# 2011
# Electric Energy Efficiency
# Annual Report

# Massachusetts Electric Company
# Nantucket Electric Company
# 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*

The Company is pleased to provide its Energy Efficiency Annual Report ("Annual Report" or "EEAR") for 2011. 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 Program Administrators) that have not been included in previous Annual Reports, and explain how the results of the EM&V studies impact program cost-effectiveness.

- Describe the performance incentives that the Company proposes to collect.

### B. *Organization of Annual Report*

The Company's 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 | $ | 185,655,651 | | | 116,094,289 | | -37% |
| Performance Incentive | $ | 10,629,270 | | | 9,425,469 | | -11% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 4,564,884 | 4,322,486 | -5% | 4,003,217 | -7% | -12% |
| Annualized | MWh | 422,914 | 370,685 | -12% | 342,996 | -7% | -19% |
| Demand | | | | | | | |
| Lifetime | kW | 889,623 | 624,836 | -30% | 623,009 | 0% | -30% |
| Annualized | | | | | | | |
| Summer | kW | 72,146 | 49,171 | -32% | 48,431 | -2% | -33% |
| Winter | kW | 73,572 | 64,722 | -12% | 60,097 | -7% | -18% |
| NEB (Lifetime) (change to | $ | 123,319,617 | 63,351,383 | -49% | 118,812,918 | 88% | -4% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 771,019,277 | | | 642,157,614 | | -17% |
| TRC Costs | $ | 255,561,359 | | | 151,624,749 | | -41% |
| Net Benefits | $ | 515,457,918 | | | 490,532,865 | | -5% |
| BCR | n/a | 3.02 | | | 4.24 | | 40% |

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

As shown in Table I.A above, significant variances at the portfolio level between planned and evaluated occurred with summer kW and lifetime kW where preliminary value was 30% and 32% lower than planned values, and Lifetime NEBs where preliminary value was 49% lower than planned values. Significant variances at the portfolio level between preliminary and actual value occurred with Lifetime NEBs where actual value was 88% higher than the preliminary value. Total Program Costs was 37% lower than planned.[2,]

1 The Company is also providing the Department of Public Utilities (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% 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 | $ | 185,210,771 | 200,576,453 | 8% |
| TRC Costs | $ | 67,108,718 | 62,851,291 | -6% |
| Net Benefits | $ | 118,102,053 | 137,725,163 | 17% |
| BCR | n/a | 2.76 | 3.19 | 16% |
| **Low-Income** | | | | |
| TRC Benefits | $ | 57,044,958 | 43,189,291 | -24% |
| TRC Costs | $ | 21,302,758 | 14,220,390 | -33% |
| Net Benefits | $ | 35,742,201 | 28,968,902 | -19% |
| BCR | n/a | 2.68 | 3.04 | 13% |
| **C&I** | | | | |
| TRC Benefits | $ | 528,763,548 | 398,391,870 | -25% |
| TRC Costs | $ | 167,149,884 | 74,553,069 | -55% |
| Net Benefits | $ | 361,613,664 | 323,838,801 | -10% |
| BCR | n/a | 3.16 | 5.34 | 69% |
| **TOTAL** | | | | |
| TRC Benefits | $ | 771,019,277 | 642,157,614 | -17% |
| TRC Costs | $ | 255,561,359 | 151,624,749 | -41% |
| Net Benefits | $ | 515,457,918 | 490,532,865 | -5% |
| BCR | n/a | 3.02 | 4.24 | 40% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

As shown in Table I.B above, significant variances exist in the Low-Income sector for TRC Benefits and TRC Costs. TRC Benefits are 24% below planned estimates and costs are 33% below planned values. The C&I Sector also had lower than planned TRC Benefits, spending and BCR. TRC Benefits are 25% below planned estimates, costs are 55% below planned values, resulting in a BCR 69% higher than planned. These two sectors, along with the Residential sector, had year end spending that was 41 % lower than planned resulting in a BCR 40 % higher than planned.

Within the Low Income sector, all the programs had lower than planned total resource costs, contributing to the variance between planned and evaluated values. Please reference section II.B.2 for a more detailed discussion of the variances by program within this sector.

Within the C&I sector, all the programs had lower than planned total resource costs, contributing to the variance between planned and evaluated values. Please reference section II.C.2 for a more detailed discussion of the variances by program within this sector.

# II. Program Performance

## A. *Residential Sector Programs*

### 1. Summary

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

*Residential Programs:*

- Residential New Construction & Major Renovation
- Residential Cooling & Heating Equipment
- Residential Multi-Family Retrofit
- MassSAVE
- Behavior/Feedback Program
- ENERGY STAR® Lighting
- ENERGY STAR® Appliances

*Residential Pilot Programs:*

- Deep Energy Retrofit
- Residential New Construction & Major Renovation - Major Renovation Statewide Pilot
- Residential New Construction – Multi Family (4-8 story) Statewide Pilot
- Residential New Construction - Lighting Design Statewide Pilot
- R&D and Demonstration
- Community Based Pilot

Tables II.A.1 through II.A.3 provide summary information on the performance of the residential programs at the sector, end use, and program levels, respectively, while sections II.A.2 and II.A.3 provide detailed information on the performance of each residential program and pilot 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 | $ | 57,610,395 | | | 47,880,166 | | -17% |
| Performance Incentive | $ | 2,744,105 | | | 3,019,761 | | 10% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 760,284 | 830,458 | 9% | 753,648 | -9% | -1% |
| Annual | MWh | 124,878 | 136,863 | 10% | 122,268 | -11% | -2% |
| Demand | | | | | | | |
| Lifetime | kW | 158,841 | 97,832 | -100% | 86,299 | -12% | -46% |
| Annualized | | | | | | | |
| Summer | kW | 14,774 | 13,003 | -12% | 11,545 | -11% | -22% |
| Winter | kW | 27,788 | 29,907 | 8% | 26,492 | -11% | -5% |
| NEB (Lifetime) | $ | 75,528,071 | 50,633,414 | -33% | 99,968,319 | 97% | 32% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 185,210,771 | | | 200,576,453 | | 8% |
| TRC Costs | $ | 58,189,237 | | | 62,851,291 | | 8% |
| Net Benefits | $ | 127,021,534 | | | 137,725,163 | | 8% |
| BCR | n/a | 3.18 | | | 3.19 | | 0% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

| Table II.A.2: Residential Sector Summary of End Uses | | | | |
|---|---|---|---|---|
| End Uses | Units (Lifetime) | Preliminary Year-End Results | Evaluated Results | % Change from Preliminary to Evaluated |
| **Lighting** | | | | |
| Energy | MWh | 626,169 | 568,639 | -9% |
| Demand | kW | 57,602 | 52,363 | -9% |
| NEB | $ | 4,433,842 | 4,198,238 | -5% |
| **HVAC** | | | | |
| Energy | MWh | 83,734 | 79,069 | -6% |
| Demand | kW | 29,131 | 23,603 | -19% |
| NEB | $ | 37,911,209 | 89,660,052 | 137% |
| **Refrigeration** | | | | |
| Energy | MWh | 58,729 | 48,498 | -17% |
| Demand | kW | 6,896 | 5,870 | -15% |
| NEB | $ | 0 | 1,058,450 | 0% |
| **Hot Water** | | | | |
| Energy | MWh | 3,051 | 2,542 | -17% |
| Demand | kW | 282 | 234 | -17% |
| NEB | $ | 8,288,363 | 5,051,578 | -39% |
| **Process** | | | | |
| Energy | MWh | 10,307 | 12,847 | 25% |
| Demand | kW | 817 | 1,501 | 84% |
| NEB | $ | 0 | - | 0% |
| **Behavior** | | | | |
| Energy | MWh | 48,315 | 41,901 | -13% |
| Demand | kW | 3,095 | 2,624 | -15% |
| NEB | $ | 0 | - | 0% |
| **Total** | | | | |
| Energy | MWh | 830,458 | 753,648 | -9% |
| Demand | kW | 97,832 | 86,299 | -12% |
| NEB | $ | 50,633,414 | 99,968,319 | 97% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

