40] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[41] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[42] 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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ΔkW = Max kW reduction: 0.054 kW[43]

For ENERGY STAR Lighting, Multi-Family Retrofit and, MassSAVE

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
ΔkW = Average connected kW reduction: 0.088 kW[44]
Hours = Average annual operating hours

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

[43] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[44] Nexus Market Research, Inc., RLW Analytics (2004) *Impact Evaluation of the MA, RI, and VT 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.
[45] Nexus Market Research, Inc., 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.

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Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Torchieres	MassSAVE	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	0.80	1.00
Torchieres	LI MF Retrofit	CLC only	1.00	1.00	1.00	1.00	1.00	0.19	1.00

In-Service Rates

- ES Lighting, MassSAVE: 2004 Impact Evaluation of MA, RI, VT Residential Lighting Program[47]
- MF Retrofit assumed to be the same as for ES Lighting and MassSAVE
- 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 for ES Lighting, MassSave and RNC are based on the 2009 Lighting Markdown Study.[48]
- MF Retrofit assumed to be the same as for ES Lighting and MassSAVE.
- Coincident factors for LI 1-4 Retrofit and LI MF Retrofit are estimated using demand allocation methodology described the Cadmus Demand Impact Model.[49]

[47] Nexus Market Research, Inc., RLW Analytics (2004). *Impact Evaluation of the MA, RI, and VT 2003 Residential Lighting Programs.* Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR, and Unitil Energy Systems, Inc.; Page 11.
[48] Nexus Market Research and RLW Analytics (2009). Residential *Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.
[49] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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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 Light-Emitting Diode (LED) screw-in bulbs and fixtures. 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

Algorithms for Calculating Primary Energy Impact

Unit savings 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 or fixture
ΔkWh	=	Average annual energy savings: 48 kWh[50]
ΔkW	=	Average connected kW reduction: 0.008 kW[51]
kW_{BASE}	=	Average connected kW of baseline bulb
kW_{LED}	=	Average connected kW of LED bulb
Hours	=	Average annual operating hours

Baseline Efficiency

The baseline efficiency case is a 65-watt incandescent bulb in a screw-based socket or fluorescent under cabinet light.

High Efficiency

The high efficiency case is an 18-watt LED downlight.

Hours

The average annual operating hours are 1,022 hours/year (2.8 hours/day[52] * 365 days/year).

[50] 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.*
[51] 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.[53]

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 Lamp	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22
LED Fixture	ES Lighting	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22
LED Fixture	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	0.11	0.22

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 from the 2009 Lighting Markdown Study.[54]

[52] Nexus Market Research (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT; Page 6.
[53] Expected lifetime form ENERGY STAR ®.
[54] Nexus Market Research and RLW Analytics (2009). *Residential Lighting Markdown Impact Evaluation*. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT.

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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 (not National Grid)

Algorithms for Calculating Primary Energy Impact

Unit savings are based on the following algorithms which use averaged inputs[55]:

$$\Delta kWh = kW \times Hours \times \%Unoccupied$$
$$\Delta kW = 0$$

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[56]
Hours	=	Average annual operating hours for connected lighting wattage without controls
%Unoccupied	=	Average % of time that controlled space is unoccupied: 35%[57]

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.[58]

Measure Life

The measure life is 10 years.[59]

[55] Waste Reduction Partners (2004). *Occupancy Sensors- Utility Savings Initiative- Fact Sheet*; Page 2, algorithm based on the Lighting Fixture Basis formula.
[56] Ibid; Page 2, based on the savings for a 3-lamp T8.
[57] Ibid; Page 2, assumption based on the U.S. EPA Prediction for Corridors.
[58] Ibid; assumption form 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

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}
Common Area Occupancy Sensors	MF Retrofit	All	0.97	0.99	1.00	1.00	1.00	0.00	0.00

In-Service Rates
The In-Service rate is from the 2011 Residential Retrofit Multifamily Impact Analysis[60]

Savings Persistence Factor
The Savings Persistence Factor is from the 2011 Residential Retrofit Multifamily Impact Analysis[61]

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.

[59] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[60] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[61] Ibid.

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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[62]
ΔkW	=	Average annual kW savings per unit: 0.006 kW[63]

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.[64]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[62] Deemed savings developed based on assumptions in CEE (2008). *Consumer Electronics Program Guide: Information on Voluntary Approaches for the Promotion of Energy Efficient Consumer Electronics - Products and Practices*; Page 9, Table 1.
[63] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
[64] 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

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}
Computer Monitors	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	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 the Cadmus Demand Impact Model[65]

[65] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Process – Desktop Computers

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Rebates for ENERGY STAR® Desktop 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[66]
ΔkW = Average kW savings per unit: 0.013 kW[67]

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.[68]

Measure Life

The measure life is 4 years.[69]

[66] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Office Equipment.* Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_office_eq.xls.
[67] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[68] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Office Equipment.* Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_office_eq.xls.
[69] 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}
PC Computers	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	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 the Cadmus Demand Impact Model.[70]

[70] 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[71]
ΔkW	=	Average connected load reduction: 0.048 kW[72]
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.[73]

[71] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Cleaner.* Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorRoomAirCleaner.xls
[72] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[73] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Room Air Cleaner.* Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorRoomAirCleaner.xls

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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}
Room Air Cleaner	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	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 the Cadmus Demand Impact Model[74]
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[74] 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: 30 kWh[75]
ΔkW	=	Average connected load reduction: 0.005 kW[76]

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-stop 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.[77]

[75] 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 10/14/10; savings found by taking 30% of the average Total Energy Consumption form the Qualified Set-top Box Product List.
[76] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[77] Massachusetts Common Assumption.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impact

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}
Set Top Box	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	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 the Cadmus Demand Impact Model[78]

[78] 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, MassSAVE, 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: 75 kWh[79]
ΔkW = Max kW savings per unit: 0.013 kW[80]

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

The savings are based on 8,760 hours per year.

Measure Life

The measure life is 5 years.[81]

Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

[79] ECOS 2008 Entertainment Center and DVDs.
[80] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[81] Massachusetts Common Assumptions.

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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	0.65	1.00
Smart Strips	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Smart Strips	MF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Smart Strips	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Smart Strips	LI MF Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.65	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 the Cadmus Demand Impact Model[82]

[82] 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 televisions that meet ENERGY STAR® version 5.1 specifications.
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:

$$\Delta kWh = kWh_{BASE} - kWh_{EE}$$
$$\Delta kW = kW_{BASE} - kW_{EE}$$

Where:

Unit	=	Rebated television
kWh_{BASE}	=	Average kW consumption of baseline models
kWh_{EE}	=	Average kWh consumption of energy efficient models
kW_{BASE}	=	Average kW load of baseline models
kW_{EE}	=	Average kW load of energy efficient models

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[83]. The savings, which are weighted between on and standby modes, for various models are given in the following table.

Television Size	Weighted kW Savings[84]	ΔkWh /Unit
LCD/TV	0.013	75
Version 4.1 TV <60”	0.032	180
Version 4.1 TV >=60”	0.066	372
Version 5.1 TV <60”	0.042	235

[83] 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.
[84] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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Version 5.1 TV >=60"	0.094	528

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.

Measure Life

The measure life is 6 years.[85]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impact

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}
LCD/TV	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Version 4.1 TV < 60"	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Version 4.1 TV >= 60"	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Version 5.1 TV < 60"	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Version 5.1 TV >= 60"	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.65	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 the Cadmus Demand Impact Model.[86]

[85] Environmental Protection Agency (2008). Life *Cycle Cost Estimate for ENERGY STAR Television*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Televisions_Bulk.xls
[86] 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[87]
ΔkW	=	Average kW reduction over non-ES refrigerator: 0.013 kW[88]

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.

[87] 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.
[88] 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 12 years.[89]

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	0.87
Refrigerators	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	1.00	0.87

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 the Cadmus Demand Impact Model.[90]

[89] 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
[90] 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: MassSAVE, Multi-Family Retrofit (not National Grid), Low-Income MultiFamily Retrofit (not National Grid), Low-Income 1-4 Family Retrofit

Algorithms for Calculating Primary Energy Impact

For MassSAVE

Unit savings are deemed based on the following algorithms and averaged inputs:

$$\Delta kWh = \Delta kWh_{RETIRE} + \Delta kWh_{ES}$$
$$\Delta kW = \Delta kW_{RETIRE} + \Delta kW_{ES}$$

Where:

Unit	=	Replacement of existing refrigerator with new ENERGY STAR® Refrigerator
ΔkWh_{RETIRE}	=	Annual energy savings over remaining life of existing equipment: 884 kWh[91]
ΔkWh_{ES}	=	Annual energy savings over full life of new ES refrigerator: 80 kWh[92,93]
ΔkW_{RETIRE}	=	Average demand reduction over remaining life of existing equipment: 0.106 kW[94]
ΔkW_{ES}	=	Average demand reduction over full life of new ES refrigerator: 0.009 kW[95]

For Multi-Family Retrofit and Low-Income Multifamily Retrofit

$$\Delta kWh = \Delta kWh_{RETIRE} + \Delta kWh_{ES}$$
$$\Delta kW = \Delta kW_{RETIRE} + \Delta kW_{ES}$$

[91] Michael Blasnik & Associates (2004). *Measurement & Verification of Residential Refrigerator Energy Use 2003 - 2004 Metering Study*. Prepared for NSTAR MECO, NECO, and WMECO.
[92] 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
[93] NSTAR uses the Lost Opportunity savings of 107 kWh as the annual savings over the life of the new ES refrigerator. See *Refrigerator(Lost Opportunity) section.*
[94] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[95] Ibid.

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Where:

Unit	=	Replacement of existing refrigerator with new ENERGY STAR® Refrigerator
ΔkWh_{RETIRE}	=	Annual energy savings over remaining life of existing equipment: 884 kWh[96]
ΔkWh_{ES}	=	Annual energy savings over full life of new ES refrigerator: 80 kWh[97,98]
ΔkW_{RETIRE}	=	Average demand reduction over remaining life of existing equipment: 0.112 kW[99]
ΔkW_{ES}	=	Average demand reduction over full life of new ES refrigerator: 0.010 kW[100,101]

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	=	Removal of existing refrigerator and installation of new efficient refrigerator
ΔkWh	=	Average annual kWh savings per unit: 762 kWh[102]
ΔkW	=	Max kW Reduction: 0.092 kW[103]

Baseline Efficiency

For MassSAVE, 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.[104]

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.

[96] Michael Blasnik & Associates (2004). *Measurement & Verification of Residential Refrigerator Energy Use 2003 - 2004 Metering Study*. Prepared for NSTAR MECO, NECO, and WMECO.
[97] 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
[98] NSTAR uses the Lost Opportunity savings of 107 kWh as the annual savings over the life of the new ES refrigerator. See *Refrigerator(Lost Opportunity) section.*
[99] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[100] Ibid.
[101] 0.014 kW for NSTAR
[102] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[103] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[104] 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.

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Hours

Savings are based on 8,760 operating hours per year.

Measure Life

For MassSAVE, 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. [105]

For Low-Income 1-4 Family Retrofit: The measure life is 19 years.[106]

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}
Refrigerators	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	1.00	0.87
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	0.87

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

- MassSAVE, 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

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[107]

[105] 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.
[106] Massachusetts Common Assumption.
[107] 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:

$$\Delta kWh = \Delta kWh_{BASE} - \Delta kWh_{ES}$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installed ENERGY STAR® freezer
ΔkWh	=	Annual savings over non-ES freezers averaged by model type: 136 kWh[108]
ΔkW	=	Average kW reduction over non-ES freezer: 0.016 kW[109]

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 12 years.[110]

[108] NEEP. *Refrigerator and Freezer Screening Tool*; average savings of all given models.
[109] 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 Impact

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}
Freezer Rebate	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.87

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 the Cadmus Demand Impact Model.[111]

[110] 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
[111] 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 (not National Grid)

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[112]
ΔkW = Max kW Reduction: 0.029 kW for LI 1-4 Retrofit and 0.033 for LI MF Retrofit[113]

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.[114]

[112] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[113] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[114] Massachusetts Common Assumption: it has been assumed that LI 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	0.87
Freezer Replacement	LI MF Retrofit	All (Not National Grid)	1.00	1.00	1.00	1.00	1.00	1.00	0.74

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.[115]

[115] 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: Refer to Appendix D: Non-Resource Impacts
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.

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Removed secondary refrigerator or freezer
ΔkWh	=	Average annual kWh savings per unit.
ΔkW	=	Average kW reduction per unit

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 four possible scenarios including recycling of a freezer, recycling of a secondary unit with no replacement (refrigerator), recycling of a secondary unit with replacement (refrigerator) and recycling of a primary unit with replacement (refrigerator).

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Measure	ΔkW[116]	ΔkWh[117]
Refrigerator Recycle Primary	0.064	533
Refrigerator Recycle Secondary Replaced	0.084	696
Refrigerator Recycle Secondary Not Replaced	0.100	835
Freezer Recycle	0.080	663
Refrigerator Recycle (combined)	0.091	755

Hours

Refrigerator and freezer operating hours are 8,760 hours/year.

Measure Life

The measure life is 8 years.[118]

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}
Ref Frz Recycling	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	1.00	0.87

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.[119]

[116] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[117] 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.
[118] KEMA, Inc (2008). *The Opportunity for Energy Efficiency that is Cheaper than Supply in Rhode Island – Phase I Report.* Prepared for RI Energy Efficiency and Resource Management Council; Page 9-2.
[119] 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[120]
ΔkW = Max kW reduction: 0.142 kW [121]

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.[122]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[120] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[121] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[122] 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	0.87

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.[123]

[123] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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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: HVAC
Program: Low-Income 1-4 Family Retrofit, Low-Income MultiFamily Retrofit (not National Grid)

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: 25 kWh[124]
ΔkW = Max kW Reduction: 0.004 kW for LI 1-4 Retrofit and 0.003 kW for LI MF Retrofit[125]

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[126]
ΔkW = Max kW Reduction: 0.020 kW[127]

Baseline Efficiency

The baseline efficiency case assumes no measures installed.

[124] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[125] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[126] 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.
[127] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators
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High Efficiency

The high efficiency case includes basic educational measures such as pool and air conditioner timers, LED nightlights, refrigerator brushes.

Hours

Not applicable.

Measure Life

The measure life is 5 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}
Baseload	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.65	1.00
Baseload	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.89	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.[129]

[128] Massachusetts Common Assumption.
[129] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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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[130]
$SEER_{BASE}$ = 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 13 SEER Central AC system with an EER of 11.

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.[131]

Measure	$SEER_{EE}$	EER_{EE}
CoolSmart AC (SEER 14.5 / EER 12)	14.5	12.0
CoolSmart AC (SEER 15.0 >= / EER >= 12.5)	15.0	12.5
CoolSmart AC (SEER 15.0 >= / EER >= 13)	15.0	13.0

[130] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.
[131] The PAs are looking into abilities to track and calculate savings based on actual installed efficiencies for each project.

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CoolSmart AC (SEER 16 / EER 13)	16.0	13.0

Hours

The 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	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

[132] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis*. Prepared for CL&P; 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.

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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:

$$\Delta kWh = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left[\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}} \right) \times Hours_C + \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}} \right) \times Hours_H \right]$$

$$\Delta kW = \max(\Delta kW_{COOL}, \Delta kW_{HEAT})$$

$$\Delta kW_{COOL} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}} \right)$$

$$\Delta kW_{HEAT} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}} \right)$$

Where:

Unit	=	Installation of heat pump system
Tons	=	Capacity of HP equipment: Current default is 3 tons[134]
$SEER_{BASE}$	=	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

Baseline Efficiency

The baseline efficiency case is a heat pump with a HSPF of 7.6, SEER of 13 and EER of 11.

[134] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis*. Prepared for CL&P; Page 4-12, Table 4-9.

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High Efficiency

The high efficiency case is an ENERGY STAR® qualified Air Source Heat Pump.

Measure	$SEER_{EE}$	EER_{EE}	$HSPF_{EE}$
CoolSmart HP (SEER 14.5 / EER 12)	14.5	12.0	8.2
CoolSmart HP (SEER >= 15.0)	15.0	12.5	8.5
CoolSmart HP MS (SEER 19 / EER 12.8 / HSPF 10.1)	19.0	12.8	10.1
CoolSmart HP MS (SEER 23 / EER 13 / HSPF 10.6)	23.0	13.0	10.6

Hours

Equivalent full load hours are 1200 hours/year for heating[135] and 360 hours/year for cooling.[136]

Measure Life

The measure life is 18 years.[137]

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	0.67	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.

[135] Massachusetts Common Assumption.
[136] ADM Associates, Inc. (2009). Residential *Central AC Regional Evaluation – Free-Ridership Analysis*. Prepared for CL&P; Page 4-5, Table 4-3.
[137] 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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HVAC – Ductless Mini Split 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:

$$\Delta kWh = \Delta kWh_{HP} + \Delta kWh_{SEAL}$$

$$\Delta kW = \max(\Delta kW_{COOL}, \Delta kW_{HEAT}) + \Delta kW_{SEAL}$$

$$\Delta kWh_{HP} = Tons \times \frac{12\ kBtu/hr}{Ton}\left[\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right) \times Hours_C + \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right) \times Hours_H\right]$$

$$\Delta kW_{COOL} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

$$\Delta kW_{HEAT} = Tons \times \frac{12\ kBtu/hr}{Ton} \times \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right)$$

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
ΔkWh_{SEAL}	=	Annual energy savings from duct sealing: See *HVAC – Duct Sealing*
ΔkW_{SEAL}	=	Annual demand reduction from duct sealing: See *HVAC – Duct Sealing*
Tons	=	Capacity of HP equipment: Current default is 3 tons[138]
$SEER_{BASE}$	=	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

[138] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.

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$Hours_H$ = EFLH for heating

Baseline Efficiency

The baseline efficiency case is a non- ENERGY STAR® rated ductless mini split heat pump.

High Efficiency

The high efficiency case is an ENERGY STAR® qualified Ductless Mini Split System.

Hours

The equivalent full load hours are 1200 hours/year for heating[139] and 360 hours/year for cooling.[140]

Measure Life

The measure life is 18 years.[141]

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	0.67	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] Massachusetts Common Assumptions.
[140] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-5, Table 4-3.
[141] 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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HVAC – Ductless Mini Split 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[142]
$SEER_{BASE}$	=	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
ΔkWh_{SEAL}	=	Annual energy savings from duct sealing: See *HVAC – Duct Sealing*
ΔkW_{SEAL}	=	Annual demand reduction from duct sealing: See *HVAC – Duct Sealing*

Baseline Efficiency

The baseline efficiency case is a 13 SEER Central AC system with an EER of 11.

High Efficiency

The high efficiency case is a Ductless Mini Split system with SEER of 14 and EER of 11.5 and duct sealing measures implemented.

Hours

Equivalent full load cooling hours are 360 hours per year.[143]

[142] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.

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Measure Life

The measure life is 18 years.[144]

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	0.85	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 Massachusetts Common Assumptions.

[143] ADM Associates, Inc. (2009). Residential Central AC Regional Evaluation – Free-Ridership Analysis. Prepared for CL&P; Page 4-5, Table 4-3.
[144] 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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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
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons [145]
SEER	=	Seasonal efficiency of AC equipment
EER	=	Peak efficiency of AC equipment
Hours	=	Equivalent full load hours
5%	=	Average percent demand reduction: 5.0%[146]

Baseline Efficiency

The baseline efficiency case is a system whose installation is inconsistent with manufacturer specifications.

High Efficiency

The high efficiency case is a system whose installation is consistent with manufacturer specifications.

Hours

Equivalent full load cooling hours are 360 hours per year.[147]

[145] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.
[146] Massachusetts Common Assumption.
[147] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis*. Prepared for CL&P; Page 4-5, Table 4-3.

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Measure Life

The measure life is 18 years.[148]

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}
CoolSmart AC QIV ES	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	0.00
CoolSmart AC QIV NES	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

[148] 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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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
Tons	=	Cooling capacity of HP equipment: Current default is 3 tons [149]
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%[150]

Baseline Efficiency

The baseline efficiency case is a system whose installation is inconsistent with manufacturer specifications.

[149] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.
[150] Massachusetts Common Assumption.

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High Efficiency

The high efficiency case is a 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.[151]

Measure Life

The measure life is 18 years.[152]

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}
CoolSmart HP QIV ES	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.59	0.50
CoolSmart HP QIV NES	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.59	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.

[151] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-5, Table 4-3.
[152] 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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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
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons[153]
SEER	=	Seasonal efficiency of AC equipment
EER	=	Peak efficiency of AC equipment
Hours	=	Equivalent full load hours
5%	=	Average demand reduction: 5%[154]

Baseline Efficiency

The baseline efficiency case is a system that does not operate according to manufacturer specifications.

High Efficiency

The high efficiency case is a system that operates according to manufacturer specifications.

Hours

The equivalent full load cooling hours are 360 hours per year.[155]

[153] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.
[154] Massachusetts Common Assumption.
[155] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis*. Prepared for CL&P; Page 4-5, Table 4-3.

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Measure Life

The measure life is 5 years.[156]

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}
CoolSmart AC Digital Check-up/Tune-up	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

[156] 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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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
Tons	=	Cooling capacity of HP equipment: Current default is 3 tons[157]
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%[158]

Baseline Efficiency

The baseline efficiency case is a system that does not operating according to manufacturer specifications.

High Efficiency

The high efficiency case is a system that does operate according to manufacturer specifications.

[157] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.
[158] Massachusetts Common Assumption.

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Hours

The equivalent full load hours are 1200 hours per year for heating[159] and 360 hours per year for cooling.[160]

Measure Life

The measure life is 5 years[161]

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}
CoolSmart HP Digital Check-up/Tune-up	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.70	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.

[159] Massachusetts Common Assumptions.
[160] ADM Associates, Inc. (2009). Residential Central AC Regional Evaluation – Free-Ridership Analysis. Prepared for CL&P; Page 4-5, Table 4-3.
[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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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[162]:

$$\Delta kWh = \Delta kWh$$

$$\Delta kW = \Delta kW$$

Where:
Unit = Completed job
ΔkWh = Average annual kWh reduction based on DOE2 modeling[163]: 212 kWh
ΔkW = Average annual kW reduction based on DOE2 modeling[164]: 0.300 kW

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.[165]

[162] The PAs are looking into abilities to track and calculate savings based on project-specific detail.
[163] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market.*; Page 3, Table 2.
[32] Ibid.