| Table II.A.3: Residential Program Summary | | | | |
|---|---|---|---|---|
| Program / Performance Category | Units | Planned Value | Evaluated Results | |
| | | | Value | % Change from Planned |
| **Residential New Construction & Major Renovation** | | | | |
| TRC Benefits | $ | 3,574,065 | 6,340,313 | 77% |
| TRC Costs | $ | 2,838,840 | 2,419,297 | -15% |
| Net Benefits | $ | 735,225 | 3,921,017 | 433% |
| BCR | n/a | 1.26 | 2.62 | 108% |
| **Residential Cooling & Heating Equipment** | | | | |
| TRC Benefits | $ | 4,225,774 | 7,420,144 | 76% |
| TRC Costs | $ | 2,735,569 | 2,548,640 | -7% |
| Net Benefits | $ | 1,490,205 | 4,871,504 | 227% |
| BCR | n/a | 1.54 | 2.91 | 88% |
| **Multi-Family Retrofit** | | | | |
| TRC Benefits | $ | 22,117,450 | 32,092,424 | 45% |
| TRC Costs | $ | 10,548,937 | 7,087,103 | -33% |
| Net Benefits | $ | 11,568,513 | 25,005,320 | 116% |
| BCR | n/a | 2.10 | 4.53 | 116% |
| **MassSAVE** | | | | |
| TRC Benefits | $ | 100,202,856 | 83,129,563 | -17% |
| TRC Costs | $ | 23,296,607 | 20,868,544 | -10% |
| Net Benefits | $ | 76,906,249 | 62,261,018 | -19% |
| BCR | n/a | 4.30 | 3.98 | -7% |
| **Behavior/Feedback Pilot** | | | | |
| TRC Benefits | $ | 7,396,648 | 5,946,035 | -20% |
| TRC Costs | $ | 2,656,732 | 2,890,903 | 9% |
| Net Benefits | $ | 4,739,916 | 3,055,132 | -36% |
| BCR | n/a | 2.78 | 2.06 | -26% |
| **ENERGY STAR Lighting** | | | | |
| TRC Benefits | $ | 40,542,706 | 56,522,195 | 39% |
| TRC Costs | $ | 10,317,775 | 16,889,501 | 64% |
| Net Benefits | $ | 30,224,932 | 39,632,693 | 31% |
| BCR | n/a | 3.93 | 3.35 | -15% |
| **ENERGY STAR Appliances** | | | | |
| TRC Benefits | $ | 7,151,272 | 9,125,780 | 28% |
| TRC Costs | $ | 3,967,126 | 4,525,030 | 14% |
| Net Benefits | $ | 3,184,145 | 4,600,750 | 44% |
| BCR | n/a | 1.80 | 2.02 | 12% |
| **Deep Energy Retrofit** | | | | |
| TRC Benefits | $ | n/a | n/a | n/a |
| TRC Costs | $ | 827,107 | 415,042 | -50% |
| Net Benefits | $ | n/a | n/a | n/a |
| BCR | n/a | n/a | n/a | n/a |
| **Residential New Construction & Major Renovation - Major Renovation Statewide Pi** | | | | |
| TRC Benefits | $ | n/a | n/a | n/a |
| TRC Costs | $ | 306,430 | 60,292 | -80% |
| Net Benefits | $ | n/a | n/a | n/a |
| BCR | n/a | n/a | n/a | n/a |
| **Residential New Construction Multi Family (4-8 story) Statewide Pilot** | | | | |
| TRC Benefits | $ | n/a | n/a | n/a |
| TRC Costs | $ | 342,310 | 328,062 | -4% |
| Net Benefits | $ | n/a | n/a | n/a |
| BCR | n/a | n/a | n/a | n/a |
| **Residential New Construction Lighting Design Statewide Pilot** | | | | |
| TRC Benefits | $ | n/a | n/a | n/a |
| TRC Costs | $ | 96,027 | 27,904 | -71% |
| Net Benefits | $ | n/a | n/a | n/a |
| BCR | n/a | n/a | n/a | n/a |
| **R&D and Demonstration** | | | | |
| TRC Benefits | $ | n/a | n/a | n/a |
| TRC Costs | $ | 251,000 | 45,241 | -82% |
| 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 | $ | 255,778 | 100,762 | -61% |
| Net Benefits | $ | n/a | n/a | n/a |
| BCR | n/a | n/a | n/a | n/a |
| **TOTAL** | | | | |
| TRC Benefits | $ | 185,210,771 | 200,576,453 | 8% |
| TRC Costs | $ | 58,189,237 | 62,851,291 | 8% |
| Net Benefits | $ | 127,021,534 | 137,725,163 | 8% |
| BCR | n/a | 3.18 | 3.19 | 0% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

**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 & Major Renovation - In 2011, with over 100 communities adopting the Stretch Energy Code, this program, also known as Massachusetts New Homes with ENERGY STAR program, 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 Program Administrators 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 to builders, building code offices, homeowners, tornado relief centers, town meetings/events and churches.

- Residential Cooling & Heating Equipment - The program, also known as the COOL Smart program, started the year with a strong volume of equipment rebate production for high efficiency equipment, and successfully achieved its 2011 equipment rebate goal. COOL Smart actively planned and conducted quality installation training sessions, including system design, duct diagnostics, brushless fan motors and ENERGY STAR Heating, Ventilation and Air Conditioning ("HVAC") quality installation online training. The annual COOL Talk meeting was held at which program achievements were highlighted, HVAC contractor feedback obtained and a program preview of 2012 presented. Contractor outreach, training and education was enhanced through joint electric and gas integration through the establishment of circuit rider outreach for COOL Smart through the GasNetworks™ existing vendor, and joint participation of COOL Smart and GasNetworks at the Plumbing Heating Cooling Contractors Annual Trade Show and the annual GasNetworks fall conference. A request for proposals ("RFP") was completed and a statewide vendor was selected for COOL Smart rebate processing.

- 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 Mass Save 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.

- <u>MassSAVE</u> – 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 Mass Save 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 ("BPWG") 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. BPWG 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 Mass Save 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 implementing weatherization work
  - Various lead vendor process enhancements
  - Workforce development including subsidies for various trainings:

- Weatherization boot camps
- Combustion safety training
- Weatherization crew chief training
- Building analyst training

In 2011, the HEAT Loan program continued to offer micro loans ($500-$2,000) and the program has increased the amount that a property owner can borrow ($2,000 - $25,000). HEAT Loan offerings were extended to include many gas customers in municipal electric territory. Additionally, PAs saw an increase in both the average loan amount and the number of customers financing multiple measures.

- ENERGY STAR® Lighting - In 2011, the ENERGY STAR Lighting program provided strong results for the PAs, with all the PAs meeting or exceeding savings goals. LED fixtures were well received by customers, allowing the PAs to adjust rebate levels incrementally downward with minimum impact on sales. Specialty and "Hard-to-Reach" categories also performed well in most areas.

  The PAs transitioned to the new incentive fulfillment contractor in the last half of 2011 for most programs.

- ENERGY STAR® Appliances – The ENERGY STAR Appliances program results varied by Program Administrator. ENERGY STAR refrigerators and freezers were once again strong performers for this program, with ENERGY STAR televisions also performing well. Other measures like computers, LCD monitors, pool pumps and room air conditioners lagged behind expectations due to rapid changes in technology and some products not meeting program criteria. The sales of Advanced Power Strips (Smart Strips) varied by PA, due mostly to retail availability. School fundraisers and "Pop-up" retail accounted for a large number of sales of Smart Strips The refrigerator/freezer recycling program did not perform well for most PAs.

- The PAs successfully transitioned all aspects of this program to the new incentive fulfillment contractor in the last half of 2011.

## 2. Residential Programs

### a. Residential New Construction & 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 served under this program.

**Targeted End-Uses:**

- Lighting
- HVAC
- Hot Water
- Envelope
- Refrigeration

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

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

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

| Table II.A.4: Residential New Construction & Major Renovation | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Performance Category** | **Units** | **Planned Value** | **Preliminary Year-End Results** | | **Evaluated Results** | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 1,700,715 | | | 1,664,823 | | -2% |
| Performance Incentive | $ | 30,080 | | | 83,580 | | 178% |
| Participants | Accounts | 646 | | | 919 | | 42% |
| Program Cost/ Participant | $ | 2,633 | | | 1,812 | | -31% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 22,685 | 23,411 | 3% | 20,123 | -14% | -11% |
| Annualized | MWh | 1,712 | 2,136 | 25% | 1,741 | -19% | 2% |
| Average Measure Life | yrs | 13 | 11 | -17% | 12 | 6% | -13% |
| Demand | | | | | | | |
| Lifetime | kW | 3,153 | 5,129 | 63% | 4,798 | -6% | 52% |
| Annualized | | | | | | | |
| Summer | kW | 203 | 319 | 58% | 280 | -12% | 38% |
| Winter | kW | 328 | 399 | 22% | 325 | -18% | -1% |
| Average Measure Life | yrs | 16 | 16 | | 17 | | |
| NEB (Lifetime) | $ | 742,676 | 2,303,756 | 210% | 3,393,899 | 47% | 357% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 3,574,065 | | | 6,340,313 | | 77% |
| TRC Costs | $ | 2,838,840 | | | 2,419,297 | | -15% |
| Net Benefits | $ | 735,225 | | | 3,921,017 | | 433% |
| BCR | n/a | 1.26 | | | 2.62 | | 108% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

The majority of electric energy savings in the Residential New Construction program was due to energy efficient lighting. Preliminary energy savings increased by 25% compared to planned estimates due to an increase in the amount of energy efficient lighting installed. Evaluated energy savings decreased by 19% compared to preliminary due to the incorporation of penetration rates of energy efficient lighting and appliances from the Mini-Baseline study.

The majority of electric demand savings in the Residential New Construction program was due to a combination of energy efficient lighting and central air conditioning ("AC"). Preliminary demand savings increased 58% due to the combination of an increase in the amount of energy efficient lighting installed and an increase in the number of 2011 completed housing units with central AC. Evaluated demand savings decreased by 12% compared to preliminary due to the incorporation of penetration rates of energy efficient lighting and appliances from the Mini-Baseline study.

The large increase in NEB Value from planned to preliminary was due to more homes coming through at higher tier levels than what was planned. The increase in NEB Value from preliminary to evaluated was 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

EM&V studies included in the Annual Report that 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.At this point in time no mid-term modification is planned for 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The Residential New Construction & Major Renovation Program is cost-effective with a BCR of 2.62.

b. Residential Cooling & Heating Equipment

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

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

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

**Targeted End-Uses:** HVAC

**Delivery Mechanism:** The program was administered by each Program Administrator in its service territory. Delivery was through a common vendor selected through a common RFP. Whenever possible, there was coordination with the related gas Program Administrator's initiatives. To this end, the COOL Smart and Gas Networks' High Efficiency Heating and Hot Water programs worked to procure a single, joint circuit rider to support both programs in the field. Program initiatives were also piggybacked onto the residential new construction and HES programs:

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

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

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

The program continued to use equipment distributors to process rebates, sell high-efficiency and QIV-related technology, and to provide indoor training labs for HVAC contractors.

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

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

| Table II.A.5: Residential Cooling & Heating Equipment | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 2,516,166 | | | 2,447,821 | | -3% |
| Performance Incentive | $ | 17,325 | | | 100,819 | | 482% |
| Participants | Accounts | 5,256 | | | 4,179 | | -20% |
| Program Cost/ Participant | $ | 479 | | | 586 | | 22% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 26,082 | 38,009 | 46% | 37,641 | -1% | 44% |
| Annualized | MWh | 1,518 | 2,125 | 40% | 2,105 | -1% | 39% |
| Average Measure Life | yrs | 17 | 18 | 4% | 18 | 0% | 4% |
| Demand | | | | | | | |
| Lifetime | kW | 11,425 | 22,478 | 97% | 19,826 | -12% | 74% |
| Annualized | | | | | | | |
| Summer | kW | 807 | 1,276 | 58% | 1,128 | -12% | 40% |
| Winter | kW | 246 | 183 | -25% | 398 | 117% | 62% |
| Average Measure Life | yrs | 14 | 18 | | 18 | | |
| NEB (Lifetime) | $ | (494,425) | (538,965) | 9% | 96,357 | -118% | -119% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 4,225,774 | | | 7,420,144 | | 76% |
| TRC Costs | $ | 2,735,569 | | | 2,548,640 | | -7% |
| Net Benefits | $ | 1,490,205 | | | 4,871,504 | | 227% |
| BCR | n/a | 1.54 | | | 2.91 | | 88% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary lifetime and annual MWh savings were 46% and 40% higher than planned values, respectively. This variance was due to measure mix, where the Company rebated a different quantity of measures than initially planned. Specifically, the Company rebated more warm air furnace ECMs, mini-split heat pumps, and high efficiency ACs than planned. These measures have higher energy savings relative to other measures within this program. Additionally, these measures also have higher demand savings relative to other measures in the program, driving the preliminary lifetime demand savings to be 97% higher than planned values.

Evaluated savings were 1% lower than preliminary year-end estimates. This decrease was due to the impact evaluation described below.

Evaluated NEBs were 118% higher than preliminary year-end estimates. This increase was 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

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

- *Brushless Fan Motors Impact Evaluation*
  This impact evaluation study was designed to quantify the energy savings associated with brushless fan motor (BFM) retrofits in residential HVAC applications. This study affected the 2011 Residential Cooling and Heating Equipment program by quantifying key metrics such as annual kWh savings and coincidence factors. The results of this

study varied by PA; based on measure mix, the Company saw a net decrease in evaluated results for 2011. This study is discussed in more detail in Section III, Study 8.

- *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 did not see a change 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The Residential Cooling & Heating Equipment Program is cost-effective with a BCR of 2.91.

c. 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
- HVAC
- Motors and Drives
- Refrigeration
- Domestic Hot Water
- Building Envelope
- End Use Behavior

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

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

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

| Table II.A.6: Multi-Family Retrofit | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 10,204,471 | | | 6,504,681 | | -36% |
| Performance Incentive | $ | 257,153 | | | 477,869 | | 86% |
| Participants | Units | 11,355 | | | 9,148 | | -19% |
| Program Cost/ Participant | $ | 899 | | | 711 | | -21% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 177,450 | 103,567 | -42% | 85,435 | -18% | -52% |
| Annualized | MWh | 10,564 | 6,525 | -38% | 5,386 | -17% | -49% |
| Average Measure Life | yrs | 17 | 16 | -6% | 16 | 0% | -6% |
| Demand | | | | | | | |
| Lifetime | kW | 15,806 | 3,625 | -77% | 3,139 | -13% | -80% |
| Annualized | | | | | | | |
| Summer | kW | 954 | 294 | -69% | 214 | -27% | -78% |
| Winter | kW | 2,731 | 1,777 | -35% | 1,329 | -25% | -51% |
| Average Measure Life | yrs | 17 | 12 | | 15 | | |
| NEB (Lifetime) | $ | 2,259,731 | 3,067,411 | 36% | 23,057,021 | 652% | 920% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 22,117,450 | | | 32,092,424 | | 45% |
| TRC Costs | $ | 10,548,937 | | | 7,087,103 | | -33% |
| Net Benefits | $ | 11,568,513 | | | 25,005,320 | | 116% |
| BCR | n/a | 2.10 | | | 4.53 | | 116% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary lifetime and annual MWh savings were 42% and 38% lower than planned values, respectively. The main reason for this variance was due to the fact that the Company did not reach its planned number of participants. This shortfall in participation also accounts for preliminary costs being 36% lower than planned. Additionally, the Company planned that each participant would install approximately 6 CFL bulbs and 4.5 fixtures. These assumptions were derived from looking at historical participation levels from previous years. However, preliminary year-end results show that on average, participants installed only 4 CFL bulbs and 3.5 fixtures. Combined, the lower participation and lower than anticipated lighting measures explain the variance between planned and preliminary savings values.

Despite the shortfall in savings, preliminary NEBs were 36% higher than planned values. This variance was due to a higher than planned number of installed direct hot water ("DHW") measures. The Company planned for 1,825 DHW measures and installed 5,150. The dollar value of the gallons of water saved per year from these measures contributed to increased NEBs and account for the higher than planned values.

Evaluated savings were 18% less than preliminary year-end estimates. This change was due to the effects of the results of impact evaluation described below. Evaluated NEBs were 652% higher than preliminary year-end estimates. This increase was 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

EM&V studies included in the Annual Report that 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.
- *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 decrease 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The Multifamily Retrofit Program is cost-effective with a BCR of 4.53.

d. MassSAVE

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

**Targeted Customers:** The HES target market is all non-low-income residential customers living in single-family houses or one- to-four-unit buildings that are not part of a larger site where an association exists (such as a 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 a unique electric account served under this program.