[165] 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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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}
Duct Sealing	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

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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
ΔkWh/Ton = Average annual kWh reduction based on DOE2 modeling[166]: 203 kWh
ΔkW/Ton = Average annual kW reduction based on DOE2 modeling[167]: 0.295 kW

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.[168]

Secondary-Energy Impacts

There are no secondary energy impacts for this measure.

[166] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market.*; Page 3, Table 2.
[167] Ibid.
[168] 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

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}
Down Size ½ Ton	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

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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 kWh reduction based on DOE2 modeling[169]: 123 kWh
ΔkW = average annual kW reduction based on DOE2 modeling[170]: 0.150 kW

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.[171]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[169] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market.*; Page 3, Table 2.
[170] Ibid.
[171] 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

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}
Right Sizing	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

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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: None
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 HP equipment: Current default is 3 tons[172]
$SEER_{BASE}$	=	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

Baseline Efficiency

The baseline efficiency case is assumed to be a typical 13 years old AC or heat pump unit.

[172] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.

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High Efficiency

The high efficiency case is an ENERGY STAR® qualified central AC or heat pump unit.

Hours

The equivalent full load hours are 1,200 hours per year for heating[173] and 360 hours per year for cooling.[174]

Measure Life

The measure life is 7 years.[175]

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}
Early Replacement of AC/HP Equipment	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

[173] Massachusetts Common Assumptions.
[174] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis*. Prepared for CL&P; Page 4-5, Table 4-3.
[175] 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 form the 18 year measure life for new equipment.

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HVAC – Quality Installation with Duct Sealing

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 kWh reduction based on DOE2 modeling[176]: 513 kWh with duct modifications, 212 kWh without duct modifications
ΔkW	=	Average annual kW reduction based on DOE2 modeling[177]: 0.850 kW with duct modifications, 0.300 kW without duct modifications

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.[178]

[176] RLW Analytics (2002). *Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market.*; Page 3, Table 2.
[177] 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}
Energy Star QI	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	0.00
Energy Star QI w/ Duct modifications	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

[178] 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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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
ΔkW	=	Average annual kW reduction
Tons	=	Cooling capacity of AC equipment: Current default is 3 tons[179]
SEER	=	Seasonal efficiency of AC equipment
Hours	=	Annual operating hours
10.5%	=	Average percent demand reduction: 10.5%[180]

Baseline Efficiency

The baseline efficiency case is a system with a fixed orifice expansion.

High Efficiency

The high efficiency case is a system with a Thermostatic eXpansion Valve (TXV).

Hours

Not applicable.

Measure Life

The measure life is 7 years.[181]

[179] ADM Associates, Inc. (2009). *Residential Central AC Regional Evaluation – Free-Ridership Analysis.* Prepared for CL&P; Page 4-12, Table 4-9.
[180] NEEP (2006). *Strategies to Increase Residential HVAC Efficiency in the Northeast*. Prepared for NASEO; Appendix B.
[181] 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

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}
TXV Replacement of Fixed Orifice	RHVAC	All	1.00	1.00	1.00	1.00	1.00	0.85	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 Massachusetts Common Assumptions.

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HVAC – Warm Air Furnace Electronically Commutated Motor (ECM)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of an electronically commutated variable speed air supply motor.
Primary Energy Impact: Electric
Secondary Energy Impact: NG – Res Heating
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 ECM
ΔkWh	=	Gross annual kWh savings from the measure: 600 kWh[182]
ΔkW	=	Gross connected kW savings from the measure: 0.173 kW[183]

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.[184]

Secondary Energy Impacts

This is the increased heating load as a result of a more efficient motor.

[182] Sachs, Harvey (2003). *Energy Savings form Efficient Furnace Air Handlers in Massachusetts.*
[183] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators..
[184] Sachs, Harvey (2003). *Energy Savings form Efficient Furnace Air Handlers in Massachusetts.*

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Measure	Energy Type	Savings	ΔMMBtu/Unit
CoolSmart Warm Air Furnace ECM	NG – Residential Heating	-1.575 MMBtu[185]	-1.575

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}
CoolSmart Warm Air Furnace ECM	RHVAC	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% 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.[186]

[185] Ibid. An adjustment is made to the savings value of 2.3 MMBtu given in the study. The original savings value is multiplied by 420 heating hours divided by 600 total running hours (420/600=0.70). An AFUE adjustment of 90/92 is also multiplied to the original value to create a more realistic final value.

[186] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Brushless Furnace Fan Motor

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a high efficiency steady state brushless furnace fan motor.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas
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 BFF motors
ΔkWh = Gross annual kWh savings: 246 kWh[187]
ΔkW = Gross connected kW savings: 0.182 kW[188]

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.[189]

Secondary Energy Impacts

This is the increased heating load as a result of a more efficient motor.

[187] The Cadmus Group, Inc. (2012) *Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation.* Prepared for: The Electric and Gas Program Administrators of Massachusetts
[188] Ibid
[189] 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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Measure	Energy Type	ΔMMBtu/Unit
Brushless Furnace Fan Motor	NG – Residential Heating	-0.676 MMBtu[190]

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}
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

The Cadmus Group, Inc. (2012) Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation. Prepared for: The Electric and Gas Program Administrators of Massachusetts[191].

[190] The Cadmus Group, Inc. (2012) *Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation.* Prepared for: The Electric and Gas Program Administrators of Massachusetts
[191] Ibid.

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HVAC – Room AC (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, Multi-Family Retrofit (not National Grid)

Algorithms for Calculating Primary Energy Impact

Unit savings are based on the following algorithms which use averaged inputs:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kWh / Hours$$

Where:

Unit	=	Rebated room AC unit
ΔkWh	=	Average annual kWh savings per unit: 49 kWh[192]
ΔkW	=	Average demand reduction per unit: 0.052 kW[193]
Hours	=	Equivalent full load hours

Baseline Efficiency

The baseline efficiency case is a window AC unit that meets the minimum federal efficiency standard for efficiency.

High Efficiency

The high efficiency level is a room AC unit meeting or exceeding the federal efficiency standard by 10% or more. Average size and EERs is estimated from rebated units in previous year and updated annually.

Hours

Equivalent full load hours are 200 hours per year.[194]

[192] 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.
[193] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[194] RLW Analytics (2008). *Coincidence Factor Study Residential Air Conditioners.* Prepared for Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group; Page 32, Table 22 - found by averaging the EFLH values for MA states (Boston and Worcester): (228+172)/2 = 200.

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Measure Life

The measure life is 9 years.[195]

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 (Upstream)	ES Appliances	All	1.00	1.00	1.00	1.00	1.00	0.134	0.00	0.304	0.00
Room AC	MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.134	0.00	0.304	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
All PAs use CFs from a 2008 residential room AC coincidence factor study[196]. CFs are provided for both on-peak and seasonal peak periods.

[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.
[196] RLW Analytics (2008). *Coincidence Factor Study Residential Air Conditioners.* Prepared for Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group.

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HVAC – Window AC Replacement (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 (not National Grid)

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 window AC unit and installation of new efficient window AC unit
ΔkWh = Average annual kWh savings per unit: 204 kWh[197]
ΔkW = Max load kW reduction: 0.216 kW[198]

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 12 years.[199]

[197] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts..
[198] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[199] 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 Impact

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.[200]

[200] 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 planning to offer this measure in 2011.

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on the following algorithms and assumptions:

$$\Delta kWh_{ES} = Capacity \times \frac{0.473}{24} \times \left(\frac{1}{Eff_{BASE}} - \frac{1}{Eff_{ES}} \right) \times Hours$$

$$\Delta kWh_{RETIRED} = Capacity \times \frac{0.473}{24} \times \left(\frac{1}{Eff_{RETIRED}} - \frac{1}{Eff_{BASE}} \right) \times Hours$$

$$\Delta kW_{ES} = \Delta kWh_{ES} / Hours$$

$$\Delta kW_{RETIRED} = \Delta kWh_{RETIRED} / Hours$$

Where:

Unit	=	Replacement of existing dehumidifier with new ENERGY STAR® dehumidifier
ΔkWh_{ES}	=	Annual energy savings due to ES unit compared to new baseline unit: 66 kWh
$\Delta kWh_{RETIRED}$	=	Annual energy savings of baseline units compared to existing unit: 77 kWh
ΔkW_{ES}	=	ES replacement demand load savings: 0.038 kW
$\Delta kW_{RETIRED}$	=	Retired demand load savings: 0.044 kW
Capacity	=	Average capacity of dehumidifier in Pints/24 Hours: 35 Pints/Day[201]
Eff_{BASE}	=	Average efficiency of conventional model in Liters/kWh
Eff_{ES}	=	Average efficiency of ENERGY STAR® model in Liters/kWh
$Eff_{RETIRED}$	=	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

[201] 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[202], 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[203], 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[204].

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[205]	% Days in Season[206]	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.[207] The remaining measure life of a retired unit is 5 years.[208]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impact

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

[202] Environmental Protection Agency (2002). *Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls.
[203] Appliance Standards Awareness Project (2007). *Dehumidifiers.* http://www.standardsasap.org/products/dehumidifiers.html. Accessed on 6/30/10.
[204] Environmental Protection Agency (2002). *Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls.
[205] Opinion Dynamics Corporation (2009). *Massachusetts Residential Saturation Survey (RASS) - Volume 1: Summary Results and Analysis.* Prepared for Joint Utilities; Page 94, Table 17.
[206] Simplifying assumption.
[207] Environmental Protection Agency (2002). *Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls.
[208] 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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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	0.65	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 – Programmable Thermostats (Oil)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Replacement of existing thermostats with programmable thermostats in oil heated homes.
Primary Energy Impact: Oil
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

Algorithms for Calculating Primary Energy Impact

No electric savings are claimed for this measure.

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 10 years.[209]

Secondary Energy Impacts

Measure	Energy Type	Savings	ΔMMBtu/Unit
Programmable Thermostat (Oil)	Oil	3.1 MMBtu [210]	3.1

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

[209] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[210] 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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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 (Oil)	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 – Boiler Reset Controls (Oil or Propane)

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 or 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: MassSAVE, 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)	MassSave	7.9[212]
Boiler Reset Controls (Propane)	MassSave	7.9[213]
Boiler Reset Controls (Oil)	LI 1-4 Retrofit	4.4[214]

Non-Energy Impacts

Benefit Type	Description	Savings
Annual Non-Resource	See Appendix D: Non-Resource Impacts	See Appendix D: Non-Resource Impacts

[211] ACEEE (2006). *Emerging Technologies Report: Advanced Boiler Controls*. Prepared for ACEEE; Page 2.
[212] Ibid.
[213] Ibid.
[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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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	MassSAVE	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 – Electric 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 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: HVAC
Program: Low-Income 1-4 Family Retrofit, Low-Income MultiFamily Retrofit (not National Grid or CLC)

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 and CLC). 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. The savings for similar measures installed through the Cape Light Compact's Low-Income MultiFamily program are vendor calculated, as a Low-Income MultiFamily unit on Cape Cod is smaller than a Low-Income Single Family unit and therefore the Low-Income Single Family deemed savings are not applicable.

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 kWh reduction: 1,616 kWh[215]
ΔkW	=	Average annual kW reduction: 0.465 kW for LI 1-4 Retrofit and 0.437 for LI MF Retrofit[216]

Baseline Efficiency

The baseline efficiency case is any existing home shell measures.

[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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High Efficiency

The high efficiency case includes increased weatherization insulation levels.

Hours

Not applicable.

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}
Electric Weatherization	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Electric Weatherization	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] Massachusetts Common Assumption.
[218] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC – Oil or Propane 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 oil or propane heated homes. Electric savings are achieved from reduced fan run time for heating and cooling systems.
Primary Energy Impact: Oil or Propane
Secondary Energy Impact: Electric
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

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 kWh reduction: 377 kWh[219]
ΔkW	=	Average annual kW reduction: 0.065 kWheat and 0.053 kWcool[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]
Oil Weatherization	Oil	28.1
Propane Weatherization	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}
Oil Weatherization	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Propane Weatherization	LI 1-4 Retrofit	CLC	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)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Replacement of existing oil 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
Secondary Energy Impact: Electric
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 (not National Grid)

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).

Algorithms for Calculating Primary Energy Impact

Unit savings are deemed based on study results:

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of new high efficiency oil heating system
ΔkWh	=	Average annual kWh savings per unit: 132 kWh[225]
ΔkW	=	Average annual kW reduction per unit: 0.038 kW for LI 1-4 Retrofit and 0.036 for LI MF Retrofit[226]

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.

[225] The Cadmus Group, Inc. (2012). *Low Income Single Family 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.

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Measure Life

The measure life is 18 years.[227]

Secondary Energy Impacts

Measure	Energy Type	ΔMMBtu/Unit
Heating System Replacement (Oil)	Oil	18.4[228]

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 (Oil)	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Heating System Replacement (Oil)	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.[229]

[227] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Furnaces.xls.
[228] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[229] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC/Hot Water – ENERGY STAR® Homes 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."[230]

Baseline Efficiency

The User Defined Reference Home was revised for 2006 as a result of the baseline study completed in 2006.[231] [232]

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.

[230] ICF (2008). *Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR ® Homes Program.* Prepared for Joint Management Committee.
[231] Nexus Market Research & Dorothy Conant (2006). Massachusetts ENERGY STAR ® Homes: 2005 Baseline Study: Part I: Inspection Data Analysis Final Report. Prepared for Joint Management Committee.
[232] 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 Joint Management Committee.

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Measure Life

Measure Type	Measure Life (years)[233]
Cooling	25
Heating	25
Water Heating	15

Secondary Energy Impacts

Gas, Oil and Propane savings for heating and water heating measures are custom calculated 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	custom	custom
ES Homes – Heating	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	custom	custom
ES Homes – Water Heating	RNC, LI RNC	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 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.

[233] Massachusetts Common Assumption.

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Hot Water – Domestic Hot Water 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 (not National Grid)

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 kWh savings per unit: 128 kWh[234]
ΔkW = Average annual kW reduction per unit: 0.016 kW[235]

Cape Light Compact only installs pipe wrap under the Domestic Hot Water Measure Category for the Low Income Program. Below are deemed savings from the Cadmus Low Income Evaluation as footnoted.

$$\Delta kWh = \Delta kWh$$
$$\Delta kW = \Delta kW$$

Where:
Unit = Household with hot water efficiency measures installed
ΔkWh = Average annual kWh savings per unit: 41 kWh[236]

[234] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[235] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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ΔkW = Average annual kW reduction per unit: 0.005kW[237]

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.[238]

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	4,028 Gallons/Participant[239]
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	0.89	1.00
DHW Measures (Electric)	LI MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.59	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.[240]

[236] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[237] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[238] Massachusetts Common Assumption.
[239] NMR Group, Inc., TetraTech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

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Hot Water – Domestic Hot Water Measures (Oil, Gas, Propane)

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, gas or propane water heaters.
Primary Energy Impact: Oil, Gas or Propane
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.[241]

[240] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.
[241] Massachusetts Common Assumption.

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Secondary Energy Impacts

Measure	PA	Energy Type	ΔMMBtu/Unit[242]
DHW Measures (Gas/Propane)	All except CLC	NG – Residential DHW	0.5
DHW Measures (Gas/Propane)	CLC	NG – Residential DHW	0.4
DHW Measures (Oil)	All except 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	4,028 Gallons/Participant[243]
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/Propane)	LI 1-4 Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
DHW Measures (Oil)	LI 1-4 Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
DHW Measures (Gas/Propane)	LI MF Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
DHW Measures (Oil)	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 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.

[242] The Cadmus Group, Inc. (2012). *Low Income Single Family Impact Evaluation.*. Prepared for the Electric and Gas Program Administrators of Massachusetts..
[243] NMR Group, Inc., TetraTech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

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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: Water Savings, Refer to Appendix D: Non-Resource Impacts Reduction
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 the following algorithms and assumptions:

$$\Delta kWh = kWh_{BASE} - kWh_{EE}$$
$$\Delta kW = \Delta kW$$

Where:

Unit	=	Installation of ENERGY® dishwasher
ΔkWh	=	Gross average annual kWh savings per unit[244]: 33 kWh with gas water heating; 74 kWh with electric water heating.
ΔkW	=	Average annual kW savings per unit: 0.0047 kW[245]
kWh_{BASE}	=	Average unit energy consumption for non-qualified product
kWh_{EE}	=	Average unit energy consumption for ENERGY STAR® qualified product

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.[246]

[244] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Residential Dishwasher*. Interactive Excel Spreadsheet found at http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls
[245] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.
[246] Home: ENERGY STAR (2010). *Dishwasher Key Product Criteria.* http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers. Accessed on 10/20/10.

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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.[247]

Measure Life

The measure life is 10 years.[248]

Secondary Energy Impacts

Gas, Oil and Propane savings occur in homes where the water is heated by that fuel. Homes with gas heated water save approximately 0.19 MMBtu/year.[249]

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Reduction in annual water usage compared to conventional unit [250]	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	0.89	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
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[251].

[247] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Residential Dishwasher*. Interactive Excel Spreadsheet found at http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls
[248] Ibid.
[249] Ibid.
[250] Ibid.
[251] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Hot Water – 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: Hot Water
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
ΔkW = Average annual kW reduction: 0.275 kW[252]
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[253]

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.

[252] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators..
[253] 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.[254]

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}
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 the Cadmus Demand Impact Model.[255].

[254] Davis Energy Group (2008). *Proposal Information Template for Residential Pool Pump Measure Revisions*. Prepared for Pacific Gas and Electric Company.
[255] 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: HVAC
Program: Low-Income 1-4 Family Retrofit, Low-Income MultiFamily Retrofit (not National Grid)

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 kWh reduction: 872 kWh[256]
ΔkW	=	Average annual kW reduction: 0.156 kW for LI 1-4 Retrofit and 0.165 for LI MF Retrofit[257]

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.[258]

[256] Cadmus Group, Inc. (2009). *Impact Evaluation of the 2007 Appliance Management Program and Low Income Weatherization Program.* Prepared for National Grid.
[257] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[258] 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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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}
Waterbed	LI 1-4 Retrofit	All	1.00	1.00	1.00	1.00	1.00	0.65	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.[259]

[259] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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MassSAVE – Vendor Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Retrofit measures installed through the MassSAVE program including: building envelope insulation and air sealing, duct sealing and insulation, programmable thermostats, heating system replacement, indirect and on demand water heaters, windows and DHW measures.
Primary Energy Impact: Electric
Secondary Energy Impact: Gas, Oil, Propane
Non-Energy Impact: Water, Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: HVAC, Hot Water
Program: MassSAVE

Notes

The savings calculation methodology for these measures currently varies amongst the PAs. However, the PAs are investigating a common software tool for all implementation contractors. In addition, the 2011 evaluation plan consists of an impact evaluation that will provide updated savings values or consistent algorithms to be used statewide. Between the filing of the 2011 MA TRM – Plan Version and the filing of the 2011 MA TRM – Report Version, the working group will determine the best approach for the PAs. Once these efforts are complete the PAs will include any updates in the 2011 MA TRM – Report Version.

Algorithms for Calculating Primary Energy Impact

The Program Administrators currently use vendor calculated savings for these measures in the Residential MassSAVE 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.

Baseline Efficiency

The baseline efficiency case is the existing conditions of the participating household.

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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 ISMs	7
Duct Insulation	20
Duct Seal	20
Heating System Replacement	18
Indirect Water Heater	20
Insulation	25
Thermostats	10
Windows	25

Secondary Energy Impacts

Gas, Oil and Propane savings are project-specific.

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Residential water savings per participant	4,028 Gallons/Participant[260]
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)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Air Sealing (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
DHW ISMs (Electric)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.89	1.00
DHW ISMs (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Duct Insulation (Electric)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Duct Insulation (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Duct Sealing (Electric)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Duct Sealing (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Heating System Replacement (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Indirect Water Heater (Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Insulation (Electric)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

[260] NMR Group, Inc., TetraTech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

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Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Thermostats (Electric)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Thermostats (Gas, Oil, Other FF)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Windows (Electric)	MassSAVE	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Windows (Gas, Oil, Other FF)	MassSAVE	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 Factor
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[261]

[261] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators

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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 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: Water, Refer to Appendix D: Non-Resource Impacts
Sector: Residential, Low Income
Market: Retrofit
End Use: HVAC, Hot Water
Program: Multi-Family Retrofit; Low Income Multifamily Retrofit

Notes

The savings calculation methodology for these measures currently varies amongst the PAs. However, the PAs are investigating opportunities to align their program offerings and savings calculation assumptions and methodologies.

This section applies to Cape Light Compact, NSTAR, Unitil, and Western Massachusetts Electric Company multi-family program and for some measures in the Low Income Multifamily program. 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.

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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, cooling and water heating energy use.

Hours

Hours are project-specific.

Measure Life

Measure Name	Measure Life (years)
Air Sealing	15
DHW ISMs	7
Insulation	25
Thermostats	10

Secondary Energy Impacts

Gas, Oil and Propane savings are project-specific.

Non-Energy Impacts

Benefit Type	Description	Savings
Residential Water	Residential water savings per participant	4,028 Gallons/Participant[262]
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 National Grid)	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Air Sealing (FF)	MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.00	0.00
DHW Measures (Electric)	MF Retrofit	All (not National Grid)	1.00	0.945	1.00	1.00	1.00	0.59	1.00
DHW Measures (FF)	MF Retrofit	All (not National Grid)	1.00	0.945	1.00	1.00	1.00	0.00	1.00
Insulation (Electric)	MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Insulation (FF)	MF Retrofit	All (not National Grid)	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Thermostats (Electric)	MF Retrofit	All (not National Grid)	1.00	0.69	1.00	1.00	1.00	0.00	1.00
Thermostats (FF)	MF Retrofit	All (not National Grid)	1.00	0.69	1.00	1.00	1.00	0.00	0.00
Air Sealing (Electric)	LI MF Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Air Sealing (FF)	LI MF Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Insulation (Electric)	LI MF Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	0.00	1.00

[262] NMR Group, Inc., TetraTech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

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Measure Name	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation (FF)	LI MF Retrofit	CLC	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
Savings Persistence Factors are from the 2011 Residential Retrofit Multifamily Impact Analysis[263] DHW is the average of showerheads and faucet aerators.

Realization Rates
Realization rates are set to 100% since this program has not been evaluated and similar evaluation support this assumption.[264]

Coincidence Factor
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[265]

[263] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[264] Massachusetts Common Assumptions. Assumed 100% realization rate is supported by the results of multiple impact evaluations of National Grid's EnergyWise program.
[265] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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MultiFamily – Common Area Fixtures (NSTAR)

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Removal of existing inefficient fixtures with the installation of new efficient fixtures
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: Low-Income MultiFamily Retrofit (NSTAR Only)

Notes

The savings algorithms and assumptions described in this section are specific to NSTAR's Low-Income MultiFamily Retrofit program.

Algorithms for Calculating Primary Energy Impact

Unit savings are calculated using the following algorithms and assumptions:

$$\Delta kWh = [(QTY_{PRE} \times Watts_{PRE} \times Hours_{PRE}) - ((QTY_{EE} \times Watts_{EE-LO} \times Hours_{EE-LO}) + (QTY_{EE} \times Watts_{EE-HI} \times Hours_{EE-HI}$$

$$\Delta kW = [(QTY_{PRE} \times Watts_{PRE}) - (QTY_{EE} \times (((Watts_{EE-LO} \times Hours_{EE-LO}) + (Watts_{EE-HI} \times Hours_{EE-HI})) / (Hours_{EE-LO} + Hour$$

Where:

QTY_{PRE}	=	Quantity of pre-retrofit fixtures
QTY_{EE}	=	Quantity of efficient fixtures installed
$Watts_{PRE}$	=	Rated watts of pre-retrofit fixtures
$Watts_{EE-LO}$	=	Rated watts of efficient fixtures installed at low wattage
$Watts_{EE-HI}$	=	Rated watts of efficient fixtures installed at high wattage
$Hours_{PRE}$	=	Weekly hours of operation for pre-retrofit case lighting fixtures
$Hours_{EE-LO}$	=	Weekly hours of operation for efficient lighting fixtures at low wattage
$Hours_{EE-Hi}$	=	Weekly hours of operation for efficient lighting fixtures at high wattage
52	=	Weeks per year

Baseline Efficiency

The baseline efficiency case is the existing fixture.

High Efficiency

The high efficiency case is the new fixture.

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Measure Life

The measure life is 20 years.[266]

Hours

Operating hours are estimated by the vendor for each facility.

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}
Common Area Int Fixtures	LI MF Retrofit	NSTAR	1.00	1.00	1.00	1.00	1.00	0.19	1.00
Common Area Ext Fixtures	LI MF Retrofit	NSTAR	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 PA programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
Realization rates are assumed to be 100%.

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.[267]

[266] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Lighting Fixtures*. Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=LF.
[267] 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: 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 *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[268]

Insulation Type	kWh/Sqft[269]
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.

[268] Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[268]
[269] National Grid's 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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High Efficiency

The high efficiency case is insulation installed with a higher R-Value.

Hours

Not applicable.

Measure Life

The measure life is 25 years.[270]

Secondary Energy Impacts

There are no secondary energy impacts for this measure

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}
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.[271]

Coincidence Factors
Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[272]

[270] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[271] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[272] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – DHW (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, Low 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[273]
kW/kWh	=	Average kW reduction per kWh reduction: 0.000161 kW/kWh[274]

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.

Measure Life

The measure life is 7 years.[275]

[273] National Grid's 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%.
[274] 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 Benefits

Benefit Type	Description	Savings
Residential Water	Gallons water saved per year per unit that received DHW measures	4,028 Gallons/Participant[276]
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	0.945	0.91	0.91	0.91	0.59	1.00
Showerhead/Aerator (Non-Electric)	MF Retrofit	National Grid	1.00	0.945	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

Savings Persistence Factors are from the 2011 Residential Retrofit Multifamily Impact Analysis[277] DHW is the average of showerheads and faucet aerators.

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation[278].

Coincidence Factors

Coincidence factors are estimated using the demand allocation methodology described in the Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.[279]

[275] Massachusetts Common Assumption.
[276] NMR Group, Inc., TetraTech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.
[277] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[278] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation*. Prepared for National Grid.
[279] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.

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Multifamily – DHW (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[280]
kW/kWh	=	Average annual kW reduction per kWh reduction: 0.000161 kW/kWh[281]

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.[282]

[280] National Grid's 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%.
[281] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[282] 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}
Tank/Pipe Wrap (Electric Heat)	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 Heat)	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.[283]

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.[284]

[283] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[284] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Multifamily – Thermostats (National Grid)

Version Date and Revision History

Effective Date: 1/1/2011
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[285]
kW/kWh	=	Average annual kW reduction per kWh reduction: 0.000263 kW/kWh[286]

Baseline Efficiency

The baseline efficiency case is a system without a set back programmable thermostat.

High Efficiency

The high efficiency case is a system with a set-back programmable and fixed set point (common areas) thermostats.

Hours

Not applicable.

[285] National Grid's 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%.
[286] 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 10 years.[287]

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	0.69	0.91	0.91	0.91	0.00	1.00
Thermostat (Non-Electric)	MF Retrofit	National Grid	1.00	0.69	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

Savings Persistence Factors are from the 2011 Residential Retrofit Multifamily Impact Analysis[288].

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation[289].

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.[290]

[287] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[288] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators
[289] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation*. Prepared for National Grid.
[290] 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[291]
kW/kWh	=	Average kW reduction per kWh reduction: 0.000234 kW/kWh[292]

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.[293]

[291] National Grid's 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%.
[292] 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 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}
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.[294]

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.[295].

[293] Massachusetts Common Assumption
[294] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[295] 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.
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 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[296]
kW/kWh	=	Average kW reduction per kWh reduction: 0.000263 kW/kWh[297]

Baseline Efficiency

The baseline efficiency case is a facility that has not received comprehensive air-sealing treatment.

[296] National Grid's 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%.
[297] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.

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High Efficiency

The high efficiency case is a facility with thermal shell air leaks that are sealed, leading to a reduction in air leakage

Hours

Not applicable.

Measure Life

The measure life is 15 years.[298]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

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}
Air Sealing (Electric Heat)	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 Heat)	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.[299]

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.[300]

[298] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[299] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[300] 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[301]

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[302] and 19 years for low income.[303]

[301] 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 Heat)	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 Heat)	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.[304]

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.[305]

[302] 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.
[303] Massachusetts Common Assumption.
[304] Cadmus Group (2010). *EnergyWise 2008 Program Evaluation.* Prepared for National Grid.
[305] 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:

$$\Delta kWh = \left[\left(QTY_{PRE} \times Watts_{PRE} \times Hours_{PRE}\right) - \left(QTY_{EE} \times Watts_{EE} \times Hours_{EE}\right)\right] / 1000 \times 52$$
$$\Delta kW = \left[\left(QTY_{PRE} \times Watts_{PRE}\right) - \left(QTY_{EE} \times Watts_{EE}\right)\right] / 1000$$

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

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 20 years for fixtures.

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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	0.99	0.91	0.91	0.91	0.19	1.00
CFLs (Non-Electric)	MF Retrofit	National Grid	0.97	0.99	0.99	0.99	0.99	0.19	1.00
Fixtures (Electric)	MF Retrofit	National Grid	0.97	0.99	0.91	0.91	0.91	0.19	1.00
Fixtures (Non-Electric)	MF Retrofit	National Grid	0.97	0.99	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

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Savings Persistence Factor

Savings Persistence Factors are from the 2011 Residential Retrofit Multifamily Impact Analysis[306].

Realization Rates

Realization rates from the National Grid Energy Wise 2008 Program Evaluation.[307]

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.[308]

[306] The Cadmus Group, Inc. (2012). *Massachusetts 2011Residential Retrofit Multifamily Program Analysis*. Prepared for the Massachusetts Program Administrators

[307] Cadmus Group (2010). EnergyWise 2008 Program Evaluation. Prepared for National Grid.

[308] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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Behavior – OPOWER Electric

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The Behavior/Feedback programs send monthly 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

Notes

National Grid is the only PA providing a Behavior/Feedback program using the OPOWER vendor for electric customers in PY 2011. MA has conducted two impact and process evaluations, completed in 2011 and 2012, respectively. The results of this impact evaluation are used for reporting the 2011 program year..

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 below.
$\%SAVE_{kWh}$ = Energy savings percent per program participant. See Table below.

Behavior/Feedback Program - Electric Savings Factors[309]

PA	Measure Name	kWhBASE	%SAVE	ΔkWh/Unit	ΔkW/Unit
National Grid	OPOWER Group 2009 Pilot	10,825	2.06%	223.00	0.056
National Grid	OPOWER Group 2010 February	12,051	1.63%	196.43	0.049
National Grid	OPOWER Group 2010 Added	15,185	1.63%	247.52	0.062
National Grid	OPOWER Group 2011 February	9,767	1.37%	133.81	0.033
National Grid	OPOWER Group 2011 Added	6,000	1.37%	82.20	0.021
National Grid	OPOWER Group 2012 February	11,000	1.61%	177.10	0.044

[309] Opinion Dynamics Corporation (2012). *Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report.* Prepared for the Massachusetts Program Administrators.

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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 receives a Behavior/Feedback program report.

Hours

Not applicable.

Measure Life

The measure life is 1 year.

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 Participant Group	Behavior/Feedback	National Grid	1.00	1.00	1.00	1.00	1.00	0.25	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 based on evaluation results. [310]

[310] Ibid.

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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 secondary 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	MassSAVE	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	MassSAVE	CLC	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
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

$$\Delta kWh = \sum_{i=1}^{n}\left(\frac{Watts_{BASE,i} - Watts_{EE,i}}{1000}\right)(Area_i)(Hours_i)$$

$$\Delta kW = \sum_{i=1}^{n}\left(\frac{Watts_{BASE,i} - Watts_{EE,i}}{1000}\right)(Area_i)$$

Where:

N	=	Total number of spaces in Space-by-Space Method or 1 for Building Area Method
$Watts_{BASE,i}$	=	Allowed lighting wattage per square foot based on energy code requirements for building or space type *i*. For values, see Appendix A: **Table 27** and Appendix A: **Table 28**.
$Watts_{EE,i}$	=	Installed lighting wattage per square foot of the efficient lighting system for building or space type *i*
1000	=	Conversion factor: 1000 watts per 1 kW
$Area_i$	=	Area of building or space *i* in square feet
$Hours_i$	=	Annual hours of operation of the lighting equipment for building or space type *i*

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 for Calculating Adjusted Gross Savings).

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

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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 the Space-by-Space Method are presented.[311] Table 27 and Table 28 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 Appendix A: Table 29.

Measure Life

Measure	Measure Life [312]
Fluorescent Fixture	15 years
Hardwired CFL	15 years
LED Exit Signs	15 years
HID (interior and exterior)	15 years

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[313]
Interior Lighting	C&I Gas Heat	-0.0003649 MMBtu/ΔkWh
Interior Lighting	Oil	-0.0007129 MMBtu/ΔkWh

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	1.07	0.80	0.73	custom	custom	n/a	n/a
All	NC	NSTAR	1.00	1.00	1.14	1.11	1.30	0.85	0.59	n/a	n/a

[311] 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.
[312] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[313] Optimal Energy, Inc. (2008). Non-Electric Benefits Analysis Update. Memo Prepared for National Grid.

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Measure	Program	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
All	NC	CLC	1.00	1.00	1.14	1.11	1.30	0.85	0.59	n/a	n/a
All	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.85	0.59	n/a	n/a
All	NC	WMECO	1.00	1.00	1.05	1.23	1.05	n/a	n/a	custom	custom

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 National Grid 2008 custom lighting installations[314]; final realization rates developed in 2008 custom program analysis study[315]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2007 lighting installations[316]
- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: energy RRs are from 2007/2008 Large C&I Programs impact evaluation[317]

Coincidence Factors
- National Grid, WMECO: CFs are custom calculated based on site-specific information.
- NSTAR, CLC, Unitil: CFs from the C&I lighting loadshape project[318]

[314] KEMA (2009). *National Grid USA 2008 Custom Lighting Impact Evaluation, Final Report*. Prepared for National Grid.
[315] KEMA (2009). Sample *Design and Impact Evaluation Analysis of the 2008 Custom Program*. Prepared for National Grid; Table 19.
[316] KEMA (2009). *2007 Business & Construction Solutions (BS/CS) Programs - Measurement and Verification of 2007 Lighting Measures*. Prepared for NSTAR; Table Ex 3.
[317] KEMA (2010). *2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures*. Prepared for Western Massachusetts Electric Company.
[318] KEMA (2011). *C&I Lighting Loadshape Project*. Prepared for the Regional Evaluation, Measurement, and Verification Forum; Tables 1-10 and 1-13

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Lighting – Lighting Systems

Version Date and Revision History

Effective Date: 1/1/2011
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[319]. For lost opportunity installations, the baseline efficiency case is determined using assumed baseline wattages for each of the installed fixtures[320].

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[321].

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 Appendix A: Table 29 for non-upstream lighting installations. For all upstream lighting installations, refer to Table 30 for operating hours.

Measure Life

Equipment Type	Measure Life[322]	
	Retrofit	Lost Opportunity
Bulb – CFL screw base	5 years	N/A
Fluorescent Fixture	13 years	15 years
Hardwired CFL	13 years	15 years
LED Exit Signs	13 years	15 years
HID (interior and exterior)	13 years	15 years
LED Lighting Fixtures	13 years	15 years
LED Integral Replacement Lamps	13 years	15 years
LED Low Bay – Garage & Canopy Fixtures	13 years	15 years
Upstream Lighting – LED[323]	N/A	10 years
Upstream Lighting – T5/T8[324]	N/A	10 years

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.

Program	Measure	Energy Type	Savings[325]
Large CI	Interior Lighting	Gas Heat	-0.0003649 MMBtu/kWh
Large CI	Interior Lighting	Oil	-0.0007129 MMBtu/kWh
Small Retrofit	Interior Lighting	Gas Heat	-0.001075 MMBTu/kWh
Small Retrofit	Interior Lighting	Oil Heat	-0.000120 MMBTu/kWh

[319] MassSave (2010). *C&I Retrofit Lighting Wattage Tables.*
[320] MassSave (2010). *C&I New Construction Lighting Baseline Wattage Tables.*
[321] MassSave (2010). *C&I New Construction Lighting Wattage Tables* AND MassSave (2010). *C&I Retrofit Lighting Wattage Tables.*
[322] 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
[323] Estimate based on average life of eligible products at retail operating hours.
[324] Staff estimate.
[325] Optimal Energy, Inc. (2008). *Non-Electric Benefits Analysis Update*. Memo Prepared for National Grid. AND Small Retrofit; *Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study*, The Cadmus Group, June 12, 2012

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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	0.99	0.97	0.97	0.98	0.73	n/a	n/a
LED Exit Signs	NC	National Grid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
All	Large Retrofit	National Grid	1.00	1.00	1.04	1.03	1.03	0.89	0.63	n/a	n/a
All	Small Retrofit	National Grid	1.00	1.00	1.02	0.99	0.99	0.73	0.44	n/a	n/a
CFLs, Interior	Small Retrofit	National Grid	1.00	0.87	1.02	0.99	0.99	0.73	0.44	n/a	n/a
All	NC	NSTAR	1.00	1.00	1.14	1.11	1.30	0.85	0.59	n/a	n/a
All	Large Retrofit	NSTAR	1.00	1.00	1.01	1.18	1.26	0.85	0.59	n/a	n/a
All	Small Retrofit	NSTAR	1.00	1.00	1.02	0.99	0.99	0.73	0.44	n/a	n/a
All	NC	CLC	1.00	1.00	1.14	1.11	1.30	0.85	0.59	n/a	n/a
All	Large Retrofit	CLC	1.00	1.00	1.01	1.18	1.26	0.85	0.59	n/a	n/a
All	Small Retrofit	CLC	1.00	1.00	1.02	0.99	0.99	0.72	0.44	n/a	n/a
All	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.85	0.59	n/a	n/a
All	Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.85	0.59	n/a	n/a
All	Small Retrofit	Unitil	1.00	1.00	1.02	0.99	0.99	0.77	0.37	n/a	n/a
All	Large Retrofit	WMECO	1.00	1.00	1.05	1.23	1.05	n/a	n/a	custom	custom
All	Small Retrofit	WMECO	1.00	1.00	0.73	0.98	0.98	n/a	n/a	0.67	0.42

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 with one exception: National Grid uses 0.874 for screw-in CFLs installed through the C&I Small Retrofit program based on 1996 savings persistence study[326].

Realization Rates

New Construction & Major Renovation Commercial

- National Grid energy and demand RRs from impact evaluation of National Grid's 2007 Design 2000plus (New Construction) Lighting installations[327]. Demand RR is the connected demand RR; energy RR includes connected demand RR, hours of use RR and HVAC Interactive adjustment.

[326] HEC, Inc. (1996). *Final Report for New England Power Service Company Persistence of Savings Study*. Prepared for NEPSCo.

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- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR's Business & Construction Solutions Programs Lighting installations[328]. Energy and demand realization rates include interactive adjustments.
- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: energy RRs are from 2007/2008 Large C&I Programs impact evaluation[329]

C&I Large Retrofit
- National Grid energy RR is from impact evaluation of National Grid's 2007 Energy Initiative (Large Retrofit) Lighting program[330]. Energy RR is the ratio measured electric energy savings to gross estimates of electric energy savings, and includes electric HVAC interaction adjustment by default. National Grid demand RRs are from impact evaluation of National Grid's 2003 Energy Initiative Lighting program[331]. Demand RR is the connected demand RR.
- NSTAR, CLC, Unitil, WMECO: References are the same as *New Construction & Major Renovation Commercial*

C&I Small Retrofit
All PAs' energy and demand RRs from statewide the 2011 Small C&I Non-Controlled Lighting impact evaluation [332]

Coincidence Factors

New Construction & Major Renovation Commercial
All CFs are from the 2011 NEEP C&I Lighting Loadshape Project[333], weighted by Load Zone, except:
- National Grid CFs from National Grid's 2007 Design 2000*plus* Lighting subprogram[334]

C&I Large Retrofit
All CFs are from the 2011 NEEP C&I Lighting Loadshape Project[335] except:
- WMECO uses custom CFs based on project-specific detail.

C&I Small Retrofit
All PAs use CF values from the 2012 the Cadmus Non-Controls Multi-Season Lighting Evaluation[336] except:
- WMECO uses WMECo specific values from this same study.

[327] KEMA (2009). Design 2000*plus* Lighting Hours of Use and Load Shapes Measurement Study. Prepared for National Grid.
[328] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report*. Prepared for NSTAR.
[329] KEMA (2011). *2007/2008 Large C&I Programs,* . Prepared for Western Massachusetts Electric Company.
[330] Summit Blue Consulting, LLC. (2008). *Large Commercial and Industrial Retrofit Program Impact Evaluation 2007*. Prepared for National Grid.
[331] RLW Analytics (2004). *2003 Energy Initiative "EI" Lighting Impact Evaluation Final Report*. Prepared for National Grid.
[332] The Cadmus Group. (2012). *Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study*. Prepared for Massachusetts Joint Utilities.
[333] KEMA (2011). C&I Lighting Loadshape Project – Final Report. Prepared for the Regional Evaluation, Measurement and Verification Forum.
[334] KEMA (2009). *Design 2000plus Lighting Hours of Use and Load Shapes Measurement Study*. Prepared for National Grid.
[335] KEMA (2011). C&I Lighting Loadshape Project – Final Report. Prepared for the Regional Evaluation, Measurement and Verification Forum.
[336] The Cadmus Group. (2012). *Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study*. Prepared for Massachusetts Joint Utilities.

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Lighting – Lighting Controls

Version Date and Revision History

Effective Date: 1/1/2011
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

$$\Delta kWh = (Controlled\ kW)(Hours_{BASE} - Hours_{EE})$$

$$\Delta kW = (Controlled\ kW)$$

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 Appendix A: Table 29.

Measure Life

Measure	Measure Life[337]	
	Retrofit	Lost Opportunity
Occupancy Sensors	9 years	10 years
Daylight Dimming	9 years	10 years

Secondary Energy Impacts

Heating energy will be increased due to reduced lighting waste heat.

Measure	Energy Type	Savings[338]
Interior Lighting	C&I Gas Heat	-0.0003649 MMBtu/kWh
Interior Lighting	Oil	-0.0007129 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}
Occupancy Sensors	NC, Large Retrofit	National Grid	1.00	1.00	0.76	0.96	0.96	0.30	0.19	n/a	n/a
Daylight Dimming	NC, Large Retrofit	National Grid	1.00	1.00	0.38	0.96	0.96	0.15	0	n/a	n/a
Occupancy Sensors	Small Retrofit	National Grid	1.00	1.00	0.87	0.94	0.94	0.35	0.28	n/a	n/a
All	NC	NSTAR	1.00	1.00	1.14	1.11	1.30	0.85	0.59	n/a	n/a
All	Large Retrofit	NSTAR	1.00	1.00	1.01	1.18	1.26	0.85	0.59	n/a	n/a
All	Small Retrofit	NSTAR	1.00	1.00	0.89	0.92	0.92	0.80	0.37	n/a	n/a
All	NC	CLC	1.00	1.00	1.14	1.11	1.30	0.85	0.59	n/a	n/a
All	Large Retrofit	CLC	1.00	1.00	1.01	1.18	1.26	0.85	0.59	n/a	n/a
All	Small Retrofit	CLC	1.00	1.00	0.89	0.92	0.92	0.80	0.37	n/a	n/a
All	NC, Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.85	0.59	n/a	n/a
All	Small Retrofit	Unitil	1.00	1.00	1.02	0.99	0.99	0.77	0.37	n/a	n/a
All	NC, Large Retrofit	WMECO	1.00	1.00	1.05	1.23	1.05	n/a	n/a	custom	custom
All	Small Retrofit	WMECO	1.00	1.00	0.94	0.99	0.99	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.

[337] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1

[338] Optimal Energy, Inc. (2008). *Non-Electric Benefits Analysis Update*. Memo Prepared for National Grid.

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Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
All PAs use the same RRs as for Lighting Systems installations except:
- National Grid impact evaluation of C&I lighting controls installations.[339]
- WMECO: large commercial RRs are from 2007/2008 Large C&I Programs impact evaluation[340] and small retrofit RRs are from impact evaluation of 2008 program[341].