**Targeted End-Uses:**

- Lighting
- HVAC
- Hot Water
- Envelope
- Refrigeration

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

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

- Consistent statewide training
- Data reporting
- Achieving aggressive savings
- Customer satisfaction
- Quality Control standards
- Scheduling requirements
- Technical Assistance
- Maintain and report health and safety information

Two groups of Mass Save participating contractors, HPCs and IICs, provided services in addition to those services offered by the lead vendor. All participating contractors had to meet program eligibility and requirements. HPCs independently recruited customers, provided 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. 09-116, Exhibit NG-1.

| Table II.A.7: MassSAVE | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 18,259,676 | | | 16,329,348 | | -11% |
| Performance Incentive | $ | 1,680,072 | | | 1,381,699 | | -18% |
| Participants | Audits | 19,000 | | | 17,893 | | -6% |
| Program Cost/ Participant | $ | 961 | | | 913 | | -5% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 133,702 | 129,280 | -3% | 105,731 | -18% | -21% |
| Annualized | MWh | 14,981 | 17,790 | 19% | 14,504 | -18% | -3% |
| Average Measure Life | yrs | 9 | 7 | -19% | 7 | 0% | -18% |
| Demand | | | | | | | |
| Lifetime | kW | 86,688 | 13,925 | -84% | 9,018 | -35% | -90% |
| Annualized | | | | | | | |
| Summer | kW | 4,663 | 1,737 | -63% | 1,317 | -24% | -72% |
| Winter | kW | 2,273 | 3,412 | 50% | 2,839 | -17% | 25% |
| Average Measure Life | yrs | 19 | 8 | | 7 | | |
| NEB (Lifetime) | $ | 70,590,068 | 42,582,630 | -40% | 69,142,260 | 62% | -2% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 100,202,856 | | | 83,129,563 | | -17% |
| TRC Costs | $ | 23,296,607 | | | 20,868,544 | | -10% |
| Net Benefits | $ | 76,906,249 | | | 62,261,018 | | -19% |
| BCR | n/a | 4.30 | | | 3.98 | | -7% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary annual MWh savings were 19% higher than planned. This variance was due to the installation of more compact fluorescent bulbs ("CFLs") than originally planned. Based on historical results within the program, the Company planned to install, on average, twelve CFL bulbs per home. In 2011, the Company installed an average of sixteen bulbs per home, resulting in higher annual savings than originally planned.

Despite saving 19% above the planned value for electric savings, preliminary NEBs were 40% lower than planned. This variance was due to completing fewer than anticipated measures in oil-heated homes, such as insulation or oil heating systems. These measures achieve little to no electric savings but contribute heavily to the TRC Benefits of this program.

Evaluated electric savings decreased 18% from preliminary year-end estimates. This decrease was due to the Home Energy Services Net-to-Gross Evaluation described below.

The evaluated non-electric benefits are 62% higher than preliminary results. 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

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

- *Home Energy Services Net-to-Gross Evaluation*
  This impact evaluation determined measure-specific and program-level net-to-gross (NTG) ratios for the Home Energy Services (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 decrease in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 4.

- *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 decrease in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 9.
- *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 Company is still reviewing program performance and the results of the described evaluations to determine what, if any, changes to the program design or implementation may result in future years.

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The MassSAVE Program is cost-effective with a BCR of 3.98.

**e.** Behavioral/Feedback Program

**Purpose/Goal:** 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 targets residential customers with high energy usage.

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

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

**Delivery Mechanism:** The program is administered independently by National Grid. The vendor is OPOWER.

**Significant Differences in Actual Program Design from Approved Program Design:** The program added 59,000 participants to the planned number of participants.

**Docket/Exhibit where the Program is Discussed and Approved:** D.P.U. 09-116, 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 | $ | 2,561,921 | | | 2,819,130 | | 10% |
| Performance Incentive | $ | 94,812 | | | 71,773 | | -24% |
| Participants | Accounts | 200,000 | | | 268,799 | | 34% |
| Program Cost/ Participant | $ | 13 | | | 10 | | -18% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 52,018 | 48,315 | -7% | 41,901 | -13% | -19% |
| Annualized | MWh | 52,018 | 48,315 | -7% | 41,901 | -13% | -19% |
| Average Measure Life | yrs | 1 | 1 | 0% | 1 | 0% | 0% |
| Demand | | | | | | | |
| Lifetime | kW | 3,330 | 3,095 | -7% | 2,624 | -15% | -21% |
| Annualized | | | | | | | |
| Summer | kW | 3,330 | 3,095 | -7% | 2,624 | -15% | -21% |
| Winter | kW | 13,275 | 12,341 | -7% | 10,462 | -15% | -21% |
| Average Measure Life | yrs | 1 | 1 | | 1 | | |
| NEB (Lifetime) | $ | 0 | 0 | 0% | - | 0% | 0% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 7,396,648 | | | 5,946,035 | | -20% |
| TRC Costs | $ | 2,656,732 | | | 2,890,903 | | 9% |
| Net Benefits | $ | 4,739,916 | | | 3,055,132 | | -36% |
| BCR | n/a | 2.78 | | | 2.06 | | -26% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

There were no significant variances between planned and preliminary values for this program.

The evaluated lifetime savings were 19% lower than planned values. The evaluated results were lower than planned values for two reasons. First, the results of the impact evaluation included in the Massachusetts Three Year Cross Cutting Behavioral Evaluation Integrated Report had higher or lower savings than planned for some cohorts and higher or lower baseline consumption for some cohorts. The overall effect of the impact evaluation led to lower than planned values. Second, the program had more participants than planned.

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

- *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 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 decreases 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 2.06.

## f. ENERGY STAR® Lighting

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

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

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

**Targeted End-Uses:** Residential lighting

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

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

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

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

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

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

| Table II.A.9: ENERGY STAR® Lighting | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 8,721,269 | | | 8,626,692 | | -1% |
| Performance Incentive | $ | 562,625 | | | 794,804 | | 41% |
| Participants | Hholds | 398,550 | | | 739,745 | | 86% |
| Program Cost/ Participant | $ | 22 | | | 12 | | -47% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 294,094 | 419,785 | 43% | 402,064 | -4% | 37% |
| Annualized | MWh | 37,384 | 51,922 | 39% | 49,390 | -5% | 32% |
| Average Measure Life | yrs | 8 | 8 | 3% | 8 | 1% | 3% |
| Demand | | | | | | | |
| Lifetime | kW | 31,905 | 41,941 | 31% | 39,516 | -6% | 24% |
| Annualized | | | | | | | |
| Summer | kW | 4,019 | 5,404 | 34% | 5,107 | -6% | 27% |
| Winter | kW | 8,039 | 10,808 | 34% | 10,213 | -6% | 27% |
| Average Measure Life | yrs | 8 | 8 | | 8 | | |
| NEB (Lifetime) | $ | 2,430,020 | 3,218,582 | 32% | 3,220,331 | 0% | 33% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 40,542,706 | | | 56,522,195 | | 39% |
| TRC Costs | $ | 10,317,775 | | | 16,889,501 | | 64% |
| Net Benefits | $ | 30,224,932 | | | 39,632,693 | | 31% |
| BCR | n/a | 3.93 | | | 3.35 | | -15% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Lifetime and annual MWh savings for this program were 43% and 39% above planned values, respectively. The variance was mostly due to higher overall participation in the program. Participation was 86% higher than originally anticipated, driven by a higher number of hard-to-reach CFL bulbs, specialty CFL bulbs, LED bulbs and LED Fixtures than initially anticipated.

Evaluated savings were 4% lower than preliminary savings due to evaluation results from the Massachusetts Energy Star Lighting Program: 2010 Annual Report, which was previously filed in National Grid (electric) D.P.U. 11-108 and the evaluation study discussed below.

Evaluated NEBs increased slightly compared to Preliminary savings. 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

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

- *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 decrease in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 9.

- *Massachusetts Consumer Survey Results 2011*
  This multipart study assessed market research conducted for energy-efficient light bulbs, with particular emphasis on establishing a baseline at the onset of the changes in lighting standards resulting from the Energy Independence and Security Act of 2007 (EISA). The study primarily focuses on 100 Watt bulbs, but addressed customer attitudes towards CFL, customer knowledge of EISA standards, customers understanding and usage of current lighting technology, as well as potential stockpiling of incandescent bulbs. This is only the first wave of the study, and more waves will follow up on other bulb wattages as the EISA standards take effect. The process evaluation has no impact on 2011 evaluated results. This study is discussed in more detail in Section III, Study 10.

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The ENERGY STAR® Lighting Program is cost-effective with a BCR of 3.35.

## g. ENERGY STAR® Appliances

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

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

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

**Targeted End-Uses:**

- Refrigerators
- Freezers
- Televisions
- Room Air Cleaners
- Personal Desktop Computers
- LCD Computer Monitors
- Advanced Power Strips ("Smart Strips")
- Secondary refrigerators and freezers (recycling)
- Pool pumps

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

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

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

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

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

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

| Table II.A.10: ENERGY STAR® Appliances | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 2,919,609 | | | 3,865,398 | | 32% |
| Performance Incentive | $ | 77,517 | | | 109,218 | | 41% |
| Participants | Rebates | 27,300 | | | 35,654 | | 31% |
| Program Cost/ Participant | $ | 107 | | | 108 | | 1% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 54,253 | 68,092 | 26% | 60,753 | -11% | 12% |
| Annualized | MWh | 6,700 | 8,050 | 20% | 7,241 | -10% | 8% |
| Average Measure Life | yrs | 8 | 8 | 4% | 8 | -1% | 4% |
| Demand | | | | | | | |
| Lifetime | kW | 6,533 | 7,637 | 17% | 7,378 | -3% | 13% |
| Annualized | | | | | | | |
| Summer | kW | 798 | 877 | 10% | 874 | 0% | 10% |
| Winter | kW | 896 | 987 | 10% | 925 | -6% | 3% |
| Average Measure Life | yrs | 8 | 9 | | 8 | | |
| NEB (Lifetime) | $ | 0 | 0 | 0% | 1,058,450 | 0% | 0% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 7,151,272 | | | 9,125,780 | | 28% |
| TRC Costs | $ | 3,967,126 | | | 4,525,030 | | 14% |
| Net Benefits | $ | 3,184,145 | | | 4,600,750 | | 44% |
| BCR | n/a | 1.80 | | | 2.02 | | 12% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary lifetime and annual savings were 26% and 20% higher than planned values, respectively. This variance was mostly due to issuing more rebates for refrigerators than originally anticipated. The Company planned for 8,000 refrigerator rebates, but by 2011 year-end had processed over 18,400 rebates. The increase in refrigerator rebates was spurred by supplemental rebates available to customers through ARRA-funded dollars. These additional rebates were also the driver for the variance between the planned budget and preliminary costs.

Evaluated savings declined 11% overall compared to preliminary savings. The decrease was primarily due to the results of the Massachusetts Appliance Turn-in Program Evaluation Integrated Report Findings, which was previously filed in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108 and the evaluation report discussed below.

Evaluated NEBs increased compared to preliminary savings. This increase was primarily due to the results of the Massachusetts Appliance Turn-in Program Evaluation Integrated Report Findings, which was previously filed in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

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

- *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 decrease 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.

The ENERGY STAR® Appliances Program is cost-effective with a BCR of 2.02.

### 3. Residential Pilot Programs

The following section describes residential pilot program activities in 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 percent of total on-site energy use through deep retrofits of existing residential buildings and to identify incremental savings and how to reduce the costs and challenges associated with deep retrofits.

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

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

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

**Targeted End-Uses:**

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

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

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

**How Achievement of the Pilot's Stated Goal was Measured:** The overall goal of the Pilot was to attract participants into this "broader and deeper" energy-savings initiative, knowing that 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. 09-116, Exhibit NG-1.

| Table II.A.11: Deep Energy Retrofit | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 827,107 | | | 415,042 | | -50% |
| Participants | TBD | 20 | | | 5 | | -75% |
| Program Cost / Participant | $ | 41,355 | | | 83,008 | | 101% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | n/a | n/a | n/a | n/a | n/a | n/a |
| Winter | | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 827,107 | | | 415,042 | | -50% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

In 2011, the pilot program participation was 75% lower than planned and program spending was 50% 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. New Construction & Major Renovation - Major Renovation Statewide Pilot

**Description of Pilot/Specific Activities Intended to Study:** The pilot was implemented to capture lost opportunities and encourage energy efficient additions and renovations to existing homes.

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

**Targeted Customers:** This program targeted customers who want to build an addition on their existing home.

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

**Targeted End-Uses:**

- Lighting
- HVAC
- Hot Water
- Envelope

**Delivery Mechanism:** The Program Administrators, along with the JMC, included this pilot as an offering under the Massachusetts New Homes with ENERGY STAR program. This pilot combines elements of the Residential New Construction program (for the addition) and the Mass Save program (for the existing portion) to provide a comprehensive whole-house approach. Each home in the program had a HERS analysis performed in order to better understand the existing structure. Recommendations were provided to the homeowner for the existing portion (under a Mass Save model) and also to increase the energy efficiency of the new addition by the market-based rater in the program.

**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. Ultimately, achievement of this goal is measured by the pilot's cost-effectiveness.

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

| Table II.A.12: New Construction & Major Renovation - Major Renovation Statewide Pilot | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 303,616 | | | 60,292 | | -80% |
| Participants | TBD | 50 | | | 5 | | -90% |
| Program Cost / Participant | $ | 6,072 | | | 12,058 | | 99% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | n/a | n/a | n/a | n/a | n/a | n/a |
| Winter | | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 306,430 | | | 60,292 | | -80% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

By the end of 2011, there were 34 active projects enrolled in the Major Renovations Pilot. Five of those projects were near completion and 10 completed statewide by the end of 2011, of which 5 were in National Grid's service territory.

The pilot has been a learning process thus far. The PAs made several improvements to the pilot in 2012. These improvements included a more standardized approach to incentivizing, changing the pilot to be contractor rather than homeowner based, and simplifying the verification process to reduce costs. The PAs will continue to monitor homes that are in process to determine further how to morph the program into a solidified program for the 2013-2015 three year plan.

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

- *Memo: Major Renovations Pilot Evaluation:*
  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. The results of this study did not impact the 2011 evaluated results. This study is discussed in more detail in Section III, Study 11.

c. Residential New Construction MultiFamily (4-8 Story) Statewide Pilot

**Description of Pilot/Specific Activities Intended to Study:** The pilot was implemented to broaden participation and achieve deeper savings in the multi-family new construction 4-8 story category through an incentive design that encourages such action.

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

**Targeted Customers:** This pilot targeted 4-8 story multi-family new construction projects.

**Definition of Pilot Program Participant:** Participants are defined as the number of units served under this program.

**Targeted End-Uses:**

- Lighting
- Hot Water
- HVAC
- Motors and Drives
- Envelope

**Delivery Mechanism:** This pilot was delivered by the Program Administrators and the statewide new construction program lead vender.

**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. Ultimately, achievement of this goal is measured by the pilot's cost-effectiveness.

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

| Table II.A.13: Residential New Construction Multi Family (4-8 Story) Statewide Pilot | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 328,310 | | | 328,062 | | 0% |
| Participants | TBD | 209 | | | 8 | | -96% |
| Program Cost / Participant | $ | 1,571 | | | 41,008 | | 2511% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | n/a | n/a | n/a | n/a | n/a | n/a |
| Winter | | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 342,310 | | | 328,062 | | -4% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

The Multi Family Pilot completed a successful 2011 calendar year having exceeded all of its unit and savings goals. Statewide project and unit completions achieved a 125% success rate; electric savings goals reached 149%; and gas savings 417%. The 2012 project pipeline was further solidified during 2011 and is projected to yield results well above the established unit and savings goals. Also, work continued on a revised Project Saving Tool that is in alignment with many of the EPA Multi Family High Rise Standard prerequisites, and addresses the lost savings opportunities identified during the past two years of the pilot. The revised tool will be used for demonstration purposes for both the PAs sponsoring the pilot and the participants, with an eye towards establishing a more comprehensive Multi Family New Construction program for 2013 and beyond.

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

- *Massachusetts Residential New Construction Four to Eight Story Multifamily Pilot Interview Findings*
  This study assessed 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 focused on the lessons learned from the pilot about addressing the energy efficiency potential of the mid-rise multifamily new construction market. The results of this study did not impact the 2011 evaluated results. This study is discussed in more detail in Section III, Study 12.

### d. Residential New Construction Lighting Design Statewide Pilot

**Description of Pilot/Specific Activities Intended to Study:** The Program Administrators worked with lighting designers and build/design teams to identify creative ways to approach energy savings through proper lighting design on a portfolio level.