Coincidence Factors
All PAs use the same CFs as for Lighting Systems installations except:
- National Grid CFs from impact evaluation C&I lighting controls installations.[342]
- NSTAR for Small Retrofit uses results from 2007 RLW Coincidence Factor study.[343]

[339] RLW Analytics (2007). *Lighting Controls Impact Evaluation - Final Report, 2005 Energy Initiative, Design 2000plus and Small Business Services Programs*. Prepared for National Grid.
[340] KEMA (2010). *2007/2008 Large C&I Programs.* Prepared for Western Massachusetts Electric Company.
[341] The Cadmus Group, Inc. (2010). *Western Massachusetts SBEA (Small Business Energy Advantage) Impact Evaluation Report Program Year 2008*. Prepared for Western Massachusetts Electric Company.
[342] RLW Analytics (2007). *Lighting Controls Impact Evaluation - Final Report, 2005 Energy Initiative, Design 2000plus and Small Business Services Programs*. Prepared for National Grid.
[343] RLW (2007). *Coincidence Factor Study Residential and Commercial Industrial Lighting Measures*. Prepared for New England State Program Working Group.

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Lighting/Refrigeration – Freezer/Cooler LEDs

Version Date and Revision History

Effective Date: 1/1/2011
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, Refrigeration
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: 1.3 kW/ton[344]

Baseline Efficiency

The baseline efficiency case is the existing lighting fixtures in the cooler or freezer cases.

[344] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation*. Prepared for National Grid.

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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.[345]

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	National Grid	1.00	1.00	1.00	1.00	1.00	0.89	0.63	n/a	n/a
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	Large Retrofit	NSTAR, CLC	1.00	1.00	1.00	1.00	1.00	0.85	0.59	n/a	n/a
Freezer/Cooler LEDs	Small Retrofit	NSTAR	1.00	1.00	1.00	1.00	1.00	0.73	0.44	n/a	n/a
Freezer/Cooler LEDs	Small Retrofit	CLC	1.00	1.00	1.00	1.00	1.00	0.72	0.44	n/a	n/a
Freezer/Cooler LEDs	Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Freezer/Cooler LEDs	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Freezer/Cooler LEDs	Large Retrofit	WMECO	1.00	1.00	1.00	1.00	1.00	n/a	n/a	0.10	0.10
Freezer/Cooler LEDs	Small Retrofit	WMECO	1.00	1.00	0.86	1.00	1.00	n/a	n/a	0.10	0.10

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.

[345] Energy & Resource Solutions (2005*). Measure Life Study*. Prepared for The Massachusetts Joint Utilities.

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Realization Rates

- National Grid: RRs for small retrofit installations based on impact evaluation of 2005 small retrofit custom measures[346] and the measure mix for 2011 installations; RRs for large retrofit installations are 100% based on no evaluations
- NSTAR, Unitil: energy and demand RRs are 100% based on no evaluations
- CLC Large Retrofit: energy and demand RRs are 100% based on no evaluations
- WMECO small retrofit RRs are from impact evaluation of 2008 program[347].

Coincidence Factors

- NSTAR: CFs from 2011 Small C&I Non-Controlled Lighting impact evaluation[348]
- National Grid CLC, Unitil: CFs from the 2011 C&I lighting loadshape study[349]
- WMECO: CFs based on engineering estimates.

[346] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation*. Prepared for National Grid.
[347] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report Year 2008*. Prepared for Western Massachusetts Electric Company.
[348] The Cadmus Group. (2012). *Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study*. Prepared for Massachusetts Joint Utilities.
[349] RLW Analytics (2007). *Coincidence Factor Study Residential and Commercial Industrial Lighting Measures*. Prepared for the New England State Program Working Group; Table i-29 & Table i-30 (On-Peak) and Table i-31 & Table i-32 (Seasonal Peak).
[349] KEMA (2011). *C&I Lighting Loadshape Project.* Prepared for the Regional Evaluation, Measurement, and Verification Forum; Tables 1-10 and 1-13

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HVAC – Single–Package and Split System Unitary Air Conditioners

Version Date and Revision History

Draft Date: 10/22/2010
Effective Date: 1/1/2011

Measure Overview

Description: This measure promotes the installation of high efficiency unitary air conditioning equipment. 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 1 for values.
$SEER_{EE}$	=	Seasonal Energy Efficiency Ratio of the energy efficient equipment.
$EFLH_{Cool}$	=	Cooling equivalent full load hours. See Appendix A: **Table 31** for default values.
EER_{BASE}	=	Energy Efficiency Ratio of the baseline equipment. See Table 1 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.

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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 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 ASHREA 2004 standards as baseline.[350] Table 1 details the specific efficiency requirements by equipment type and capacity.

Table 1: Unitary Air Conditioners Baseline Efficiency Levels[351]

Equipment Type	Size Category	Subcategory or Rating Condition	Baseline Efficiency	
			New Installation	Replacement Installation
Air conditioners, air cooled	<65,000 Btu/h[b]	Split system	13.0 SEER	12.0 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[a]	10.1 EER[a]
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	11.0 EER[a]	9.5 EER[a]
	≥240,000 Btu/h and <760,000 Btu/h	Split system and single package	10.0 EER[a]	9.3 EER[a]
	≥760,000 Btu/h	Split system and single package	9.7 EER[a]	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[a]	11.5 EER[a]
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	11.0 EER[a]	11.0 EER[a]
	≥240,000 Btu/h	Split system and single package	11.0 EER[a]	10.8 EER[a]

a. Deduct 0.2 from the required EERs for units with a heating section other than electric heat[352].
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

[350] Note: starting in 2012 the baseline efficiency case for replacement units use the Federal Manufacturing standards (indicated in the table with an asterisk) or the ASHREA 2004 standards as baseline, whichever is most rigorous. The use of the Federal Manufacturing standards was only considered after planning of 2011, and so is not used for 2011 savings calculations.
[351] International Code Council (2009). *2009 International Energy Conservation Code*; Page43, Table 503.2.3(1).
[352] 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: Table 31 for cooling full load hours by building type.

Measure Life

The measure life is 15 years.[353]

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	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	1.01	1.09	1.57	0.82	0.05	n/a	n/a
Unitary AC	NC	CLC	1.00	1.00	1.50	1.09	1.57	0.55	0.05	n/a	n/a
Unitary AC	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.82	0.05	n/a	n/a
Unitary AC	NC	WMECO	1.00	1.00	1.91	1.20	1.09	n/a	n/a	0.82	0.00

In-Service Rates
All installations have 100% in service rate since all programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factors.

Realization Rates
- National Grid, Unitil: energy and demand RRs based on a 1998 impact evaluation of unitary AC installations.[354]
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[355]
- NSTAR, CLC: energy and demand RRs from impact evaluations of NSTAR 2006 HVAC installations[356]

Coincidence Factors
All CFs based 2011 NEEP C&I Unitary AC Loadshape Project[357] except:
- WMECO: CFs from 2005 coincidence factor study.358

[353] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[354] SAIC (1998). Impact Evaluation of the Design 2000 Unitary HVAC Program, Final Report. Prepared for New England Power Service Company.
[355] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.
[356] RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report. Prepared fro NSTAR; Table 17.
[357] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.
[358] RLW Analytics (2007). *Final Report, 2005 Coincidence Factor Study*. Prepared for United Illuminating Company and Connecticut Lighting & Power.

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HVAC – Single Package or Split System Heat Pump Systems

Version Date and Revision History

Effective Date: 1/1/2011
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:

$$\Delta kWh = \Delta kWh_{Cool} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Cool} = (kBtu/h)\left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right)(EFLH_{COOL})$$

$$\Delta kWh_{Heat} = (kBtu/h)\left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right)(EFLH_{HEAT})$$

$$\Delta kW = (kBtu/h)\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

For all water source, groundwater source, ground source units, and air cooled units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWh = \Delta kWh_{Cool} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Cool} = (kBtu/h_{COOL})\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)(EFLH_{COOL})$$

$$\Delta kWh_{Heat} = \frac{(kBtu/h_{HEAT})}{3.412}\left(\frac{1}{COP_{BASE}} - \frac{1}{COP_{EE}}\right)(EFLH_{HEAT})$$

$$\Delta kW = (kBtu/h)\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

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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.
$kBtu/h$[359]	=	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 2 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 2 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 2 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 2 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 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. The baseline efficiency case for replacement units are not required to meet the IECC 2009. Instead, replacement installations use the ASHREA 2004 standards as baseline, whichever is most rigorous. **Table 2** details the specific efficiency requirements by equipment

[359] 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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type and capacity. The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

Table 2: Unitary and Applied Heat Pumps Baseline Efficiency Levels[360]

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 / 12.0 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] / 9.1 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] / 8.8 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[361].
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. 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.

[360] International Code Council (2009). *2009 International Energy Conservation Code*; Page 44, Table 503.2.3(2).
[361] 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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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: **Table 32**.

Measure Life

The measure life is 15 years.[362]

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, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
Heat Pumps	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.82	0.05	n/a	n/a
Heat Pumps-Cooling	NC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	0.82	0.00
Heat Pumps-Heating	NC	WMECO	1.00	1.00	0.57	0.78	0.81	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.

Realization Rates
- National Grid and energy and demand RRs based on a 1994 study of HVAC and process cooling equipment.[363]
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[364]
- Unitil realization rates same as *Unitary AC*.
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[365]

Coincidence Factors
CFs based 2011 NEEP C&I Unitary AC Loadshape Project.[366]

[362] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[363] 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.
[364] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[365] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.
[366] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.

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HVAC – Dual Enthalpy Economizer Controls (DEEC)

Version Date and Revision History

Effective Date: 1/1/2011
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, C&I Large Retrofit

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[367]
$SAVE_{kW}$ = Average kW reduction per ton of cooling capacity: 0.289 kW/ton[368]

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.

[367] Patel, Dinesh (2001). *Energy Analysis: Dual Enthalpy Control*. Prepared for NSTAR.
[368] Ibid.

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Measure Life

The measure life is 10 years for lost-opportunity applications.[369] The measure life is 7 years for retrofit installations.[370]

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	0.01	n/a	n/a
DEEC	NC	NSTAR, CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
DEEC	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.82	0.05	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.

Realization Rates
- National Grid RRs are 1.0 since there have been no impact evaluations of the prescriptive savings calculations.
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[371]
- Unitil realization rates same as *Unitary AC*.
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[372]

Coincidence Factors
- National Grid, NSTAR, CLC, Unitil: CFs based 2011 NEEP C&I Unitary AC Loadshape Project.[373]
- WMECO: CFs set to 0.0 since no DEEC savings are occur during seasonal peak periods.

[369] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1
[370] 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.
[371] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[372] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.
[373] 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: Lost Opportunity
End Use: HVAC
Program: C&I New Construction and Major Renovation

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.[374] 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[375]
$SAVE_{kW}$ = Average kW reduction per ton of cooling capacity: 0.15 kW/ton[376]

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.

[374] Detailed descriptions of the DCV Savings Calculation Tools are included in the TRM Library under the "C&I Spreadsheet Tools" folder.
[375] Keena, Kevin (2008). *Analysis of CO2 Control Energy Savings on Unitary HVAC Units.* Prepared for National Grid.
[376] Ibid.

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Hours

The operating hours are site-specific for custom savings calculations.

Measure Life

The measure life is 10 years.[377]

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[378]
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[379]
- 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[380]

Coincidence Factors

- National Grid: CFs based on engineering estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs from 2005 coincidence factor study.[381]

[377] 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.
[378] Optimal Energy, Inc. (2008). *Non-Electric Benefits Analysis Update*. Memo Prepared for National Grid.
[379] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[380] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.
[381] RLW Analytics (2007). *Final Report, 2005 Coincidence Factor Study*. Prepared for United Illuminating Company and Connecticut Lighting & Power.

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HVAC – ECM Fan Motors

Version Date and Revision History

Effective Date: 1/1/2011
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

$$\Delta kWh = (Design\,CFM)(Box\,Size\,Factor)(\%Flow_{ANNUAL})(Hours)$$
$$\Delta kW_{SP} = (Design\,CFM)(Box\,Size\,Factor)(\%Flow_{SP})$$
$$\Delta kW_{WP} = (Design\,CFM)(Box\,Size\,Factor)(\%Flow_{WP})$$

Where:
Design CFM = Capacity of the VAV box in cubic feet per minute
Box Size Factor = Savings factor in Watts/CFM. See Table 3 for values.
$\%Flow_{ANNUAL}$ = Average % of design flow over all operating hours. See Table 3 for values.
$\%Flow_{SP}$ = Average % of design flow during summer peak period. See Table 3 for values.
$\%Flow_{WP}$ = Average % of design flow during summer peak period. See Table 3 for values.
Hours = Annual operating hours for VAV box fans

Table 3: ECM Fan Motor Savings Factors [382]

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.

High Efficiency

The high efficiency case must have a motor installed on new, qualifying HVAC equipment.

[382] Factors based on engineering analysis developed at National Grid.

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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.[383]

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	0.82	0.05	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[384]
- 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[385]

Coincidence Factors
- National Grid: CFs based on engineering estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs from 2005 coincidence factor study.[386]

[383] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[384] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[385] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.
[386] RLW Analytics (2007). *Final Report, 2005 Coincidence Factor Study*. Prepared for United Illuminating Company and Connecticut Lighting & Power.

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HVAC – Energy Management System

Version Date and Revision History

Effective Date: 1/1/2011
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: Lost Opportunity, 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.[387]

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[388]. For retrofit applications, the measure life is 10 years[389].

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:

[387] Detailed descriptions of the EMS Savings Calculation Tools are included in the TRM Library under the "C&I Spreadsheet Tools" folder.
[388] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[389] Ibid.

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Measure	Energy Type	Savings[390]
EMS	C&I Gas Heat	0.001277 MMBtu/ΔkWh
EMS	Oil	0.002496 MMBtu/ΔkWh

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	NC	CLC	1.00	1.00	1.01	1.09	1.57	0.82	0.05	n/a	n/a
EMS	Small Retrofit	CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
EMS	Large Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.82	0.05	n/a	n/a
EMS	Large Retrofit	WMECO	1.00	1.00	1.01	1.09	1.57	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 RRs derived from a 1994 study of HVAC and process cooling equipment.[391]
- NSTAR energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[392]
- CLC NC application based on Large Retrofit assumptions and Small Retrofit application based on HVAC – Programmable Thermostat assumptions
- 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[393]

Coincidence Factors

- National Grid, WMECO: CFs are custom calculated.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.

[390] Optimal Energy, Inc. (2008). *Non-Electric Benefits Analysis Update*. Memo Prepared for National Grid.
[391] The Fleming Group (1994). *Persistence of Commercial/Industrial Non-Lighting Measures, Volume 3, Energy Management Control Systems*. Prepared for New England Power Service Company.
[392] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[393] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.

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HVAC – High Efficiency Chiller

Version Date and Revision History

Effective Date: 1/1/2011
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, Retrofit
End Use: HVAC
Program: C&I New Construction & Major Renovation, C&I Large 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.[394]

Alternatively, the energy and demand savings may be calculated using the following algorithms and inputs:

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:

$$\Delta kWh = (Tons)(kW/ton_{BASE} - kW/ton_{EE})(Hours)$$

$$\Delta kW = (Tons)(kW/ton_{BASE} - kW/ton_{EE})$$

Where:

[394] Detailed descriptions of the Chiller Savings Calculation Tools are included in the TRM Library under the "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 4 for values.
EER_{EE} = Energy Efficiency Ratio of the efficient equipment. See Table 4 for values.
kW/ton_{BASE} = Energy efficiency rating of the baseline equipment. See Table 4 for values.
kW/ton_{EE} = Energy efficiency rating of the efficient equipment. See Table 4 for values.
Hours = Equivalent full load hours for chiller operation
LF = Load Factor

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) 2006 with the 2007 Supplement or ASHRAE 90.1-2007. Both documents present consistent requirements for water chilling packages. Table 4 details the specific efficiency requirements by equipment type and capacity.

Table 4: Water Chilling Packages - Minimum Efficiency Requirements[395]

Equipment Type	Size Category	Units	Full Load	IPLV
Air cooled chillers	All capacities	EER	≥ 9.562	≥ 10.416
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 150 tons	kW/ton	≤ 0.790	≤ 0.676
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.717	≤ 0.627
	≥ 300 tons	kW/ton	≤ 0.639	≤ 0.571
Water cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.703	≤ 0.669
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.634	≤ 0.596
	≥ 300 tons	kW/ton	≤ 0.576	≤ 0.549

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.

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 31**.

Measure Life

The measure life is 23 years.[396]

[395] DOE (2009). 2009 IECC Based Building Codes; Table 503.2.3(7): Water Chilling Packages, Efficiency Requirements - before 1/1/2020 minimum efficiency values.

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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	Large Retrofit	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	0.82	0.05	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.[397]
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[398]
- CLC Large Retrofit application based on NC assumptions
- 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[399]

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

[396] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[397] 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.
[398] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[399] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.

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HVAC – Hotel Occupancy Sensors

Version Date and Revision History

Effective Date: 1/1/2011
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[400]
$SAVE_{kW}$	=	Average annual kWh reduction per unit: 0.09 kW[401]

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.[402]

[400] MassSave (2010). *Energy Analysis: Hotel Guest Occupancy Sensors*.
[401] Ibid.

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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	Small Retrofit	CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	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

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 large retrofit energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations[403]
- CLC Small Retrofit application based on HVAC – Programmable Thermostat assumptions
- Unitil: energy and demand RRs are 100% based on no evaluations.
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[404]

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 occur during seasonal peak periods.

[402] 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.
[403] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[404] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.

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HVAC – Programmable Thermostats

Version Date and Revision History

Effective Date: 1/1/2011
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 5.
$SAVE_{kW}$ = Average annual kWh reduction per SQFT of controlled. See Table 5.

Table 5: Savings Factors (Save)[405]

Equipment Type	$SAVE_{kWh}$ (kWh/SQFT)	$SAVE_{kW}$ (kW/SQFT)
Cool Only No Existing Control	0.539	0.00
Cool 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.

High Efficiency

The high efficiency case includes control of the space cooling and/or heating system as indicated in the equipment type selection.

[405] Factors form National Grid tracking system. Source unknown.

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Hours

Not applicable.

Measure Life

For retrofit applications, the measure life is 8 years.[406]

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}
Thermostats	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Thermostats	Small Retrofit	NSTAR	1.00	1.00	0.91	0.92	0.92	0.82	0.05	n/a	n/a
Thermostats	Small Retrofit	CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Thermostats	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Thermostats	Small Retrofit	WMECO	1.00	1.00	1.00	1.00	1.00	n/a	n/a	0	0

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, WMECO: RRs set to 100% based on no evaluations.
- NSTAR, CLC: RRs based on NSTAR 2002-2004 small retrofit program impact evaluations.

Coincidence Factors

- National Grid, WMECO: CFs set to zero since no savings are expected during peak periods.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.

[406] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.

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Refrigeration – Door Heater Controls

Version Date and Revision History

Effective Date: 1/1/2011
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.[407]
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[408]: 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 with the heaters operating at 80% (adjustable)[409].

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).

[407] The assumptions and algorithms used in this section are specific to NRM products.
[408] The value is an estimate by NRM based on hundreds of downloads of hours of use data form Door Heater controllers. These values are also supported by Select Energy (2004). *Cooler Control Measure Impact Spreadsheet User's Manual*. Prepared for NSTAR.
[409] Select Energy (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.[410]

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	1.13	1.00	1.00	0.73	1.46	n/a	n/a
Door Heater Control	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	0.38	1.00	n/a	n/a
Door Heater Control	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.75	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.[411]

Coincidence Factors

- National Grid: CFs from the 1995 HEC study of walk-in cooler anti-sweat door heater controls.[412]
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs based on staff estimates.

[410] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[411] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report Year 2008*. Prepared for Western Massachusetts Electric Company.
[412] HEC, Inc. (1995). *Analysis of Door Master Walk-In Cooler Antu-Sweat Door Heater Controls Installed at Ten Sites in Massachusetts*. Prepared for NEPSCo; Table 9.

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Refrigeration – Novelty Cooler Shutoff

Version Date and Revision History

Effective Date: 1/1/2011
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.[413]
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[414]

HoursOFF = Potential hours off per night, estimated as one less than the number of hours the store is closed per day

DC_{AVG} = Weighted average annual duty cycle[415]

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.

[413] The assumptions and algorithms used in this section are specific to NRM products.
[414] Conservative value based on 15 years of NRM field observations and experience.
[415] Ibid; the estimated duty cycles for Novelty Coolers are supported by Select Energy (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.[416]

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	1.13	1.00	1.00	0.00	0.00	n/a	n/a
Novelty Cooler Shutoff	Small Retrofit	NSTAR	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Novelty Cooler Shutoff	Small Retrofit	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.[417]

Coincidence Factors
Coincidence factors are set to zero since demand savings typically occur during off-peak hours.

[416] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[417] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report 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
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.[418]
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

$$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Fan} = kW_{Fan} * LRF * Hours$$

$$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$$

$$\Delta kW = \Delta kWh / Hours$$

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[419]
LRF	=	Load reduction factor for motor replacement (65%)[420]
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[421]

Baseline Efficiency

The baseline efficiency case is an existing evaporator fan motor.

High Efficiency

The high efficiency case is the replacement of existing evaporator fan motors with ECMs.

[418] The assumptions and algorithms used in this section are specific to NRM products.
[419] Conservative value based on 15 years of NRM field observations and experience.
[420] 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.
[421] Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience.

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Hours

The annual operating hours are assumed to be 4,730 hours/year if the facility has an evaporator fan controls or 8,760 hours if the facility does not have evaporator fan controls.

Measure Life

The measure life is 15 years.[422]

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[423]

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	1.55	1.08	0.51	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	0.38	1.00	n/a	n/a
Evap Fan ECMs	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.75	n/a	n/a
Evap Fan ECMs	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 PA programs include verification of equipment installations.

Savings Persistence Factor
All PAs use 100% savings persistence factor.

Realization Rates
- National Grid: RRs from impact evaluation analysis of 2005 Custom SBS Program[424] which uses the results from impact evaluation of 2005 custom SBS installations[425]. Study results are weighted by 2011 installation measure mixes.
- 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.[426]

Coincidence Factors
- National Grid, WMECO: CFs based on staff estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.