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

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

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

**Targeted End-Uses:** Lighting and controls.

**Delivery Mechanism:** The Program Administrators, along with the JMC, included this pilot as an offering under the Massachusetts New Homes with ENERGY STAR program.

**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. Ultimately, achievement of this goal is measured by the pilot's cost-effectiveness.

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

| Table II.A14: Residential New Construction Lighting Design Statewide Pilot | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 92,277 | | | 27,904 | | -70% |
| Participants | TBD | 6 | | | 8 | | 33% |
| Program Cost / Participant | $ | 15,380 | | | 3,488 | | -77% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | n/a | n/a | n/a | n/a | n/a | n/a |
| Winter | | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 96,027 | | | 27,904 | | -71% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Of the fifteen projects enrolled in the2011 Lighting Design Pilots statewide, there were 11 completions. All projects successfully utilized the use of working with a Lighting Designer and incorporated high efficacy lamps and/or lighting controls i.e. dimmers, occupancy sensors, vacancy sensors, timers, etc. The Lighting Design Pilot calculator has changed to accommodate tracking code compliance, kilowatt hours, lumens, efficacy (lm/W) for every room of each home that participated in the Pilot.

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

e. R&D and Demonstration

**Description of Pilot/Specific Activities Intended to Study:** Participate in funding electric demonstration projects that apply to emerging technologies. Specific technologies that were reviewed include the following: Programmable Controllable Thermostats (PCT), Electronically Commutated Hot Water Circulating Pumps (ECM), Multi Family Occupancy/Temperature Control (MFTC), Oil Boiler Load Controls (OBLC) and Heat Pump Water Heater (HPWH)

**Targeted Customers:** Residential customers who can benefit from improved technologies that use electricity as the main power source for the technology.

- For the PCT Pilot we selected towns for customer participation that had both gas and electric. Customers were required to have central air conditioning
- The ECM Pilot participants were selected from towns that had National Grid electric service. Participants were required to be replacing a boiler and installing new hot water circulating pumps.
- The MFTC Pilot was one site with multiple families. The site required the use of electric for heating and air conditioning, and the ability to use occupancy sensors for the controls.
- The OBLC Pilot was open to oil customers in National Grid electric service territory. Customers were required to have an oil hot water boiler.
- The HPWH Pilot was open to electric customers and was a continuation of a pilot installed in 2010. Customers were required to be replacing an electric resistance hot water heater.

**Targeted End-Uses:** Residential electric controlled equipment.

**Delivery Mechanism:**

- PCT pilot units were installed by a third party HVAC contractor. The systems were required to have central air conditioning. The program administrator handled the rebate processing and processed the contractor payments. A third party evaluation contractor is being used to evaluate the product.
- ECM pilot units were installed as part of a new boiler installation by a plumbing contractor. The contractor would install (1) new ECM pump replacing single and multiple pump systems. The program administrator processed the customer rebates which were paid to the contractor. A third party evaluation contractor will be evaluating the reliability and results.
- The MFTC pilot was installed by a third party control contractor. The contractor worked with the owner to develop a scope with the approval of National Grid. The program administrator worked with the customer and vendor on the project. Upon completion of the installs, a third party evaluation contractor was hired to evaluate the system performance and customer benefits.
- The OBLC pilot was installed by a plumbing contractor in existing oil boiler installations. The program administrator paid the rebate to the oil contractor for the installation services for installing the controls. A third party evaluation contractor will evaluate the results achieved.

- The HPWH pilot was installed by a plumbing contractor in 2010. The units were monitored and evaluated by a third party contactor during 2011.

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

**How Achievement of the Pilot's Stated Goal was Measured:**

- PCT Pilot is determining whether customers will interact with controllable thermostats and use the enhanced options that will result in increased electric savings. Determine if a greater percentage of customers utilize the programmable option. Evaluation is ongoing which will define our goal.
- ECM Pilot is assessing whether single and multiple pump system can be replace with a single high efficiency variable speed motor. Installing a single motor significant savings can be achieved because of the pumping reduction capacity. Evaluation is ongoing and will determine our goal and the optimal configuration for installations.
- MFTC pilot is determining what level of savings can be achieved by automating the temperature control system as well as automating the lighting and outlet control based on unit occupancy. Occupancy feedback is also a key component to this type of technology. Evaluation is ongoing and will determine the final goal and best practices to implement.
- OBLC pilot is attempting to achieve oil savings based on an advanced control technology that uses the boilers thermal demand to provide cycling of the boiler resulting in reduced fuel consumption. Evaluation is ongoing and will determine the best application for installations and if we are able to achieve our goal.
- HPWH pilot is developing a new technology that would replace existing electric resistance water heaters that can use up to 70% less energy. Customer satisfaction with the technology is also an important goal for this technology. An evaluation is being performed to determine if we can achieve our goals.

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

| Table II.A.15: R&D and Demonstration | | | | | | | |
|---|---|---|---|---|---|---|---|
| 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 | $ | 251,000 | | | 45,241 | | -82% |
| Participants | TBD | 4 | | | 23 | | n/a |
| Program Cost / Participant | $ | n/a | | | n/a | | n/a |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | n/a | n/a | n/a | n/a | n/a | n/a |
| Winter | | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 251,000 | | | 45,241 | | -82% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

In 2011, the program launched several new exciting technologies that will have the potential to provide future savings for our customers and programs. The Company launched a pilot in Multi Family to help understand savings that can be achieved in small square footage residences with occupancy controls and communicating thermostats. The Company also launched another new initiative installing variable speed circulating pumps for single and multi pump applications.

Spending fell below anticipated levels due to the ECM pump pilot being only partially completed, and several new technologies only reaching the planning and development stage in 2011. The Company also implemented strategies that kept costs lower in the completed installations. There were 23 active participants in the program during the year.

The program conducted research with an external company on integrating controls and energy saving equipment into an audit tool for calculation purposes. This tool will provide insight into savings and realization of savings for our customers in the multi family space that wish to install more advanced levels of controls and other associated equipment.

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

- *Heat Pump Water Heaters Evaluation of Field Installed Performance*
  This technical evaluation of Heat Pump Water Heaters (HPWH) was designed to quantify the in-situ performance of three types of HPWHs. The study evaluated 14 different units over the course of a year and the results will be applied to future analysis of HPHWs. The results of this study do not affect program results for 2011. This study is discussed in more detail in Section III, Study 14.

### f. Community Based Pilot

**Description of Pilot/Specific Activities Intended to Study**: The term "Community-Based Pilots" encompassed a number of unique partnerships in 2011 between the Program Administrators and local communities designed to harness the power of community-based outreach to achieve broader participation in the Commonwealth's energy efficiency programs. The Company partnered with various community groups to implement community mobilization initiatives.

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

**Targeted Customers:** The Program Administrators and interested stakeholders selected communities with the greatest opportunities for success, based on an assessment of the proposal submitted. Targeted customers varied by pilot, but in general included residential customers with incomes between 60 and 120 percent of median household income in their community.

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

**Targeted End-Uses**: The end-uses targeted by the community based pilots included the same end-uses addressed under the Company's existing audit and weatherization programs.

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

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

**How Achievement of the Pilot's Stated Goal was Measured:** A multi-year evaluation of community based pilots was conducted by Opinion Dynamics Corporation to assess the effectiveness of these pilots and determine their potential for replication. This process evaluation 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.17: Community Based Pilot | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 255,778 | | | 100,762 | | -61% |
| Participants | TBD | 2 | | | 0 | | -100% |
| Program Cost / Participant | $ | 127,889 | | | #DIV/0! | | #DIV/0! |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | n/a | n/a | n/a | n/a | n/a | n/a |
| Winter | | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 255,778 | | | 100,762 | | -61% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

The Electric Community Based Pilot spent 61% less than planned in 2011. The variance between planned costs and preliminary costs in 2011 was due to the long start up time needed for the one electric CMI in Lynn. The initial community group training took place late in Q2 with the pilot officially launching in Q3. Although a pipeline was starting to build up in 2011, there were no weatherization job completions in 2011.

EM&V studies included in the Annual Report that 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-scaleimplementation 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.

## B. *Low-Income Sector Programs*

### 1. Summary

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

- Low-Income Residential New Construction
- Low-Income 1-4 Family Retrofit
- Low-Income MultiFamily Retrofit

Tables II.B.1 through II.B.3 provide summary information on the performance of the low-income programs at the sector, end use, and program 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 | $ | 19,979,831 | | | 13,132,996 | | -34% |
| Performance Incentive | $ | 1,166,492 | | | 1,085,484 | | -7% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 200,630 | 119,349 | -41% | 105,258 | -12% | -48% |
| Annualized | MWh | 14,240 | 8,511 | -40% | 7,515 | -12% | -47% |
| Demand | | | | | | | |
| Lifetime | kW | 20,494 | 11,634 | -43% | 11,603 | 0% | -43% |
| Annualized | | | | | | | |
| Summer | kW | 1,429 | 822 | -42% | 884 | 8% | -38% |
| Winter | kW | 3,375 | 1,685 | -50% | 1,394 | -17% | -59% |
| NEB (Lifetime) | $ | 33,625,043 | 27,811,809 | -17% | 30,573,024 | 10% | -9% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 57,044,958 | | | 43,189,291 | | -24% |
| TRC Costs | $ | 21,302,758 | | | 14,220,390 | | -33% |
| Net Benefits | $ | 35,742,201 | | | 28,968,902 | | -19% |
| BCR | n/a | 2.68 | | | 3.04 | | 13% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

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

| Table II.B.2: Low-Income Sector Summary of End Uses | | | | |
|---|---|---|---|---|
| **End Uses** | **Units (Lifetime)** | **Preliminary Year-End Results** | **Evaluated Results** | **% Change from Preliminary to Evaluated** |
| **Lighting** | | | | |
| Energy | MWh | 43,239 | 44,579 | 3% |
| Demand | kW | 4,114 | 5,185 | 26% |
| NEB | $ | 887,598 | 830,340 | -6% |
| **HVAC** | | | | |
| Energy | MWh | 10,026 | 13,089 | 31% |
| Demand | kW | 214 | 676 | 216% |
| NEB | $ | 23,047,760 | 17,567,665 | -24% |
| **Refrigeration** | | | | |
| Energy | MWh | 62,398 | 46,114 | -26% |
| Demand | kW | 6,951 | 5,627 | -19% |
| NEB | $ | 1,754,496 | 1,520,692 | -13% |
| **Hot Water** | | | | |
| Energy | MWh | 1,052 | 999 | -5% |
| Demand | kW | 101 | 115 | 13% |
| NEB | $ | 1,811,528 | 939,822 | -48% |
| **End Use Behavior** | | | | |
| Energy | MWh | 2,634 | 477 | -82% |
| Demand | kW | 254 | - | -100% |
| NEB | $ | 310,426 | 3,015,448 | 871% |
| **Total** | | | | |
| Energy | MWh | 119,349 | 105,258 | -12% |
| Demand | kW | 11,634 | 11,603 | 0% |
| NEB | $ | 27,811,809 | 30,573,024 | 10% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

| Table II.B.3: Low-Income Program Summary | | | | |
|---|---|---|---|---|
| Program / Performance Category | Units | Planned Value | Evaluated Results | |
| | | | Value | % Change from Planned |
| **Low-Income Residential New Construction** | | | | |
| TRC Benefits | $ | 651,384 | 1,231,982 | 89% |
| TRC Costs | $ | 499,051 | 266,219 | -47% |
| Net Benefits | $ | 152,333 | 965,763 | 534% |
| BCR | n/a | 1.31 | 4.63 | 255% |
| **Low-Income 1 to 4 Family Retrofit** | | | | |
| TRC Benefits | $ | 34,388,847 | 27,244,556 | -21% |
| TRC Costs | $ | 12,690,898 | 9,991,147 | -21% |
| Net Benefits | $ | 21,697,949 | 17,253,409 | -20% |
| BCR | n/a | 2.71 | 2.73 | 1% |
| **Low-Income Multi Family Retrofit** | | | | |
| TRC Benefits | $ | 22,004,727 | 14,712,753 | -33% |
| TRC Costs | $ | 7,487,944 | 3,569,524 | -52% |
| Net Benefits | $ | 14,516,783 | 11,143,229 | -23% |
| BCR | n/a | 2.94 | 4.12 | 40% |
| **TOTAL** | | | | |
| TRC Benefits | $ | 57,044,958 | 43,189,291 | -24% |
| TRC Costs | $ | 21,302,758 | 14,220,390 | -33% |
| Net Benefits | $ | 35,742,201 | 28,968,902 | -19% |
| BCR | n/a | 2.68 | 3.04 | 13% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

## 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 Residential New Construction

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

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

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

**Targeted End-Uses:**

- Lighting
- HVAC
- Refrigeration
- Hot Water
- Envelope

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

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

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

| Table II.B.4: Low Income Residential New Construction | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 336,230 | | | 241,301 | | -28% |
| Performance Incentive | $ | 6,386 | | | 23,933 | | 275% |
| Participants | Accounts | 204 | | | 678 | | 232% |
| Program Cost / Participant | $ | 1,648 | | | 139 | | -92% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 3,955 | 3,283 | -17% | 2,502 | -24% | -37% |
| Annualized | MWh | 412 | 318 | -23% | 243 | -24% | -41% |
| Average Measure Life | yrs | 10 | 10 | 8% | 10 | 0% | 7% |
| Demand | | | | | | | |
| Lifetime | kW | 518 | 448 | -13% | 363 | -19% | -30% |
| Annualized | | | | | | | |
| Summer | kW | 45 | 36 | -19% | 28 | -22% | -37% |
| Winter | kW | 82 | 63 | -24% | 49 | -23% | -41% |
| Average Measure Life | yrs | 12 | 12 | | 13 | | |
| NEB (Lifetime) | $ | 143,052 | 361,818 | 153% | 1,032,301 | 185% | 622% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 651,384 | | | 1,231,982 | | 89% |
| TRC Costs | $ | 499,051 | | | 266,219 | | -47% |
| Net Benefits | $ | 152,333 | | | 965,763 | | 534% |
| BCR | n/a | 1.31 | | | 4.63 | | 255% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Electric savings decreased 23% and demand decreased 19% from planned to preliminary, this is mainly due to fewer units completing in the program and fewer lighting and appliances being installed. The 24% energy decrease and 22% demand decrease from preliminary to evaluated is due to the incorporation of penetration rates of energy efficient lighting and appliances from the Massachusetts Mini Baseline Study of Homes Built at the End of the 2006 IECC Cycle.

NEB value increased from planned to preliminary due to the fact that a higher percentage of the completed homes had higher efficiency levels than what was originally planned. This resulted in greater than anticipated savings from Non Electric Benefits. The increase from preliminary to evaluated NEB value was 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

EM&V studies included in the Annual Report that 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.
- *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 (filed in D.P.U 11 -108). 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.At this point in time no mid-term modification is planned for 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The Low-Income Residential New Construction Program is cost-effective with a BCR of 4.63.

b. Low-Income 1-4 Family Retrofit

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

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

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

**Targeted End-Uses:**

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

**Delivery Mechanism:** PAs used a lead vendor and/or worked closely with their respective Community Action Program ("CAP") agencies on all aspects of the program design and implementation. All PAs worked in conjunction with the Low-Income Energy Affordability Network ("LEAN"). The 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 lead vendor/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. 09-116, Exhibit NG-1.

| Table II.B.5: Low Income 1-4 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 | $ | 12,020,443 | | | 9,402,303 | | -22% |
| Performance Incentive | $ | 670,455 | | | 856,773 | | 28% |
| Participants | Hholds | 4,006 | | | 4,318 | | 8% |
| Program Cost / Participant | $ | 3,001 | | | 2,177 | | -27% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 75,330 | 75,493 | 0% | 62,183 | -18% | -17% |
| Annualized | MWh | 6,638 | 5,652 | -15% | 4,730 | -16% | -29% |
| Average Measure Life | yrs | 11 | 13 | 18% | 13 | -2% | 16% |
| Demand | | | | | | | |
| Lifetime | kW | 8,149 | 8,545 | 5% | 8,300 | -3% | 2% |
| Annualized | | | | | | | |
| Summer | kW | 682 | 610 | -11% | 679 | 11% | 0% |
| Winter | kW | 1,511 | 1,102 | -27% | 824 | -25% | -45% |
| Average Measure Life | yrs | 12 | 14 | | 12 | | |
| NEB (Lifetime) | $ | 25,220,984 | 23,494,395 | -7% | 19,379,136 | -18% | -23% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 34,388,847 | | | 27,244,556 | | -21% |
| TRC Costs | $ | 12,690,898 | | | 9,991,147 | | -21% |
| Net Benefits | $ | 21,697,949 | | | 17,253,409 | | -20% |
| BCR | n/a | 2.71 | | | 2.73 | | 1% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary annual savings were 15% lower than planned values while preliminary lifetime savings had little to no change from Planned. The Company rebated fewer CFLs and more refrigerators than planned. This change in measure mix did not cover the shortfall in annual savings. However, because refrigerators have longer measure lives than CFLs, the Company was able to meet its lifetime energy savings goals. Preliminary summer and winter demand savings were 11% and 27% lower than planned. This variance was also due to the change in measure mix.