[422] ERS (2005). *Measure Life Study*. Prepared for The MA Joint Utilities; 15-year measure life for retrofit motor installations.
[423] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation.* Prepared for National Grid
[424] RLW Analytics (2007). *Impact Evaluation Analysis of the 2005 Custom SBS Program*. Prepared for National Grid.
[425] RLW Analytics (2007). *Small Business Services Custom Measure Impact Evaluation*. Prepared for National Grid.
[426] The Cadmus Group, Inc. (2010), *Western MA SBEA Evaluation Report Year 2008.* Prepared for Western MA Electric Company.

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Refrigeration – Case Motor Replacement

Version Date and Revision History

Draft Date: 10/22/2010
Effective Date: 1/1/2011
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.[427]
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

$$\Delta kWh = \Delta kWh_{Motor} + \Delta kWh_{Heat}$$

$$\Delta kWh_{motor} = kW_{Motor} * LRF * Hours$$

$$\Delta kWh_{heat} = \Delta kWh_{Motor} * 0.28 * Eff_{RS}$$

$$\Delta kW = \Delta kWh / Hours$$

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[428]
Hours	=	Average runtime of case motors (8,500 hours)[429]
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) [430]

Baseline Efficiency

The baseline efficiency case is the existing case motor.

[427] The assumptions and algorithms used in this section are specific to NRM products.
[428] Load factor is an estimate by NRM based on several pre- and post-meter readings of installations
[429] Conservative value based on 15 years of NRM field observations and experience.
[430] Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience.

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High Efficiency

The high efficiency case is the replacement of the existing case motor with an ECM.

Hours

Hours are the annual operating hours of the case motors.

Measure Life

The measure life is 15 years.[431]

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	0.38	1.00	n/a	n/a
Case ECMs	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.75	n/a	n/a
Case ECMs	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, 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[432].

Coincidence Factors

- National Grid, WMECO: CFs based on staff estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.

[431] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; 15-year measure life for retrofit motor installations.
[432] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report Year 2008*. Prepared for Western Massachusetts Electric Company.

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Refrigeration – Cooler Night Covers

Version Date and Revision History

Draft Date: 10/22/2010
Effective Date: 1/1/2011
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.[433]
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 6.
Hours = Annual hours that the night covers are in use

Table 6: Savings Factors[434]

Cooler Case Temperature	Savings Factor
Low Temperature (-35 F to -5 F)	0.03 kW/ft
Medium Temperature (0 F to 30 F)	0.02 kW/ft
High Temperature (35 F to 55 F)	0.01 kW/ft

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.

[433] The assumptions and algorithms used in this section are specific to NRM products.
[434] 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.[435]

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}
Cooler Night Cover	Small Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Cooler Night Cover	Small Retrofit	NSTAR	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Cooler Night Cover	Small Retrofit	CLC	1.00	1.00	0.91	0.92	0.92	0.00	0.00	n/a	n/a
Cooler Night Cover	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	0.00	0.00	n/a	n/a
Cooler Night Cover	Small Retrofit	WMECO	1.00	1.00	0.86	0.57	0.57	n/a	n/a	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% 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.[436]

Coincidence Factors
Coincidence factors are set to zero since demand savings typically occur during off-peak hours.

[435] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Page 4-5 to 4-6.
[436] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report 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
End Date: TBD

Measure Overview

Description: A control mechanism to skip defrost cycles when defrost is unnecessary.[437]
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

$$\Delta kWh = \Delta kWh_{Defrost} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Defrost} = kW_{Defrost} * Hours * DRF$$

$$\Delta kWh_{Heat} = \Delta kWh_{Defrost} * 0.28 * Eff_{RS}$$

$$\Delta kW = \Delta kWh / Hours$$

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%)[438]
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)[439]

Baseline Efficiency

The baseline efficiency case is an evaporator fan 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.

[437] The assumptions and algorithms used in this section are specific to NRM products.
[438] 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 Deforst capability.
[439] Estimated average refrigeration efficiency for small business customers.

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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.[440] 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.[441]

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	0.38	1.00	n/a	n/a
Defrost Control	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.75	n/a	n/a
Defrost 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, 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.[442]

Coincidence Factors
- National Grid, WMECO: CFs based on staff estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.

[440] Conservative value based on 15 years of NRM field observations and experience.
[441] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities.
[442] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report 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
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.[443]
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[444]
%Off	=	Percent of annual hours that the evaporator is turned off: 46%[445]
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[446]
kW_{CP}	=	Total power demand of compressor motor and condenser fan calculated from equipment nameplate data and estimated 0.85 power factor[447]
$Hours_{CP}$	=	Equivalent annual full load hours of compressor operation[448]
5%	=	Reduced run-time of compressor and evaporator due to electronic controls[449]

[443] The assumptions and algorithms used in this section are specific to NRM products.
[444] Conservative value based on 15 years of NRM field observations and experience.
[445] Select Energy (2004). *Analysis of Cooler Control Energy Conservation Measures.* Prepared for NSTAR.
[446] Estimated average refrigeration efficiency for small business customers.
[447] This value is an estimate by NRM based on hundreds of downloads of hours of use data form the electronic controller.
[448] Conservative value based on 15 years of NRM field observations and experience.

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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[450].

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	1.00	1.00	0.58	1.00	1.00	0.23	0.84	n/a	n/a
Evap Fan Control	Small Retrofit	NSTAR, CLC	1.00	1.00	0.91	0.92	0.92	0.38	1.00	n/a	n/a
Evap Fan Control	Small Retrofit	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.75	n/a	n/a
Evap Fan 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 small retrofit RRs from 1996 savings analysis[451]
- 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[452].

Coincidence Factors
- National Grid CFs from 1996 savings analysis[453]

[449] Conservative estimate supported by less conservative values given by several utility-sponsored 3rd Party studies including: Select Energy (2004). *Analysis of Cooler Control Energy Conservation Measures*. Prepared for NSTAR.
[450] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[451] HEC, Inc. (1996), *Analysis of Savings from Walk-In Cooler Air Economizers and Evaporator Fan Controls*. Prepared for NEPSCo.
[452] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report Year 2008*. Prepared for Western Massachusetts Electric Company.

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- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs based on staff estimates.

[453] HEC, Inc. (1996). *Analysis of Savings form Walk-in Cooler Air Economizers and Evaporator Fan Controls*. Prepared for NEPSCo.

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Refrigeration – Vending Misers

Version Date and Revision History

Effective Date: 1/1/2011
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 7 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 7 for values.

Table 7: Vending Machine and Cooler Controls Savings Factors [454]

Equipment Type	kW_{RATED}	SAVE (%)	ΔkW	ΔkWh
Refrigerated Beverage Vending Machines	0.40	46	0.184	1612
Non-Refrigerated Snack Vending Machines	0.085	46	0.391	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.

[454] 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.[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

Measure	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	0.91	0.67	n/a	n/a
Vending Misers	Small Retrofit	NSTAR	1.00	1.00	0.91	0.92	0.92	0.91	0.67	n/a	n/a
Vending Misers	Large Retrofit	CLC	1.00	1.00	0.85	0.41	0.24	0.91	0.67	n/a	n/a
Vending Misers	Small Retrofit	CLC	1.00	1.00	0.91	0.92	0.92	0.91	0.67	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	1.00	0.57	0.57	n/a	n/a	0.00	0.00
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

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[456]; small retrofit RRs from impact evaluation of 2002 program year[457]
- WMECO: Small Retrofit RRs from impact evaluation of 2008 small retrofit program[458]; large retrofit RRs set to 100% based on no evaluations.

[455] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[456] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[457] RLW Analytics (2003). *Small Business Solutions Program Year 2002 Impact Evaluation - Final Report*. Prepared for NSTAR.

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- WMECO: Large Retrofit RRs are from 2007/2008 Large C&I Programs impact evaluation[459]

Coincidence Factors

- National Grid CFs based on staff estimates.
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO: CFs set to 0.0 since no DEEC savings occur during seasonal peak periods.

[458] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report Year 2008*. Prepared for Western Massachusetts Electric Company.
[459] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.

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Compressed Air – High Efficiency Air Compressors

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: 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 8 for values.
Hours = Annual operating hours of the air compressor.

Table 8: Air Compressor kW Reduction per Horsepower

Control Type	Nominal Horsepower (HP)	kW Reduction per Horsepower (Save)[460]	
		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.

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

[460] Form NSTAR analysis based on metering data. The location of original data and analysis is unknown.

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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.[461]

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}
Air Compressor	NC, Large Retrofit	National Grid	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
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	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.[462]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[463]
- WMECO: energy RRs are from 2007/2008 Large C&I Programs impact evaluation[464]

Coincidence Factors
- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.[465]
- NSTAR, CLC: CFs based on standard assumptions.
- WMECO: CFs are custom calculated

[461] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[462] Ibid.
[463] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[464] KEMA (2010). *2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures*. Prepared for Western Massachusetts Electric Company.
[465] Demand Management Institute (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 Intiative and Design 2000 Programs*. Prepared for National Grid.

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Compressed Air – Refrigerated Air Dryers

Version Date and Revision History

Effective Date: 1/1/2011
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 9.
Hours = Annual operating hours of the refrigerated air dryer.

Table 9: Default kW Reduction per CFM by Dryer Capacity (*SAVE*)

Dryer Capacity (CFM_{DRYER})	kW Reduction per CFM (Save)
<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.

Hours

The annual hours of operation for compressed air dryers are site-specific.

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Measure Life

The measure life is 15 years.[466]

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}
Refrigerated Air Dryers	NC	National Grid	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
Refrigerated Air Dryers	NC	NSTAR, CLC	1.00	1.00	1.25	0.95	0.80	0.88	0.69	n/a	n/a
Refrigerated Air Dryers	NC	Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.54	0.77	0.54
Refrigerated Air Dryers	NC	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.[467]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[468]
- WMECO: energy RRs are from 2007/2008 Large C&I Programs impact evaluation[469]

Coincidence Factors
- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.[470]
- NSTAR, CLC: CFs based on standard assumptions.
- WMECO: CFs are custom calculated

[466] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[467] 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.*
[468] RLW Analytics (2008). *BS/CS Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[469] KEMA (2010). *2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures*. Prepared for Western Massachusetts Electric Company.
[470] 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*

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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.

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Measure Life

For lost-opportunity installations, the lifetime for this measure is 5 years. For retrofit projects, the lifetime is 3 years.[471]

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.[472]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[473]
- WMECO: RRs from 2011 WMECO C&I impact evaluation.[474]

Coincidence Factors

- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.[475]
- NSTAR, CLC: CFs based on standard assumptions.
- WMEC: CFs are custom calculated.

[471] Based on typical replacement schedules for low pressure filters (NSTAR staff estimates).
[472] 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 Intiative and Design 2000 Programs*. Prepared for National Grid.
[473] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[474] KEMA (2011). 2007/2008 Large C&I Programs. Prepared for Western Massachusetts Electric Company.
[475] 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 Intiative 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[476]
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.[477]

[476] Based on NSTAR analysis assuming a typical timed drain settings discharge scenario.
[477] 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.[478]
- NSTAR, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[479]
- WMECO: RRs from 2011 WMECO C&I impact evaluation.[480]

Coincidence Factors

- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.[481]
- NSTAR, CLC: CFs based on standard assumptions.
- WMECO: CFs are custom calculated.

[478] 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 Intiative and Design 2000 Programs*. Prepared for National Grid.
[479] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report*. Prepared for NSTAR Electric and Gas; Table 17.
[480] KEMA (2011). 2007/2008 Large C&I Programs. Prepared for Western Massachusetts Electric Company.
[481] 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 Intiative and Design 2000 Programs*. Prepared for National Grid.

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Motors/Drives – Premium Efficiency Motors

Version Date and Revision History

Effective Date: 1/1/2011
End Date: 12/31/2010

Measure Overview

Description: This measure promotes the purchase and installation of NEMA Premium Efficiency motors for new construction or time-of-replacement applications. Motors covered by this program must be new, three phase, induction motors, NEMA Design A & B, 1-200 HP, Open Drip-Proof (ODP) or Totally Enclosed Fan Cooled (TEFC), 1200, 1800, 3600 RPM and operate a minimum of 2,000 hours per year.
Primary Energy Impact: Electric
Secondary Energy Impact: None
Non-Energy Impact: None
Sector: Commercial & Industrial
Market: Lost Opportunity
End Use: Motors/Drives
Program: C&I New Construction & Major Renovation

Notes

NEMA Premium specifications will be considered baseline in starting in 12/2010 due to the federal manufacturing standards enacted by the Energy Independence and Security Act of 2007. Due to this updated baseline, Premium Efficiency Motors will be discontinued as prescriptive measure at the end of program year 2011, but motor installations may still go through custom programs if proven to be cost-effective. For projects initiated before the measure end date including projects initiated during program year 2011, savings will be estimate using the previous code standard (EPACT 1992) for the baseline motor efficiency level.

Algorithms for Calculating Energy and Demand Savings

$$\Delta kWh = (HP)(0.746)(LF)\left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{ee}}\right)(HOURS)$$

$$\Delta kW = (HP)(0.746)(LF)\left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{ee}}\right)$$

Where:

HP	=	Motor rated nameplate horsepower.
0.746	=	kW per HP.
LF	=	Motor load factor: (NSTAR, CLC: use 0.8; National Grid, Unitil: use 0.62[482]; WMECO: load factor is included in peak coincidence factor
η_{base}	=	Baseline motor efficiency. See Table 33.
η_{ee}	=	Installed motor efficiency. See Table 34.
HOURS	=	Motor annual run hours.

[482] SAIC (1995). *Motor Run-Time and Persistence Study Final Report.* Prepared for New England Power Service Company; Exhibit 5.1.

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Baseline Efficiency

For both lost opportunity and retrofit applications, it is assumed that the baseline efficiency meets the minimum federal manufacturing requirements as legislated by the Energy Policy Act of 1992 (EPACT 1992). The Baseline Efficiency levels are presented in Appendix A: Common Lookup Tables, Table 33.

High Efficiency

The high efficiency scenario assumes compliance with NEMA Premium Efficiency Motors requirements by motor type and size. These requirements are reproduced in Appendix A: Common Lookup Tables, Table 34.

Hours

The annual hours of operation for motors 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 Appendix A: Common Lookup Tables, Table 31 for HVAC applications. For non-HVAC related applications, assume 4,500 hours.[483]

Measure Life

The measure life is 20 years.[484]

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}
Motors	NC	National Grid	1.00	1.00	0.97	1.00	1.00	0.76	0.60	n/a	n/a
Motors	NC	NSTAR, CLC	1.00	1.00	0.67	0.85	0.78	0.58	0.64	n/a	n/a
Motors	NC	Unitil	1.00	1.00	1.00	1.00	1.00	1.00	0.82	n/a	n/a
Motors (Cooling)	NC	WMECO	1.00	1.00	1.31	0.85	0.60	n/a	n/a	0.82	0.00
Motors (Heating)	NC	WMECO	1.00	1.00	1.31	0.85	0.60	n/a	n/a	0.00	0.63
Motors (Other)	NC	WMECO	1.00	1.00	0.90	1.02	1.22	n/a	n/a	0.72	0.72

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 energy RR is the hours of use realization rate[485]; demand RR is set to 100% since the motor load factor is based on evaluated results.
- NSTAR, CLC energy and demand RRs from impact evaluation of NSTAR 2006 motor installations[486]

[483] ESource Technology Atlas Series: Volume IV, Drivepower, 1996.
[484] Energy & Resource Solutions (2005). *Measure Life Study.* Prepared for The Massachusetts Joint Utilities; Table 1-1.
[485] SAIC (1995). *Motor Run-Time and Persistence Study Final Report.* Prepared for New England Power Service Company; Exhibit 5.1.

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- Unitil: energy and demand RRs are 100% for all C&I New Construction projects based on no evaluations
- WMECO: RRs from 2011 WMECO C&I impact evaluation.[487]

Coincidence Factors

- National Grid CFs from motor run-time and persistence study[488]
- NSTAR, CLC, Unitil: CFs based on standard assumptions.
- WMECO CFs determined based on motor application and include motor load factor.

[486] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.* Prepared for NSTAR; Table 17.
[487] KEMA (2011). 2007/2008 Large C&I Programs. Prepared for Western Massachusetts Electric Company.
[488] SAIC (1995). *Motor Run-Time and Persistence Study Final Report.* Prepared for New England Power Service Company; Exhibit 5.1.

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Motors/Drives – Variable Frequency Drives

Version Date and Revision History

Effective Date: 1/1/2011
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

Notes

The Large Commercial & Industrial Evaluation Research Area will be commencing an impact evaluation of this measure starting the Fall of 2010. The results of this study will result in either modifications to the savings factors or the realization rates and will be used for reporting on the 2011 program year.

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:

η_{motor} = Motor efficiency

kWh/HP = Annual electric energy reduction based on building and equipment type. See **Table 10**.

kW/HP_{SP} = Electric summer demand reduction based on building and equipment type. See **Table 10**.

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Electric winter demand reduction based on building and equipment type. See

kW/HP_{WP} =

Table 10.

Table 10: VFD Savings Factors (kWh/HP and kW/HP)[489]

[489] 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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	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.

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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.[490]

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_{SP}	CF_{WP}
VFD	NC	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
VFD	Large Retrofit	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
VFD	Large Retrofit and NC	WMECO	1.00	1.00	1.31	0.85	0.60	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 factors.

Realization Rates
RRs for all PAs with the exception of WMECO set to 1.0 pending impact evaluation.
- WMECO: RRs from 2011 WMECO C&I impact evaluation.[491]

Coincidence Factors
CFs for all PAs set to 1.0 based summer and winter factors in gross calculation and pending impact evaluation.

[490] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-1.
[491] KEMA (2011). 2007/2008 Large C&I Programs. Prepared for Western Massachusetts Electric Company.

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Custom Measures

Version Date and Revision History

Effective Date: 1/1/2011
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, C&I Small Retrofit

Notes

The Large Commercial & Industrial Evaluation Research Area has statewide impact evaluations in progress for the comprehensive design and HVAC projects. The results of these impact evaluations will be used for reporting on the 2011 program year.

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.

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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.[492]

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}
C&I New Construction and C&I Large Retrofit										
Comprehensive	National Grid	1.00	1.00	0.97	0.64	0.55	custom	custom	n/a	n/a
Lighting	National Grid	1.00	1.00	0.98	1.16	0.85	custom	custom	n/a	n/a
HVAC	National Grid	1.00	1.00	1.01	0.84	0.82	custom	custom	n/a	n/a
Compressed Air	National Grid	1.00	1.00	0.85	0.76	0.74	custom	custom	n/a	n/a
Process	National Grid	1.00	1.00	0.68	0.96	0.82	custom	custom	n/a	n/a
CHP	National Grid	1.00	1.00	0.86	1.00	1.00	custom	custom	n/a	n/a
Lighting	NSTAR	1.00	1.00	1.02	0.85	0.84	custom	custom	n/a	n/a
Process	NSTAR	1.00	1.00	1.04	0.80	1.11	custom	custom	n/a	n/a
CHP	NSTAR	1.00	1.00	1.15	1.00	1.00	custom	custom	n/a	n/a
HVAC	NSTAR	1.00	1.00	1.24	0.94	0.75	custom	custom	n/a	n/a
Motors	NSTAR, CLC	1.00	1.00	0.67	0.85	0.78	custom	custom	n/a	n/a
Refrigeration	NSTAR, CLC	1.00	1.00	0.85	0.41	0.24	custom	custom	n/a	n/a
Comprehensive	NSTAR, CLC	1.00	1.00	0.91	0.64	0.60	custom	custom	n/a	n/a
Compressed Air	NSTAR, CLC	1.00	1.00	0.85	0.76	0.74	custom	custom	n/a	n/a
HVAC	CLC	1.00	1.00	1.10	0.88	0.86	custom	custom	n/a	n/a
Process	CLC	1.00	1.00	0.76	0.82	0.88	custom	custom	n/a	n/a
Lighting	CLC	1.00	1.00	0.98	0.94	0.92	custom	custom	n/a	n/a
Compressed Air	Unitil	1.00	1.00	0.85	0.76	0.74	custom	custom	n/a	n/a
Process	Unitil	1.00	1.00	0.76	0.82	0.88	custom	custom	n/a	n/a
Non-Lighting	Unitil	1.00	1.00	1.00	1.00	1.00	custom	custom	n/a	n/a
Lighting	Unitil	1.00	1.00	0.98	0.94	0.92	custom	custom	n/a	n/a
HVAC	WMECO	1.00	1.00	0.91	1.20	1.09	n/a	n/a	custom	custom
Lighting	WMECO	1.00	1.00	0.98	0.92	0.87	n/a	n/a	custom	custom
Motors/Drives	WMECO	1.00	1.00	1.31	0.85	0.60	n/a	n/a	custom	custom
Compressed Air	WMECO	1.00	1.00	0.85	0.75	0.75	n/a	n/a	custom	custom

[492] Energy & Resource Solutions (2005). *Measure Life Study*. Prepared for The Massachusetts Joint Utilities; Table 1-2.

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Measure	PA	ISR	SPF	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	CF_{SSP}	CF_{WSP}
Process	WMECO	1.00	1.00	0.76	0.84	0.89	n/a	n/a	custom	custom
C&I Small Retrofit										
Lighting	National Grid	1.00	1.00	1.03	1.04	1.12	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	CLC	1.00	1.00	1.02	0.99	0.99	custom	custom	n/a	n/a
Street Lighting	CLC	1.00	1.00	1.00	1.00	1.00	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	1.00	1.00	0.89	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	1.02	0.99	0.99	custom	custom	n/a	n/a
Non-Lighting	Unitil	1.00	1.00	1.02	1.00	1.00	custom	custom	n/a	n/a
Lighting	WMECO	1.00	1.00	0.73	0.98	0.98	n/a	n/a	0.67	0.72
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
C&I NC and C&I Large Retrofit
- Comprehensive: Realization rates from statewide impact evaluation completed in 2011.[493] National Grid uses PA specific values, all other PA's use statewide values due to small sample size.
- HVAC: Realization rates from statewide impact evaluation completed in 2011. [494] National Grid and NSTAR use PA specific values, all other PA's use statewide values due to small sample size.
- Compressed Air: Realization rates from statewide impact evaluation completed in 2012.[495] All PA's use statewide values due to poor precision on a PA level.
- Process: Realization rates from statewide impact evaluation completed in 2012.[496] National Grid and NSTAR use PA specific values, all other PA's use statewide values due to small sample size.
- Lighting: Realization rates from statewide impact evaluation completed in 2012.[497] National Grid and NSTAR use PA specific values, all other PA's use statewide values due to small sample size.
- Motor, Other, and Refrigeration: Realization rates based on previous PA-specific impact evaluations. No statewide evaluations have been performed for these categories:
    - National Grid rates from impact evaluation analysis of the National Grid 2009 custom program. [498] Motor, Other and Refrigeration projects are included in the Process populations.

[493] KEMA (2011). *Impact Evaluation of 2008 and 2009 Custom CDA Installations.* Prepared for Massachusetts program administrators; Table 9
[494] KEMA and DMI (2011). Impact Evaluation of 2009 Custom HVAC Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[495] KEMA (2012). Impact Evaluation of 2010 Custom Process and Compressed Air Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[496] Ibid.
[497] KEMA (2012). Impact Evaluation of the 2010 Custom Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council.
[498] KEMA (2010). Sample Design and Impact Evaluation Analysis of the 2009 Custom Program. Prepared for National

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- NSTAR, CLC rates from NSTAR impact evaluation of large C&I 2006 programs. [499]
- Unitil RRs have not been evaluated for this program so 100% is used.
- WMECO RRs from impact evaluation of 2004 Custom Services program.[500] Demand realization rates are assumed to be the same as energy realization rates.

- CHP: NSTAR and National Grid CHP RRs from National Grid / NSTAR impact evaluation of CHP 2010 projects.[501]
- WMECO: RRs are from 2007/2008 Large C&I Programs impact evaluation[502]

C&I Small Retrofit:

- National Grid RRs derived from impact evaluation of 2005 SBS program[503] and weighted by 2011 measure mixes.
- NSTAR and CLC lighting RRs from the 2011 Small C&I Non-Controlled Lighting impact evaluation[504]; non-lighting energy and all demand RRs based on NSTAR 2002–2004 small retrofit impact evaluations
- Unitil RRs from a 2008 small Business program impact evaluation.[505]
- WMECO: RRs from impact evaluation of 2008 small retrofit program.[506]

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.

Grid; Table 17.

[499] RLW Analytics (2008). *Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report*. Prepared for NSTAR; Tables 14-18.

[500] RLW Analytics (2006). *Custom Services Impact Evaluation - Final Report: 2004 Measure Installations*. Prepared for Northeast Utilities.

[501] KEMA (2012). *2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo.* Prepared for National Grid and NSTAR; Table 1-1

[502] KEMA (2010). *2007/2008 Large C&I Programs,* Prepared for Western Massachusetts Electric Company.

[503] RLW Analytics (2007). Small *Business Services Custom Measure Impact Evaluation*. Prepared for National Grid; Table 4.

[504] Cadmus Group (2012). *Non-Controls Lighting Evaluation for the Massachusetts Small Commercial Direct Install Program: Multi-Season Study.* Prepared for Massachusetts Utilities.

[505] Summit Blue Consulting, LLC. (2008). *Multiple Small Business Services Programs Impact Evaluation 2007*. Prepared for Massachusetts Joint Utilities.

[506] The Cadmus Group, Inc. (2010), *Western Massachusetts SBEA Evaluation Report Year 2008*. Prepared for Western Massachusetts Electric Company.

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Residential Natural Gas Efficiency Measures

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HVAC – Boiler (Forced Hot Water)

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
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
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 high efficiency boiler
ΔMMBtu = Annual MMBtu savings high efficiency boiler. See Table 11 for values.

Table 11: Savings for Residential Boilers

Measure	ΔMMBtu/Unit
Boiler (AFUE >= 85%)	7.2[507]
Boiler (AFUE >= 90%)	13.7[508]
Boiler (AFUE >= 95%)	21.3[509]

Baseline Efficiency

The baseline efficiency case is an 80% AFUE boiler.

High Efficiency

The high efficiency case is a boiler with an AFUE of 85% or greater.

Hours

Not applicable.

Measure Life

The measure life is 20 years.[510]

[507] Nexus Market Research (2010). HEHE Process and Impact Evaluation. Prepared for GasNetworks.
[508] Ibid.
[509] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[510] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers*. Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?c=boilers.pr_proc_boilers.

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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}
Boiler (AFUE >=85%)	Residential Heating and Water Heating	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Boiler (AFUE >=90%)	Residential Heating and Water Heating	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Boiler (AFUE >=95%)	Residential Heating and Water Heating	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 – Boiler Reset Controls (Retrofit only)

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 (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[511]

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.[512]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[511] ACEEE (2006). *Emerging Technologies Report: Advanced Boiler Controls*. Prepared for ACEEE; Page 2.
[512] 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}
Boiler Reset Controls	Residential Heating and Water Heating	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 – Early Replacement Boiler

Version Date and Revision History

Effective Date: 1/1/2011
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: Refer to Appendix D: Non-Resource Impacts
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 new code-compliant boiler compared to existing boiler: 9.0 MMBtu[513]
$\Delta MMBtu_{EE}$	=	Annual MMBtu savings of high efficiency boiler compared to new code-compliant boiler: 15.0 MMBtu[514]

Baseline Efficiency

For the retirement savings over the remaining life of existing boiler, the baseline is the existing inefficient boiler. For the high efficiency unit savings over lifetime of the new boiler, the baseline is a code-compliant boiler (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%).

Hours

Not applicable.

[513] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[514] Ibid.

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Measure Life

The remaining life of an existing unit is 14 years.[515] The measure life of new equipment is 20 years.[516]

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 Boiler	Residential Heating and Water Heating	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.

[515] Massachusetts Common Assumption: The remaining life of 14 years was determined by subtracting the average age of existing equipment (estimated by program vendor at 26 years) form the full lifetime of standard efficiency boilers (estimated by program vendor at 40 years).
[516] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers*. Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?c=boilers.pr_proc_boilers.

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HVAC – Programmable 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: Refer to Appendix D: Non-Resource Impacts
Sector: Residential
Market: Retrofit
End Use: HVAC
Program: Residential Heating and Water Heating, Home Energy Services, Multifamily Retrofit (not National Grid or NSTAR), Low-Income Multifamily Retrofit (not National Grid on NSTAR)

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: 7.7 MMBtu[517]

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.

Measure Life

The measure life is 15 years.[518]

[517] RLW Analytics (2007). *Validating the Impacts of Programmable Thermostats*. Prepared for GasNetworks; Page 2, conversion factor CCF to Therms is 1.024.
[518] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.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}
Programmable Thermostats	Residential Heating and Water Heating	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 – Furnace (Forced Hot Air) with ECM

Version Date and Revision History

Effective Date: 1/1/2011
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: Refer to Appendix D: Non-Resource Impacts
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 for a furnace with ECM. See Table 12 for values.

Table 12: Savings for Residential Furnaces

Measure	ΔMMBtu
Furnace w/ECM (AFUE = 92%)	12.7 [519]
Furnace w/ECM (AFUE = 94%)	15.3 [520]
Furnace w/ECM (AFUE = 96%)	20.7 [521]

Baseline Efficiency

The baseline efficiency case is a 78% AFUE furnace.

High Efficiency

The high efficiency case is a new furnace with AFUE >= 92% with an electronically commutated motor installed.

Hours

Not applicable.

[519] Nexus Market Research (2010). HEHE Process and Impact Evaluation. Prepared for GasNetworks.
[520] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks; value adjusted based on results of "Nexus Market Research (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks."
[521] Ibid.

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Measure Life

The measure life is 18 years.[522]

Secondary Energy Impacts

High efficiency furnaces equipped with ECM fan motors also save electricity from reduced fan energy requirements. Please refer to the HVAC – Warm Air Furnace Electronically Commutated Motor (ECM) measure in the Residential Electric section for more details.

Non-Energy Impacts

There are no non-energy impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings

Measure	Program	PA	ISR	SPF	RRE	RRSP	RRWP	CFSP	CFWP
Furnace w/ECM	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.

[522] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Furnaces.xls.

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HVAC – Heat Recovery Ventilator

Version Date and Revision History

Effective Date: 1/1/2011
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: None
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 [523]

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.[524]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[523] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[524] 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}
Heat Recovery Ventilator	Residential Heating and Water Heating	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 – Water Heaters

Version Date and Revision History

Effective Date: 1/1/2011
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: Refer to Appendix D: Non-Resource Impacts
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:

$$\Delta MMbtu = \Delta MMbtu$$

Where:
Units = Number of water heaters installed
ΔMMBtu = Annual MMBtu savings per stand alone storage water heater. See Table 13 for values.

Table 13: Savings for Residential Water Heaters

Equipment Type	Efficiency Requirement	ΔMMBtu
Condensing Water Heater	EF >=0.80	7.4 [525]
	TE >=95	25.0 [526]
Indirect Water Heater	ENERGY STAR® Boiler	8.0 [527]
Stand-Alone Storage Water Heater	EF >= 0.62	1.9 [528]
	EF >= 0.67	3.7 [529]
On-Demand Tankless Water Heater	EF >= 0.82	9.7 [530]
	EF >= 0.95	10.3 [531]

[525] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.
[526] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[527] Nexus Market Research and The Cadmus Group (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks.
[528] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.
[529] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.
[530] Nexus Market Research and The Cadmus Group (2010). *HEHE Process and Impact Evaluation*. Prepared for GasNetworks.
[531] 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.

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 life is 13 years for the stand-alone storage water heaters, 15 years for the condensing water heater, and 20 years for the indirect water heater and tankless water heaters [532].

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	RRE	RRSP	RRWP	CFSP	CFWP
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. 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.

[532] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 11.

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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 (Residential Heat)
Secondary Energy Impact: None
Non-Energy Impact: Refer to Appendix D: Non-Resource Impacts
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 integrated water heater/boiler unit
ΔMMBtu = Annual MMBtu savings per unit: See Table **14**.

Table 14: Savings for Residential Combo Water Heater/Boilers

Measure	ΔMMBtu
Combo Water Heater/Non-Condensing Boiler	13.5[533]
Combo Water Heater/Condensing Boiler	21.1[534]

Baseline Efficiency

The baseline efficiency case is an 80% AFUE boiler with a 0.594 EF water heater.

High Efficiency

The high efficiency cases are an integrated water heater/non-condensing boiler with an 85% AFUE boiler and a 0.86 EF water heater and an integrated water heater/condensing boiler with a 90% AFUE boiler and a 0.9 EF water heater.

Hours

Not applicable.

[533] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[534] Ibid.

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Measure Life

The measure life is 20 years.[535]

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}
Combo Water Heater/Non-Condensing Boiler	Residential HEHE	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Combo Water Heater/Condensing Boiler	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.

[535] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers*. Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?c=boilers.pr_proc_boilers; measure life assumed to be the same as a boiler.

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HVAC – Gas Heating System Replacement (Low Income)

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: Refer to Appendix D: Non-Resource Impacts
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	=	Average annual MMBtu savings per unit: 19.9[536]

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[537] for new furnaces and 20 years[538] for new boilers.

Secondary Energy Impacts

Unit electric savings are deemed based on study results.

[536] The Cadmus Group, Inc (2012). *Low Income Single Family Impact Evaluation*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[537] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Furnaces.xls.
[538] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers*. Interactive Excel Spreadsheet found at http://www.energystar.gov/index.cfm?c=boilers.pr_proc_boilers.

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PA	ΔkWh/Unit	ΔkW/Unit
All	172[539]	0.050[540]

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 the Cadmus Demand Impact Model [541]

[539] The Cadmus Group, Inc (2012). *Low Income Single Family Impact Evaluation*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[540] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[541] The Cadmus Group, Inc. (2012). *Demand Impact Model.* Prepared for the Massachusetts Program Administrators.

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HVAC –Weatherization (Low Income)

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: Refer to Appendix D: Non-Resource Impacts
Sector: Low Income
Market: Retrofit
End Use: HVAC
Program: Low-Income Single Family Retrofit, Low-Income Multifamily Retrofit (CLC Only)

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[542]

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[543].

[542] The Cadmus Group, Inc (2012). *Low Income Single Family Impact Evaluation*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[543] 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 Impact

Unit savings are deemed based on study results.

PA	ΔkWh	ΔkWheat	ΔkWcool
All	344[544]	0.059[545]	0.048[546]

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	1.00
Weatherization (Gas)	LI MF Retrofit	CLC	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
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 [547,548]

[544] The Cadmus Group, Inc (2012). *Low Income Single Family Impact Evaluation*. Prepared for the Electric and Gas Program Administrators of Massachusetts.
[545] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[546] Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators.
[547] The Cadmus Group, Inc. (2012). *Demand Impact Model*. Prepared for the Massachusetts Program Administrators.
[548] 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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ENERGY STAR® Homes – Heating, Cooling, and DHW Measures

Version Date and Revision History

Effective Date: 1/1/2011
End Date: 12/31/2011

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."[549]

Baseline Efficiency

The User Defined Reference Home was revised for 2006 as a result of the baseline study completed in 2006.[550] [551]

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.

[549] ICF International (2008). *Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR ® Homes Program*. Prepared for Joint Management Committee.
[550] Nexus Market Research & Dorothy Conant (2006). *Massachusetts ENERGY STAR® Homes: 2005 Baseline Study: Part I: Inspection Data Analysis Final Report*. Prepared for the Massachusetts Joint Management Committee.
[551] 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.

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Measure Life

Measure Type	Measure Life (years)[552]
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	custom	custom
ES Homes – Heating	RNC, LI RNC	All	1.00	1.00	1.00	1.00	1.00	custom	custom
ES Homes – Water Heating	RNC, LI RNC	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 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.

[552] Massachusetts Common Assumption.

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Behavior – OPOWER Gas

Version Date and Revision History

Effective Date: 1/1/2011
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

Notes

Only National Grid and NSTAR provide a Behavior/Feedback program for gas customers in PY 2011. Both PAs use OPOWER. The PAs conducted an impact and process evaluation of the 2009-2010 National Grid Pilot cohort and of all National Grid and NSTAR cohorts in 2011. The results of these impact evaluations are used for reporting on the 2011 program year.

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 below.
$MMbtu_{BASE}$ = Average baseline consumption MMBtu per unit. See Table below.
%SAVE = Annual percent of MMBtu savings per unit. See Table below.

Behavior/Feedback Program - Gas Savings Factors

PA	Measure Name	$MMbtu_{BASE}$	%SAVE	ΔMMBtu/Unit
National Grid	OPOWER Group 2009 Pilot	137.2	1.25	1.715
National Grid	OPOWER Group 2010 October	135	1.25	1.688
National Grid	OPOWER Group 2011 October	102.7	0.99	1.017
National Grid	OPOWER Group 2012 October	80.4	0.99	0.796
NSTAR	OPOWER Group 2010 August	55.7	0.94	0.53
NSTAR	OPOWER Group 2011 January	121.5	1.50	1.82

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.

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Hours

Not applicable.

Measure Life

The measure life is 1 year.

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}
Participant Group	Behavior/Feedback	National Grid	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Participant 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.

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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: Refer to Appendix D: Non-Resource Impacts
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
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factor
Coincidence factors are based on Massachusetts Common Assumptions.

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Multifamily – Air Sealing (National Grid)

Version Date and Revision History

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: Refer to Appendix D: Non-Resource Impacts
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

$$\Delta MMBtu = BldgVolume \times \left(ACH_{PRE} - ACH_{POST}\right) \times HDD \times 24 \times 0.018 \times \frac{CorrectionFactor}{SeasonalEff} \times \frac{1}{1{,}000{,}000}$$

Where:

$CFM50_{PRE}$	=	CFM50 measurement before air sealing (ft^3/min)
$CFM50_{POST}$	=	CFM50 measurement after air sealing (ft^3/min)
LBL	=	LBL Factor[553]
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.

[553] 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.[554]

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.

[554] 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 (National Grid)

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: Refer to Appendix D: Non-Resource Impacts
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[555]
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 [556]
Stand-Alone Storage Water Heater	13 [557]
On-Demand Tankless Water Heater	20 [558]

[555] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[556] Ibid.
[557] DOE (2008). *ENERGY STAR® Residential Water Heaters: Final Criteria Analysis*. Prepared for the DOE; Page 10.
[558] 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 (National Grid)

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, Refer to Appendix D: Non-Resource Impacts
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 15.
ΔMMBtu/Unit = Annual MMBtu savings per unit. See Table 15.

Table 15: Savings for MF DHW Measures

Measure	Unit	ΔMMBtu[559]
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.[560]

[559] Savings assumptions from National Grid program vendor.

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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 [561]	3,696 gallons/unit
Annual Resource	Residential water savings for faucet aerators [562]	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	0.945	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.

[560] Massachusetts Common Assumption.
[561] NMR Group and Tetra Tech (2011). *Residential and Low-Income Non-Energy Impacts (NEI) Evaluation* Prepared for MA Program Administrators
[562] Ibid.

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Multifamily – Duct Systems (National Grid)

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: Refer to Appendix D: Non-Resource Impacts
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 16.
1/1,000,000 = Conversion from Btu to MMBtu

Table 16: Savings Factors for MF Duct Systems

Measure Type	%SAVE[563]
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.[564]

[563] Savings assumptions from National Grid program vendor.
[564] 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 (National Grid)

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: Refer to Appendix D: Non-Resource Impacts
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.

Table 17: Baseline Efficiencies for MF Heat System Equipment

Equipment Type	$AFUE_{BASE}$ [565]
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).

[565] 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 [566]
Furnace	18 [567]

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.

[566] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers.*
[567] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Furnace.*

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Multifamily – Other Insulation (National Grid)

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.

Table 18: Savings for MF Other Insulation

Measure	Unit	ΔMMBtu[568]
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.[569]

[568] Savings assumptions from National Grid program vendor.
[569] 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 (National Grid)

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: Refer to Appendix D: Non-Resource Impacts
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

Table 19: Savings for MF Pipe Insulation

Measure	Unit	MMBtu/LF[570]
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.[571]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[570] Savings assumptions from National Grid program vendor.
[571] 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 (National Grid)

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: Refer to Appendix D: Non-Resource Impacts
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: $R_{CEILING} = 3.36$; $R_{FLOOR} = 6.16$; $R_{WALL} = 6.65$)[572].

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.

[572] Savings assumptions from National Grid program vendor.

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Measure Life

The measure life is 25 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 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.

[573] 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 (National Grid)

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: Refer to Appendix D: Non-Resource Impacts
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 20.
1/1,000,000	=	Conversion from Btu to MMBtu

Table 20: Savings for MF Thermostats

Equipment Type	%SAVE[574]
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 15 years.[575]

[574] Savings assumptions from National Grid program vendor.
[575] 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	0.69	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.

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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: Refer to Appendix D: Non-Resource Impacts
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[576]
Exterior Doors	25[577]
Shell Insulation	25[578]
Thermostats	15 [579]
Duct and Pipe Insulation	15 [580]
Showerheads	7[581]
Aerator	7[582]

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	All	1.00	1.00	1.00	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
Insulation	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
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.

[576] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[577] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks.
[578] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[579] Environmental Protection Agency (2010). *Life-Cycle Assessment for Thermostats*.
[580] GDS Associates, Inc. (2007). *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group.
[581] Massachusetts Common Assumption
[582] Ibid.

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Commercial and Industrial Natural Gas Efficiency Measures

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HVAC – Programmable Thermostat

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a 7-day programmable thermostats 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[583]

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 an ENERGY STAR® labeled or 7-day programmable thermostat installed.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[584]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[583] RLW Analytics (2007). *Validating the Impacts of Programmable Thermostats*; Page 2, conversion factor CCF to Therms is 1.024.
[584] Environmental Protection Agency (2010). *Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat*. Interactive Excel Spreadsheet found at www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls.

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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}
Programmable Thermostat	C&I Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat	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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HVAC – Boiler Reset Controls (Retrofit only)

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[585]

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 20 years.[586]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[585] 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.
[586] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts*. Prepared for GasNetworks; the study references "KEMA (2003). *CA Statewide Commercial Sector NG EE Potential Study, Study ID #SW061*. Prepared for PG&E; Appendix D."

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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}
Boiler Reset Controls	C&I Retrofit	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Boiler Reset Controls	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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HVAC – Condensing Unit Heater

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 of 151 – 400 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[587]

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.[588]

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.[589]

[587] 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.
[588] ASHRAE Standard 90.1-2007; Table 6.8.1E.
[589] Ecotope (2003). *Natural Gas Efficiency and Conservation Measure Resource Assessment*. Prepared for the Energy Trust of Oregon.

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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}
Condensing Unit 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 – Gas-Fired Low Intensity Infrared Heating

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: 22.3 MMBtu[590]

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.[591]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[590] KEMA (2012). *Prescriptive Gas Program Final Evaluation Report*. Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-4.
[591] GDS Associates, Inc. (2004). *The Maximum Achievable Cost-Effective Potential Gas DSM*. 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 Heating Unit	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 – High Efficiency Natural Gas Boiler

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a high efficiency natural gas fired steam boiler or hot water boiler. High-efficiency boilers can take advantage of improved design, sealed combustion and condensing flue gases in a second heat exchanger to achieve improved efficiency. This measure incorporates steam boilers, condensing boilers and hydronic boilers of all capacities.
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 high efficiency boiler
ΔMMBtu = Average annual MMBtu savings per unit. See Table 21 for values.

Table 21: MMBtu Savings by Boiler Type[592], [593]

Boiler Type/Size	ΔMMBTU/Unit
Steam Boiler 82% AFUE or greater	36.5
Condensing Boiler <=300 MBH - 90% AFUE or greater	29.8
Condensing Boiler 301-499 MBH - 90% thermal efficiency or greater	56.9
Condensing Boiler 500-999 MBH - 90% thermal efficiency or greater	104.6
Condensing Boiler 1000-1700 MBH - 90% thermal efficiency or greater	192.1
Condensing Boiler 1701+ MBH - 90% thermal efficiency or greater	336.2
Hydronic Boiler <= 300 MBH – 85% AFUE or greater	16.8
Hydronic Boiler 301-499 MBH – 85% thermal efficiency or greater	35.3
Hydronic Boiler 500-999 MBH – 85% thermal efficiency or greater	66.2
Hydronic Boiler 1000-1700 MBH – 85% thermal efficiency or greater	119.1
Hydronic Boiler 1701+ MBH – 85% thermal efficiency or greater	150.0

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

[592] Opinion Dynamics Corporation (2007). *Evaluation Study of KeySpan's Commercial and Industrial High Efficiency Heating Equipment Program, Final*. Prepared for KeySpan Energy Delivery; Page 40.
[593] KEMA (2012). *Prescriptive Gas Program Final Evaluation Report*. Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-2.

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specific baseline data, but the baseline information is provided here for use in the future when 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 with the 2007 Supplement or ASHRAE 90.1-2007. The requirements for gas-fired boilers differ slightly between the two, so the less stringent requirements as presented in IECC 2006 are referenced below. Table 22 details the specific efficiency requirements by equipment type and capacity.

Table 22: Boilers, Gas-Fired, Minimum Efficiency Requirements[594]

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency [a]
Boiler, Gas-Fired	<300,000 Btu/h	Hot Water	80% AFUE
		Steam	75% 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
		Steam	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.[595]

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 Boiler	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Hydronic Boiler	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Steam Boiler	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.

[594] Adapted form 2007 Supplement to the 2006 International Energy Conservation Code; Page 15, Table 503.2.3(5),.
[595] ASHRAE Applications Handbook (2003); Page 36.3.

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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 – High Efficiency Natural Gas Warm Air Furnace

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a high efficiency natural gas warm air furnace with or without 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 warm air furnace
ΔMMBtu = Average annual MMBtu savings per unit. See Table 23 for values.

Table 23: MMBtu Savings by Furnace Type[596]

Boiler Type/Size	ΔMMBTU
Furnace AFUE => 92%	5.9
Furnace AFUE => 92% w/ ECM	5.5
Furnace AFUE => 94% w/ ECM	6.2

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) 2006 with the 2007 Supplement or ASHRAE 90.1-2007. The two documents present nearly identical requirements for gas-fired furnaces, so only the requirements as presented in IECC 2006 are referenced below. Table 24 details the specific efficiency requirements by equipment type and capacity.

[596] KEMA (2012). *Prescriptive Gas Program Final Evaluation Report*. Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-3.

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Table 24: High Efficiency Natural Gas Warm Air Furnace Minimum Efficiency Requirements[597]

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.[598]

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 127 kWh[599].

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}
HE Natural Gas Furnace	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
HE Natural Gas Furnace w/ ECM	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.

[597] Adapted form 2006 International Energy Conservation Code; Page 36, Table 503.2.3(4).
[598] ASHRAE Applications Handbook (2003); Page 36.3.
[599] The heating penalty of 5.9 – 5.5 MMBTU is equivalent to 127 kWH for the 92% efficient furnace (400,000BTU/(0.92*3413 BTU/kWH).

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Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

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HVAC/Hot Water – Combined High Efficiency Boiler and 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
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 MMBtu savings per unit. See Table 25 for values.

Table 25: MMBtu Savings by Boiler/Water Heater Combo Type[600]

Boiler/Water Heater Combo Type	ΔMMBTU
Integrated water heater/condensing boiler (0.86 EF, 0.85 AFUE)	20.0
Integrated water heater/condensing boiler (0.86 EF, 0.90 AFUE)	24.6

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% or >=85%.

Hours

Not applicable.

Measure Life

The measure life is 25 years.[601]

[600] Based on an analysis conducted by Summit Blue, Inc. See "SB Gas Networks Calculations for Combined HVAC and DHW.xlsx" for source calculations.

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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}
Integrated Water Heater/Condensing Boiler	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.

[601] ASHRAE Applications Handbook (2003); Page 36.3, assumes combined boiler and water heating systems have a measure life similar to a typical boiler.

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Hot Water – Condensing Stand-Alone Water Heater

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of a condensing stand alone water heater with a capacity between 75-300 MBH and thermal efficiency of 95% or greater.
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:

$$\Delta MMBtu = \Delta MMBtu$$

Where:

Unit	=	Installed condensing stand-alone water heater
ΔMMBtu	=	Average annual MMBtu savings per unit (75,000 – 300,000 BTU) installed: 25.0 MMBtu[602]

Baseline Efficiency

The baseline efficiency case is a stand alone tank water heater with a thermal efficiency of 80%.[603]

High Efficiency

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.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[604]

[602] 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."
[603] ASHRAE Standard 90.1-2007; Table 7.8
[604] 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."

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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}
Condensing Stand-Alone Water 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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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[605]

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.[606]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[605] SBW Consulting (2004). *EM&V 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.
[606] 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
C&I Water	C&I water savings [607]	62,305 Gallons/Unit
C&I Sewer	C&I sewer water savings [608]	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.

[607] SBW Consulting (2004). *EM&V 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.
[608] Ibid.

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Hot Water – Repair/Replace Malfunctioning Steam Trap

Version Date and Revision History

Effective Date: 1/1/2011
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, Process
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[609]

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 1 year.[610]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

[609] Massachusetts Common Assumption 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.
[610] Massachusetts Common Assumption.

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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	All	C&I 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 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

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[611]

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.[612]

[611] US DOE: Federal Energy Management Program (2010). *Cost Calculator for Faucets & Shower Heads*. http://www1.eere.energy.gov/femp/technologies/eep_faucets_showerheads_calc.html#output. Accessed on 4/6/2010 using baseline 2.5 gpm and retrofit model at 1.5 gpm. Also supported by: GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; measure C-WH-15.

[612] US DOE: Federal Energy Management Program (2010). *Cost Calculator for Faucets & Shower Heads*. http://www1.eere.energy.gov/femp/technologies/eep_faucets_showerheads_calc.html#output. Accessed on 4/6/2010; Optimal Energy, ACEEE, VEIC, Resource Insight and Energy & Environmental Analysis (2006). Natural Gas Energy Efficiency Resource Development Potential in New York- Final Report. Prepared for NYSERDA; Page 27, Appendix B.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings
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.

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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

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[613]

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.[614]

[613] US DOE: Federal Energy Management Program (2010). *Cost Calculator for Faucets & Shower Heads.* http://www1.eere.energy.gov/femp/technologies/eep_faucets_showerheads_calc.html#output. Accessed on 4/6/2010 using baseline 2.2 gpm and retrofit model at 1.5 gpm. Same results also form: GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; measure C-WH-15.
[614] US DOE: Federal Energy Management Program (2010). *Cost Calculator for Faucets & Shower Heads.* http://www1.eere.energy.gov/femp/technologies/eep_faucets_showerheads_calc.html#output. Accessed on 4/6/2010; Optimal Energy, ACEEE, VEIC, Resource Insight and Energy & Environmental Analysis (2006). Natural Gas Energy Efficiency Resource Development Potential in New York- Final Report. Prepared for NYSERDA; Page 27, Appendix B.

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Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings	Notes
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.

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Hot Water – High Efficiency Indirect Water Heater

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a high-efficiency indirect 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.
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:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency indirect water heater
ΔMMBtu = Average annual MMBtu savings per unit: 20.7 MMBtu[615]

Baseline Efficiency

The baseline efficiency case is a code compliant gas-fired storage water heater with an assumed energy factor of 0.59. 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 with the 2007 Supplement or ASHRAE 90.1-2007. 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.

High Efficiency

The high efficiency scenario is an indirect water heater with a Combined Appliance Efficiency (CAE) of 85% or greater.

Hours

Not applicable.

Measure Life

The measure life is 15 years.[616]

[615] KEMA (2012). *Prescriptive Gas Program Final Evaluation Report*. Prepared for Massachusetts Energy Efficiency Program Administrators; Page 1-4.

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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}
HE Indirect Water 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.

[616] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Appendix B-2.

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Hot Water – High Efficiency Tankless Water Heater

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a high-efficiency tankless water heater with electronic ignition and an Energy Factor of at least 0.82. 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:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency tankless water heater
ΔMMBtu = Average annual MMBtu savings per unit: 7.1 MMBtu[617]

Baseline Efficiency

The baseline efficiency case is a code compliant gas-fired storage water heater with an assumed Energy Factor of 0.59. The baseline efficiency 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) 2006 with the 2007 Supplement or ASHRAE 90.1-2007. 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.

High Efficiency

The high efficiency equipment is a gas-fired instantaneous hot water heater with an Energy Factor of at least 0.82.

Hours

Not applicable.

[617] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Appendix B-2.

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Measure Life

The measure life is 20 years.[618]

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}
Tankless Water 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.

[618] 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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Hot Water – High Efficiency Free Standing Water Heater

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: The installation of a high efficiency ENERGY STAR® freestanding water heater with an Energy Factor of at least 0.62, a nominal input of 75,000 BTU/hour, or less and a rated storage volume from 20 to 100 gallons.
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:

$$\Delta MMBtu = \Delta MMBtu$$

Where:
Unit = Installed high efficiency free-standing water heater
ΔMMBtu = Average annual MMBtu savings per unit: 0.76 MMBtu[619]

Baseline Efficiency

The baseline efficiency case is a code compliant gas-fired free standing water heater with an assumed Energy Factor of 0.594. The baseline efficiency 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) 2006 with the 2007 Supplement or ASHRAE 90.1-2007. 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.

High Efficiency

The high efficiency case is an ENERGY STAR® gas-fired freestanding hot water heater with an Energy Factor of at least 0.62 and a nominal input of 75,000 BTU/hour.

Hours

Not applicable.

Measure Life

The measure life is 10 years.[620]

[619] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Appendix A-2.

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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}
HE Free Standing Water 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.

[620] GDS Associates, Inc. (2009). *Natural Gas Energy Efficiency Potential in Massachusetts.* Prepared for GasNetworks; Appendix A-2.

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Food Service – Commercial Gas-Fired Oven

Version Date and Revision History

Effective Date: 1/1/2011
End Date: TBD

Measure Overview

Description: Installation of High Efficiency Gas Ovens
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 oven
ΔMMBtu = Average annual MMBtu savings per unit. See Table 26 for values.

Table 26: Baseline and High Efficiency Ratings and MMBtu Savings by Oven Type

Oven Type	Baseline Efficiency	High Efficiency	ΔMMBTU[621]
High Efficiency Gas Convection Oven	30%	>= 40%	24.8[622]
High Efficiency Gas Combination Oven	35% Heavy Load	>= 40%	40.3
High Efficiency Gas Conveyer Oven	20% Heavy Load	>= 40%	84.5
High Efficiency Gas Rack Oven	30%	>= 50%	211.3

Baseline Efficiency

The baseline efficiency case is a standard efficiency oven. See Table 26 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 26.

Hours

Not applicable.

Measure Life

The measure life is 12 years for both convection and combination ovens. [623]

[621] 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.
[622] CEE (2008). *Technology Opportunity Assessment: Convection Ovens*; Page 5.

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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}
HE Gas Convection Oven (>=40%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
HE Gas Combination Oven (>=40%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
HE Gas Conveyer Oven (>=40%)	C&I NC	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
HE Gas 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.

[623] 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.

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Food Service – Commercial Gas-Fired 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[624]

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.[625]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

There are no non-energy impacts for this measure.

[624] 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.
[625] 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[626]
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.
B_{EE}	=	Efficiency equipment daily fryer idle time (hours). Default 13.44 hrs.
$IDLE_{EE}$	=	Efficient equipment idle energy rate (Btu/h).
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[627].

[626] Environmental Protection Agency (2009). *Life Cycle Cost Estimate for ENERGY STAR Gas Fryer.* Interactive Excel Spreadsheet found at http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Commercial_Gas_Fryers.xls.
[627] 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.[628]

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}
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.

[628] Ibid.

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Food Service – Commercial Gas-Fired Steamer

Version Date and Revision History

Effective Date: 1/1/2011
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
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:

$$\Delta MMBtu = (PANS)(SAVE)$$

Where:

Unit	=	Installed high efficiency gas-fired steamer
ΔMMBtu	=	Average annual MMBTU savings for default condition of three pans: 153.6 MMBtu
PANS	=	Efficient equipment number of pans. Default is 3 pans.
SAVE	=	Average savings per pan: default of 51.2 MMBtu[629].

Baseline Efficiency

The baseline efficiency case is a typical boiler-based steamer with the following operating parameters: Preheat Energy = 18,000 Btu, Idle Energy Rate = 3,667 Btu/h/pan, Heavy Load Efficiency = 15.0%, Production Capacity = 21.7 lbs/h/pan, Average Water Consumption Rate = 40 gal/h, and Percentage of Time in Constant Steam Mode = 90%.[630]

High Efficiency

The high efficiency case is an ENERGY STAR® qualified gas-fired steamer with the following operating parameters: Preheat Energy = 7,000 Btu, Idle Energy Rate = 2,083 Btu/h/pan, Heavy Load Efficiency =

[629] Food Service Technology Center (2010). *Gas Steamer Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/gsteamercalc.php. Accessed on 10/20/2010; the estimated annual MMBtu savings per pan is derived using the referenced cost calculator and the operating parameters described in the Baseline Efficiency, High Efficiency, and Hours sections. The savings per pan is found by averaging the per pan savings estimates for 3-,4-,5-, and 6-pan steamers.
[630] Food Service Technology Center (2010). *Gas Steamer Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/gsteamercalc.php. Accessed on 10/20/2010.

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38.0%, Production Capacity = 18.3 lbs/h/pan, Average Water Consumption Rate = 3.0 gal/h, and Percentage of Time in Constant Steam Mode = 0%.[631]

Hours

The deemed savings assumes 4,380 annual operating hours (12 hours a day * 365 days/year). [632]

Measure Life

The measure life is 10 years.[633]

Secondary Energy Impacts

There are no secondary energy impacts for this measure.

Non-Energy Impacts

Benefit Type	Description	Savings[634]
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.

[631] Ibid.
[632] Consortium for Energy Efficiency (2010). *Program Design Guidance: Steamers*.
[633] Ibid.
[634] Food Service Technology Center (2010). *Gas Steamer Life-Cycle Cost Calculator.* http://www.fishnick.com/saveenergy/tools/calculators/gsteamercalc.php. Accessed on 10/20/2010; the estimated water savings is derived using the referenced cost calculator and the operating parameters described in the Baseline Efficiency, High Efficiency, and Hours sections. The savings per pan is found by averaging the per pan savings estimates for 3-,4-,5-, and 6-pan steamers.

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Custom Measures

Version Date and Revision History

Effective Date: 1/1/2011
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

Notes

The PAs started an impact evaluation in 2010 for the Custom Gas Measures. This impact evaluation will provide PA-specific energy realization rates. This impact evaluation will be completed in July 2011 and the new realization rates will be use for reporting on the 2011 program year results.

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.

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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.

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	0.676	n/a	n/a	n/a	n/a
Custom NC	NC	NSTAR	1.00	1.00	0.473	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	0.676	n/a	n/a	n/a	n/a
Custom Retrofit	Retrofit	NSTAR	1.00	1.00	0.473	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 are from 2012 impact evaluation of 2010 Custom Gas installations[635]. NSTAR, National Grid and Columbia Gas use PA-specific results; all other PAs use the statewide result.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

[635] 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.

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APPENDICES

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Appendix A: Common Lookup Tables

Table 27: Lighting Power Densities Using the Building Area Method ($WATTS_{b,i}$)[636]

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

Table 28: Lighting Power Densities Using the Space-by-Space Method ($WATTS_{b,i}$)[637]

Common Space Types	Lighting Power Density (W/ft^2)
Office – Enclosed	1.1
Office - Open Plan	1.1
Conference/Meeting/Multipurpose	1.3

[636] IECC 2009 Lighting Provisions, Section 505 Electrical Power and Lighting Systems, Table 505.5.2 Interior Lighting Power Allowances, Lighting provisions pgs.5-6.
[637] 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)
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
Building Specific Space Types	**Lighting Power Density (W/ft2)**
Gymnasium/Exercise Center	
Exercise Area	0.9
Playing Area	1.4
Court House/Police Station/Penitentiary	

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Common Space Types	Lighting Power Density (W/ft^2)
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
Retail	
Sales Area [for accent lighting, see Section 9.6.3(c)]	1.7

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Common Space Types	Lighting Power Density (W/ft^2)
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 29: Default Effective Lighting Hours by Building Type[638]
Values for use when site-specific hours are not available.

Building Type	Annual Operating Hours
Assembly	2,857 (one shift)
Automobile	4,056 (retail)
Big Box	4,057 (retail)
Community College	3,255
Dormitory	3,056
Fast Food	5,110
Full Service Restaurant	5,110
Grocery	6,074
Heavy Industrial	4,057
Hospital	8,036
Hotel	8,583
Large Refrigerated Space	2,602 (warehouse)
Large Office	3,610
Light Industrial	4,730 (two shift)
Motel	8,583
Multi Story Retail	4,089
Multifamily high-rise	7,665 (Common Area)
Multifamily low-rise	7,665 (Common Area)
Other	3,951
Religious	1,955
K-12 Schools	2,596
Small Office	3,610
Small Retail	4,089
University	3,255
Warehouse	3,759

Table 30: Effective Lighting Hours for Upstream Lighting Measures

Lighting Measure	Annual Operating Hours
LED[639]	4,500
T5/T8[640]	3,380

[638] Lighting hours developed form Massachusetts Common Assumptions and *New York Standard Approach for Estimating Energy Savings form Energy Efficiency Programs* (2010).
[639] Hours based on NSTAR LED projects from January 2011 to October 2011.
[640] Average hours of 2010 installations, including New Construction and Retrofit.

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Table 31: Cooling Equivalent Full Load Hours by Building (or Space) Type

Building (or Space) Type	Cooling Full Load Hours (EFLH)
College	542
Convenience	3,653
Fast-Food, 1-Meal	1,810
Fast-Food, 2-Meals	2,072
Fast-Food, 3-Meals	2,295
Grocery	1,299
Hospital	1,575
Hotel	766
Motel	900
Nursing Home	898
Office, Large	1,125
Office, Medium	660
Office, Small	953
Public Assembly	1,044
Religious Worship	495
Restaurant, 1-Meal	969
Restaurant, 2-Meals	1,081
Restaurant, 3-Meals	1,210
Retail, Large	762
Retail, Small	1,047
School	538
Service	520
Warehouse, Non Refrig.	746
Warehouse, Refrig.	775
Other[641]	777

[641] SAIC (1998). *Impact Evaluation of the Design 2000plus Unitary HVAC Program.* Prepared for National Grid

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Table 32: Cooling and Heating Equivalent Full Load Hours by Building (or Space) Type

Facility Type	Cooling Full Load Hours ($EFLH_{cool}$)	Heating Full Load Hours ($EFLH_{heat}$)
Auto Related	837	1,171
Bakery	681	1,471
Banks, Financial Centers	797	1,248
Church	564	1,694
College - Cafeteria	1,139	594
College - Classes/Administrative	646	1,537
College - Dormitory	709	1,418
Commercial Condos	837	1,172
Convenience Stores	1,139	594
Convention Center	564	1,695
Court House	797	1,248
Dining: Bar Lounge/Leisure	854	1,140
Dining: Cafeteria / Fast Food	1,149	574
Dining: Family	854	1,140
Entertainment	564	1,695
Exercise Center	1,069	728
Fast Food Restaurants	1,139	594
Fire Station (Unmanned)	564	1,695
Food Stores	837	1,172
Gymnasium	646	1,537
Hospitals	1,308	270
Hospitals / Health Care	1,307	272
Industrial - 1 Shift	681	1,470
Industrial - 2 Shift	925	1,003
Industrial - 3 Shift	1,172	530
Laundromats	837	1,171
Library	797	1,248
Light Manufacturers	681	1,470
Lodging (Hotels/Motels)	708	1,418
Mall Concourse	938	978
Manufacturing Facility	681	1,470
Medical Offices	797	1,248
Motion Picture Theatre	564	1,695
Multi-Family (Common Areas)	1,306	273
Museum	797	1,248
Nursing Homes	1,069	727
Office (General Office Types)	797	1,248
Office/Retail	797	1,248
Parking Garages & Lots	878	1,094
Penitentiary	1,022	817
Performing Arts Theatre	646	1,537
Police / Fire Stations (24 Hr)	1,306	273
Post Office	797	1,248
Pump Stations	563	1,696
Refrigerated Warehouse	648	1,533
Religious Building	564	1,694

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Facility Type	Cooling Full Load Hours ($EFLH_{cool}$)	Heating Full Load Hours ($EFLH_{heat}$)
Residential (Except Nursing Homes)	709	1,418
Restaurants	854	1,140
Retail	837	1,171
School / University	594	1,637
Schools (Jr./Sr. High)	594	1,637
Schools (Preschool/Elementary)	594	1,637
Schools (Technical/Vocational)	594	1,637
Small Services	798	1,247
Sports Arena	564	1,695
Town Hall	797	1,248
Transportation	1,149	574
Warehouse (Not Refrigerated)	648	1,533
Waste Water Treatment Plant	1,172	530
Workshop	798	1,247

Table 33: EPACT 1992 Baseline Motor Efficiencies[642]

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

[642] Energy Policy Act of 1992

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Table 34: Minimum Premium Efficiency Motors Compliance Efficiencies[643]

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

[643] 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 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 the 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 names into future plan updates.

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Appendix C: Net to Gross Impact Factors

Residential Electric Efficiency Measures					
Measure	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
Residential New Construction & Major Renovation					
Dishwashers	All	89%	0%	0%	11%
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	All	21%	0%	0%	79%
LED Fixture	All	21%	0%	0%	79%
Refrigerators	All	73%	0%	0%	27%
Screw-in Bulbs	All	21%	0%	0%	79%
Residential Cooling & Heating Equipment					
Brushless Furnace Fan Motor	All	15%	0%	0%	85%
CoolSmart AC (SEER >= 15 / EER >= 12.5)	All	15%	0%	0%	85%
CoolSmart AC (SEER >= 15 / EER >= 13)	All	15%	0%	0%	85%
CoolSmart AC (SEER 14.5 / EER 12)	All	15%	0%	0%	85%
CoolSmart AC (SEER 16 / EER 13)	All	15%	0%	0%	85%
CoolSmart AC Digital Check-up/Tune-up	All	15%	0%	0%	85%
CoolSmart AC MS (SEER 16 / EER 13)	All	15%	0%	0%	85%
CoolSmart AC QIV ES	All	15%	0%	0%	85%
CoolSmart AC QIV NES	All	15%	0%	0%	85%
CoolSmart HP (SEER >= 15)	All	15%	0%	0%	85%
CoolSmart HP (SEER 14.5 / EER 12)	All	15%	0%	0%	85%
CoolSmart HP Digital Check-up/Tune-up	All	15%	0%	0%	85%
CoolSmart HP MS (SEER 14.5 / EER 12)	All	15%	0%	0%	85%
CoolSmart HP MS (SEER 19 / EER 12.8 / HSPF 10.1)	All	15%	0%	0%	85%
CoolSmart HP MS (SEER 23 / EER 13 / HSPF 10.6)	All	15%	0%	0%	85%
CoolSmart HP QIV ES	All	15%	0%	0%	85%
CoolSmart HP QIV NES	All	15%	0%	0%	85%
CoolSmart Warm Air Furnace ECM	All	15%	0%	0%	85%
Down Size 1/2 Ton	All	15%	0%	0%	85%
Duct Sealing	All	15%	0%	0%	85%
Ductless Mini Split AC	All	15%	0%	0%	85%
Ductless Mini Split HP	All	15%	0%	0%	85%
Ductless Mini Split HP/AC Retrofit	All	15%	0%	0%	85%
Early Replacement of AC/HP Equipment	All	15%	0%	0%	85%
Energy Star QI	All	15%	0%	0%	85%
Energy Star QI w/ Duct modifications	All	15%	0%	0%	85%
Right Sizing	All	15%	0%	0%	85%
TXV Replacement of Fixed Orifice	All	15%	0%	0%	85%

MassSAVE					
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%
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%
On Demand Water Heater, Oil	All	25%	0%	0%	75%
On Demand 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%	86%
Refrigerator (Retirement Value)	All	14%	0%	0%	86%
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%
Solar DHW	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%

Multi-Family Retrofit					
Air Sealing (Electric)	All except NGRID	19%	0%	0%	81%
Air Sealing (FF)	All except NGRID	19%	0%	0%	81%
CFL (Electric)	National Grid	18%	0%	0%	82%
CFL (Non-Electric)	National Grid	18%	0%	0%	82%
Common Area Int Fixtures	All except NGRID	18%	0%	0%	82%
Common Area Occupancy Sensors	All except NGRID	18%	0%	0%	82%
DHW Measures (FF)	All except NGRID	15%	0%	0%	85%
DHW Measures (Electric)	All except NGRID	15%	0%	0%	85%
DHW Showerheads/Aerators (Electric)	National Grid	15%	0%	0%	85%
DHW Showerheads/Aerators (Non-Electric)	National Grid	15%	0%	0%	85%
DHW Tank/Pipe Wrap (Electric)	National Grid	15%	0%	0%	85%
DHW Tank/Pipe Wrap (Non-Electric)	National Grid	15%	0%	0%	85%
Fixtures (Electric)	National Grid	18%	0%	0%	82%
Fixtures (Non-Electric)	National Grid	18%	0%	0%	82%
Heat Pump Tune-Up (Electric)	National Grid	3%	0%	0%	97%
Indoor Fixture	All except NGRID	18%	0%	0%	82%
Insulation (Electric)	All except NGRID	19%	0%	0%	81%
Insulation (FF)	All except NGRID	19%	0%	0%	81%
Outdoor Fixture	All except NGRID	18%	0%	0%	82%
Programmable Thermostats (Electric)	All except NGRID	24%	0%	0%	76%
Programmable Thermostats (FF)	All except NGRID	24%	0%	0%	76%
Refrigerator (ES Value)	All except NGRID	3%	0%	0%	97%
Refrigerator (Retirement Value)	All except NGRID	3%	0%	0%	97%
Refrigerators/Freezers (Electric Heat)	National Grid	3%	0%	0%	97%
Refrigerators/Freezers (Non-Electric Heat)	National Grid	3%	0%	0%	97%
Room AC	All	35%	0%	0%	65%
Screw-in Bulbs	All except NGRID	18%	0%	0%	82%
Smart Strips	All	0%	0%	0%	100%
SPACE Air Sealing (Electric)	National Grid	19%	0%	0%	81%
SPACE Air Sealing (Non-Electric)	National Grid	19%	0%	0%	81%
SPACE Insulation (Electric)	National Grid	19%	0%	0%	81%
SPACE Insulation (Non-Electric)	National Grid	19%	0%	0%	81%
SPACE Thermostats (Electric)	National Grid	24%	0%	0%	76%
SPACE Thermostats (Non-Electric)	National Grid	24%	0%	0%	76%
Behavior/Feedback Program					
Group 2009 Pilot	National Grid	0%	0%	0%	100%
Group 2010 Added	National Grid	0%	0%	0%	100%
Group 2010 February	National Grid	0%	0%	0%	100%
Group 2011 February	National Grid	0%	0%	0%	100%
Group 2012 February	National Grid	0%	0%	0%	100%

ENERGY STAR 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%
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%
ENERGY STAR Appliances					
Computer Monitors	All	0%	0%	0%	100%
Dehumidifiers (ES Value)	All	0%	0%	0%	100%
Dehumidifiers (Retirement Value)	All	0%	0%	0%	100%
Freezer Rebate	All	0%	0%	0%	100%
LCD/TV	All	0%	0%	0%	100%
PC Computers	All	0%	0%	0%	100%
Pool Pumps	All	0%	0%	0%	100%
Refrigerator Recycling Primary	All	45%	0%	0%	55%
Refrigerator Recycling Secondary Replaced	All	27%	0%	0%	73%
Refrigerator Recycling Secondary Not Replaced	All	29%	0%	0%	71%
Freezer Recycling	All	41%	0%	0%	59%
Refrigerator Recycling (combined)	All	31%	0%	0%	69%
Refrigerator Rebate	All	10%	0%	0%	90%
Room AC (Upstream)	All	35%	0%	0%	65%
Room Air Cleaner	All	0%	0%	0%	100%
Set Top Box	All	0%	0%	0%	100%
Smart Strips	All	0%	0%	0%	100%
Televisions	All	0%	0%	0%	100%
Low-Income Residential New Construction					
Dishwashers	All	89%	0%	0%	11%
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	All	21%	0%	0%	79%
LED Fixture	All	21%	0%	0%	79%
Refrigerators	All	73%	0%	0%	27%
Screw-in Bulbs	All	21%	0%	0%	79%

Low-Income 1-4 Family Retrofit					
Appliance Removal	All	0%	0%	0%	100%
Baseload	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%
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%
Fuel Switching	All	0%	0%	0%	100%
Heating System Replacement (Oil)	All	0%	0%	0%	100%
Oil Weatherization	All	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%
Solar DHW	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%
Freezer Replacement	All	0%	0%	0%	100%
Heating System Replacement (Oil)	All	0%	0%	0%	100%
Refrigerator (ES Value)	All	0%	0%	0%	100%
Refrigerator (Retirement Value)	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%

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 the ENERGY STAR Lighting Screw-In Bulbs and Screw-In Bulbs (Specialty bulbs) measures on the Massachusetts ENERGY STAR® Lighting Program: 2010 Annual Report.[644]

All PAs base the NTG factors for the MassSAVE Screw-In Bulbs, Screw-In Bulbs (piggyback), Refrigerator, Air Sealing, Insulation, Duct Seal and Duct Insulation on the Massachusetts 2011 Residential Retrofit and Low Income Net to Gross Evaluation[645]. NTG factors for Screw-In Bulbs and Screw-In Bulbs (piggyback) are also 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.[646]

All PAs base the NTG factors for the Residential New Construction program appliances and lighting measures on the Massachusetts Mini-Baseline Study.[647]

[644] NMR Group, Inc (2011). *Massachusetts ENERGY STAR® Lighting Program: 2010 Annual Report.* Prepared for the Electric Program Administrators of Massachusetts; June 13, 2011.
[645] 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
[646] The Cadmus Group (2011). *2010 Net-to-Gross Findings: Home Energy Assessment*. Prepared for the Electric and Gas Program Administrators of Massachusetts
[647] NMR Group, Inc., KEMA Inc., Dorothy Conant (2012). Massachusetts Mini-Baseline Study of Homes Built at the end of the 2006 IECC Cycle; June 15, 2012.

Commercial Electric Efficiency Measures					
Measure	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
C&I New Construction and Major Renovation					
Advanced Lighting Design (Performance Lighting)	National Grid	33%	29%	0%	96%
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	National Grid	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	National Grid	33%	16%	0%	83%
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 T8s/T5s	National Grid	19%	0%	0%	81%
Upstream Lighting T8s/T5s	NSTAR	19%	0%	0%	81%
Upstream Lighting T8s/T5s	Unitil	19%	0%	0%	81%
Upstream Lighting T8s/T5s	WMECo	19%	0%	0%	81%
Upstream Lighting T8s/T5s	CLC	18%	0%	0%	82%
Upstream Lighting LEDs	All	3%	0%	0%	97%
Demand Control Ventilation (DCV)	National Grid	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)	National Grid	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	National Grid	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	National Grid	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	National Grid	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	National Grid	29%	2%	0%	73%
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	National Grid	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	National Grid	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	National Grid	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	National Grid	16%	29%	0%	113%
Custom	Unitil	20.%	11.5%	0%	92.3%
Custom - Compressed Air	NSTAR	37%	10%	1%	74%
Custom - Cooling	WMECo	30%	1%	0%	71%
Custom - HVAC	NSTAR	21%	14%	0%	94%
Custom - HVAC	CLC	22%	12%	0%	90%
Custom - Lighting	NSTAR	12%	2%	0%	90%
Custom - Lighting	WMECo	20%	9%	0%	89%
Custom - Lighting	CLC	20%	9%	0%	89%
Custom - Motors	NSTAR	23%	2%	8%	86%
Custom - Process	WMECo	7%	0%	0%	93%
Custom - Process Equipment	NSTAR	10%	1%	0%	91%
Custom - Refrigeration	NSTAR	13%	35%	0%	122%
Custom - Refrigeration	CLC	13%	35%	0%	122%
C&I Large Retrofit					
Lighting Controls	National Grid	17%	3%	0%	86%
Lighting Controls	NSTAR	18%	17%	0%	99%
Lighting Controls	Unitil	16.9%	8.4%	0%	91.5%
Lighting Controls	WMECo	20%	5%	0%	85%
Lighting Controls	CLC	17%	8%	0%	91%
Lighting Systems	National Grid	17%	3%	0%	86%
Lighting Systems	NSTAR	18%	17%	0%	99%

Lighting Systems	Unitil	16.9%	8.4%	0%	91.5%
Lighting Systems	WMECo	20%	5%	0%	85%
Lighting Systems	CLC	17%	8%	0%	91%
Vending Machine and Cooler Controls (Lighting)	NSTAR	18%	17%	0%	99%
Energy Management System (EMS)	National Grid	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	National Grid	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	13%	6%	0%	93%
LEDs in Freezers/Coolers	CLC	17%	8%	0%	91%
Vending Machine and Cooler Controls	National Grid	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	National Grid	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	National Grid	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%
Custom	National Grid	14%	8%	1%	95%
Custom	Unitil	15.7%	9.1%	0.7%	94.1%
Custom - Compressed Air	NSTAR	7%	0%	2%	95%
Custom - HVAC	NSTAR	13%	6%	0%	93%
Custom - HVAC	CLC	13%	6%	0%	93%
Custom - Lighting	NSTAR	18%	17%	0%	99%
Custom - Lighting	WMECo	20%	5%	0%	85%
Custom - Lighting	CLC	17%	8%	0%	91%
Custom – Motors	NSTAR	14%	7%	8%	101%
Custom - Process Equipment	NSTAR	26%	11%	0%	85%
Custom – Refrigeration	NSTAR	14%	56%	0%	142%
Custom – Refrigeration	CLC	9%	36%	0%	127%
Custom – CHP	NSTAR	7%	16%	0%	109%
C&I Small Retrofit					
Lighting Controls	National Grid	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%	6%	0%	97%
Lighting Systems	National Grid	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%	6%	0%	97%
Energy Management Systems (EMS)	CLC	7%	14%	0%	107%
Hotel Occupancy Sensors	CLC	7%	14%	0%	107%
Programmable Thermostats	National Grid	2%	2%	0%	100%
Programmable Thermostats	NSTAR	10%	27%	0%	117%
Programmable Thermostats	Unitil	6.8%	14%	0%	107.2%
Programmable Thermostats	CLC	7%	14%	0%	107%
Case Motor Replacement	National Grid	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	National Grid	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	National Grid	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	National Grid	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	National Grid	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%
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	National Grid	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	National Grid	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	3%	2%	0%	99%
LEDs in Freezers/Coolers	CLC	9%	6%	0%	97%
Novelty Cooler Shutoff	National Grid	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 - HVAC	CLC	7%	14%	0%	107%
Custom – Building Envelope	CLC	1%	0%	0%	99%
Custom - Lighting	CLC	9%	6%	0%	97%
Custom – Motors	CLC	14%	0%	0%	86%
Custom – Refrigeration	CLC	4%	0%	0%	96%
Custom – Hot Water	CLC	0%	98%	0%	198%

EVALUATIONS

All factors 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.[648]

[648] 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

Residential Natural Gas Measures					
Measure	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
Residential New Construction & Major Renovation					
Refrigerators	All	73%	0%	0%	27%
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	All	21%	0%	0%	79%
LED Fixture	All	21%	0%	0%	79%
Screw-in Bulbs	All	21%	0%	0%	79%
Dishwashers	All	89%	0%	0%	11%
Residential Heating and Water Heating					
Boiler (AFUE >= 85%)	All	69%	14%	0%	45%
Boiler (AFUE >= 90%)	All	60%	14%	0%	54%
Boiler (AFUE >= 96%)	All	25%	14%	0%	89%
HTR Boiler (AFUE >= 85%)	All	23%	0%	0%	77%
HTR Boiler (AFUE >= 90%)	All	20%	0%	0%	80%
HTR Boiler (AFUE >= 96%)	All	8%	0%	0%	92%
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 (Retirement Value)	All	0%	0%	0%	100%
Early Replacement Boiler (HE Value)	All	0%	0%	0%	100%
ES Programmable Thermostats	All	58%	0%	0%	42%
HTR ES Programmable Thermostats	All	19%	0%	0%	81%
Furnace w/ ECM (AFUE = 92%)	All	62%	19%	0%	57%
Furnace w/ ECM (AFUE = 94%)	All	62%	19%	0%	57%
Furnace w/ ECM (AFUE = 96%)	All	25%	19%	0%	94%
HTR Furnace w/ ECM (AFUE = 92%)	All	20%	0%	0%	80%
HTR Furnace w/ ECM (AFUE = 94%)	All	20%	0%	0%	80%
HTR Furnace w/ ECM (AFUE = 96%)	All	8%	0%	0%	92%
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	60%	14%	0%	54%
HTR Integrated water heater/condensing boiler	All	20%	0%	0%	80%
Integrated water heater/non-condensing boiler	All	69%	14%	0%	45%
HTR Integrated water heater/non-condensing boiler	All	23%	0%	0%	77%
Stand Alone Storage Water Heater (EF >= 0.62)	All	37%	0%	0%	63%
Stand Alone Storage Water Heater (EF >= 0.67)	All	37%	0%	0%	63%
HTR Stand Alone Storage Water Heater (EF >= 0.62)	All	12%	0%	0%	88%
HTR Stand Alone Storage Water Heater (EF >= 0.67)	All	12%	0%	0%	88%

Tankless Water Heaters (EF >= 0.82)	All	63%	0%	0%	37%
Tankless Water Heaters (EF >= 0.95)	All	37%	0%	0%	63%
HTR Tankless Water Heaters (EF >= 0.82)	All	21%	0%	0%	79%
HTR Tankless Water Heaters (EF >= 0.95)	All	12%	0%	0%	88%
Home Energy Services (Gas Weatherization)					
Faucet Aerators	All	0%	0%	0%	100%
Low-Flow Shower Heads	All	0%	0%	0%	100%
Air Sealing	All	8%	8%	28%	129%
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.

All PAs base the NTG factors for the Residential New Construction program appliances and lighting measures on the Massachusetts Mini-Baseline Study.[649]

In the Residential Heating and Water Heating program, free-ridership rates are based on the results of the 2010 impact evaluation[650] , the 2011 NTG study[651] or NTGR agreed upon with the PAs and Consultants.

[649] NMR Group, Inc., KEMA Inc., Dorothy Conant (2012). Massachusetts Mini-Baseline Study of Homes Built at the end of the 2006 IECC Cycle; June 15, 2012.
[650] Nexus Market Research (2010). HEHE Process and Impact Evaluation. Prepared for GasNetworks
[651] 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*

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[652].

In the Multifamily program, NTG rates are based on the 2011 NTG Study[653] while Home Energy Services (Gas Weatherization) is based on the results of the 2010 Home Energy Assessment NTG study[654] and the 2011 HES NTG study[655].

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

[652] Massachusetts Common Assumption.

[653] The Cadmus Group (2012). *Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis.* Prepared for Massachusetts Program Administrators and the Energy Efficiency Advisory Council; June 2012

[654] Cadmus (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

[655] 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; June, 2012.

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%	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%	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%	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%	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%	0.2%	75.7%
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%	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%	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%	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%	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%	0.2%	75.7%
Custom Measures	NGRID	27.9%	9.6%	1.0%	82.7%
Custom Measures	NSTAR	57.5%	11.4%	0.8%	54.7%
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%
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%	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%	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%	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%	0.2%	75.7%
Custom Measures	NGRID	27.9%	9.6%	1.0%	82.7%
Custom Measures	NSTAR	57.5%	11.4%	0.8%	54.7%
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%
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%	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%	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%	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%	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.[656] This study developed free-ridership and participant spillover rates for each PA for prescriptive and custom measures. PAs that had fewer than 10 customers surveyed for a program type used the statewide rates.

[656] TetraTech (2012). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study. June 2012

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 (Retrofit)(Low Income Only), Freezer (Retrofit)	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 and Multifamily programs 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	MMBTU Oil Savings * $1.83	per measure	Annual	Retrofit programs only

			security				
	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

(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 NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

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
	Retrofit CFL O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$18.67	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
	Retrofit LED Traffic Light O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$29.37	Unit	Annual
	New Construction and Retrofit 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
	Retrofit Fluorescent T8 Lamp-Ballast O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$0.41	Unit	Annual
	Retrofit Fluorescent Super T8 Lamp-Ballast O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$0.06	Unit	Annual
	SBS Retrofit Fluorescent Lamp-Ballast w/ Reflector O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$0.91	Unit	Annual
	Retrofit Exit Sign O&M	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$33.65	Unit	Annual
	WMECO All Lighting Lamps and Fixtures (2)	O&M Savings	Operation & Maintenance savings from fewer replacements over the life of the more efficient measure	$0.009	kWh Saved	Annual

(1) Source is Optimal Energy, Inc. MEMO "Non-Electric Benefits Analysis Update" November 7, 2008.
(2) WMECO counts O&M Benefit per kWh because their tracking system currently does not track fixture counts for all lighting projects.

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.

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	Heating System Cooling System Heating and Cooling System	$48.63 $3.92 $5.05	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.
	Noise Reduction	Less participant-perceived noise in the home	Cooling System Heating and Cooling System	$2.83 $1.42	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials	Heating System Cooling System Heating and Cooling System	$17.42 $1.54 $1.98	Annual	
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment	Heating System Cooling System Heating and Cooling System	$102.40 $7.54 $9.42	Annual	
	Health Benefits	Fewer colds and viruses, improved indoor air	Heating System Cooling System	$1.56 $0.13	Annual	

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	Heating and Cooling System	$0.16		
	Property Value Increase	Increased value of property and expected ease of selling home	Heating System Cooling System Heating and Cooling System	$678.52 $62.65 $80.69	One Time	
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	

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.

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	

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	

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	

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.

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	

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	

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 is NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation*. Prepared for the Massachusetts Program Administrators.
2. Source of Economic Development NEI is Environment Northeast (2009). Energy Efficiency: Engine of Economic *Growth: A Macroeconomic Modeling Assessment.*
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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	Heating System Heating and Hot Water System Thermostats	$48.63 $1.83 $3.99	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.
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials	Heating System Hot Water System Heating and Hot Water System Thermostats	$17.42 $2.13 $0.72 $1.33	Annual	
	Equipment Maintenance	Reduced maintenance costs of owning newer and/or more efficient appliance equipment	Heating System Heating and Hot Water System	$102.40 $3.41	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	Heating System Heating and Hot Water System Thermostats	$1.56 $0.06 $0.13	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home	Heating System Hot Water System Heating and Hot Water System Thermostats	$678.52 $82.56 $29.17 $51.49	One Time	
Weatherization	Thermal Comfort	Greater participant-perceived comfort in home	N/A	$25.00	Annual	As an approximation of program weatherization participants, values

Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Noise Reduction	Less participant-perceived noise in the home		$11.22	Annual	are applied to the 2012 insulation measure quantity.
	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 Air Sealing	$25.15 $10.13	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
	Noise Reduction	Less participant-perceived noise in the home	Insulation Air Sealing	$11.54 $4.88	Annual	
	Home	Increased	Insulation	$9.82	Annual	

Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Durability	home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials	Air Sealing	$3.95		units that result in weatherization participants.
	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 Air Sealing	$0.80 $0.32	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home	Insulation Air Sealing	$378.05 $135.83	One Time	
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	
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.

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	
	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	Greater	Insulation	$25.38	Annual	As an

Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
	Comfort	participant-perceived comfort in home	Air Sealing Heating System	$30.23 $28.01		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.
	Noise Reduction	Less participant-perceived noise in the home	Insulation Air Sealing	$13.56 $16.39	Annual	
	Home Durability	Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials	Insulation Air Sealing Heating System	$8.76 $10.61 $9.72	Annual	
	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, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home	Insulation Air Sealing Heating System	$4.77 $5.69 $5.27	Annual	
	Property Value Increase	Increased value of property and expected ease of selling home	Insulation Air Sealing Heating System	$223.63 $144.93 $249.20	One Time	

Program	NEI	Description	Measure Category	Value	Duration	Notes on Model Application
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	
	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	

Source is NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

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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

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 **Error! Not a valid result for table.**.
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.

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.
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 **Error! Not a valid result for table.**.

TERM	DESCRIPTION
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 **Error! Not a valid result for table.**.
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).

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.

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.