Total costs were 22% lower than planned. Costs were lower than anticipated because the Company had the opportunity to work with LEAN to leverage ARRA funds in order to better serve the low income community. As a result, the Company was able to achieve savings for a lower cost than planned.

Evaluated savings were 16% lower than preliminary year-end estimates. These decreases were due to the impact evaluations described below.

Evaluated NEBs were 18% lower than preliminary year-end estimates. This decrease was 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

EM&V studies included in the Annual Report that 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.
- *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 decrease in program savings for the 2011 evaluated results. This study is discussed in more detail in Section III, Study 9.
- *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 decrease 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.

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The Low-Income 1-4 Retrofit Program is cost-effective with a BCR of 2.73.

### c. Low-Income MultiFamily 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 percent 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 electric account number served in a facility with five or more units.

**Targeted End-Uses:**

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

**Delivery Mechanism:** PAs used a lead vendor and/or worked closely with their respective 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 lead vendor/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. 09-116, Exhibit NG-1.

| Table II.B.6: 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 | $ | 6,998,294 | | | 3,095,892 | | -56% |
| Performance Incentive | $ | 670,455 | | | 253,515 | | -62% |
| Participants | Units | 8,401 | | | 4,289 | | -49% |
| Program Cost / Participant | $ | 833 | | | 722 | | -13% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 121,344 | 40,573 | -67% | 40,573 | 0% | -67% |
| Annualized | MWh | 7,190 | 2,542 | -65% | 2,542 | 0% | -65% |
| Average Measure Life | yrs | 17 | 16 | -5% | 16 | 0% | -5% |
| Demand | | | | | | | |
| Lifetime | kW | 11,826 | 2,641 | -78% | 2,941 | 11% | -75% |
| Annualized | | | | | | | |
| Summer | kW | 702 | 176 | -75% | 176 | 0% | -75% |
| Winter | kW | 1,782 | 520 | -71% | 522 | 0% | -71% |
| Average Measure Life | yrs | 17 | 15 | | 17 | | |
| NEB (Lifetime) | $ | 8,261,007 | 3,955,596 | -52% | 10,161,588 | 157% | 23% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 22,004,727 | | | 14,712,753 | | -33% |
| TRC Costs | $ | 7,487,944 | | | 3,569,524 | | -52% |
| Net Benefits | $ | 14,516,783 | | | 11,143,229 | | -23% |
| BCR | n/a | 2.94 | | | 4.12 | | 40% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary lifetime and annual kWh savings were 67% and 65% lower than planned. The main reason for this variance was the Company did not reach its planned number of participants. This shortfall in participation also accounts for preliminary costs being 56% lower than planned budgets. Additionally, the Company planned that each participant would install approximately 6 CFL bulbs and 4.5 fixtures each. These assumptions were derived from looking at historical participation levels from previous years. However, preliminary year-end results show that on average, participants installed only 4 CFL bulbs and 2 fixtures each. Combined, the lower participation and lower than anticipated lighting measures explain the variance between planned and preliminary values. Evaluated savings were the same as preliminary year-end estimates.

Evaluated NEBs were 157% higher than preliminary year-end estimates. This increase was 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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

EM&V studies included in the Annual Report that 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.

- *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.
- *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 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.

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108.

The Low-Income Multifamily Retrofit Program is cost-effective with a BCR of 4.12.

## C. *Commercial & Industrial Sector Programs*

### 1. Summary

During 2011 the Company implemented the following Commercial and Industrial ("C&I") programs and C&I pilots:

*C&I Programs*:

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

*C&I Pilot Programs:*

- Community-Based Pilot

Tables II.C.1 through II.C.3 provide summary information on the performance of the C&I programs at the sector, end use, and program levels, respectively, while sections II.C.2 and II.C.3 provide detailed information on the performance of each C&I program and pilot 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 | $ | 108,065,425 | | | 55,081,127 | | -49% |
| Performance Incentive | $ | 6,718,673 | | | 5,320,223 | | -21% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 3,603,971 | 3,372,679 | -6% | 3,144,310 | -7% | -13% |
| Annualized | MWh | 283,796 | 225,310 | -21% | 213,214 | -5% | -25% |
| Demand | | | | | | | |
| Lifetime | kW | 710,288 | 515,370 | -27% | 525,107 | 2% | -26% |
| Annualized | | | | | | | |
| Summer | kW | 55,943 | 35,346 | -37% | 36,002 | 2% | -36% |
| Winter | kW | 42,408 | 33,130 | -22% | 32,211 | -3% | -24% |
| NEB (Lifetime) | $ | 14,166,504 | (15,093,840) | -207% | (11,728,426) | -22% | -183% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 528,763,548 | | | 398,391,870 | | -25% |
| TRC Costs | $ | 167,149,884 | | | 74,553,069 | | -55% |
| Net Benefits | $ | 361,613,664 | | | 323,838,801 | | -10% |
| BCR | n/a | 3.16 | | | 5.34 | | 69% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

| Table II.C.2: C&I Sector Summary of End Uses | | | | |
|---|---|---|---|---|
| End Uses | Units (Lifetime) | Preliminary Year-End Results | Evaluated Results | % Change from Preliminary to Evaluated |
| **Lighting** | | | | |
| Energy | MWh | 1,019,029 | 993,580 | -2% |
| Demand | kW | 195,407 | 189,500 | -3% |
| NEB | $ | (5,039,772) | (3,965,179) | -21% |
| **HVAC** | | | | |
| Energy | MWh | 1,548,742 | 1,302,414 | -16% |
| Demand | kW | 208,498 | 192,119 | -8% |
| NEB | $ | (30,079,268) | (27,159,468) | -10% |
| **Motors and Drives** | | | | |
| Energy | MWh | 122,644 | 160,922 | 31% |
| Demand | kW | 9,277 | 10,050 | 8% |
| NEB | $ | (48,300) | (44,548) | -8% |
| **Refrigeration** | | | | |
| Energy | MWh | 132,547 | 144,848 | 9% |
| Demand | kW | 13,237 | 14,884 | 12% |
| NEB | $ | (4) | (4) | -8% |
| **Process** | | | | |
| Energy | MWh | 518,912 | 516,460 | 0% |
| Demand | kW | 83,684 | 114,080 | 36% |
| NEB | $ | 20,073,504 | 20,900,081 | 4% |
| **End Use Behavior** | | | | |
| Energy | MWh | - | - | 0% |
| Demand | kW | - | - | 0% |
| NEB | $ | - | - | 0% |
| **Compressed Air** | | | | |
| Energy | MWh | 30,805 | 26,087 | -15% |
| Demand | kW | 5,267 | 4,474 | -15% |
| NEB | $ | - | - | 0% |
| **Total** | | | | |
| Energy | MWh | 3,372,679 | 3,144,310 | -7% |
| Demand | kW | 515,370 | 525,107 | 2% |
| NEB | $ | (15,093,840) | (11,728,426) | -22% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

| Table II.C.3 C&I Program Summary | | | | |
|---|---|---|---|---|
| **Program / Performance Category** | **Units** | **Planned Value** | **Evaluated Results** | |
| | | | Value | % Change from Planned |
| **C&I New Construction & Major Renovation** | | | | |
| TRC Benefits | $ | 107,234,520 | 128,144,047 | 19% |
| TRC Costs | $ | 32,899,481 | 17,606,195 | -46% |
| Net Benefits | $ | 74,335,040 | 110,537,852 | 49% |
| BCR | n/a | 3.26 | 7.28 | 123% |
| **C&I Large Retrofit** | | | | |
| TRC Benefits | $ | 356,226,803 | 223,409,897 | -37% |
| TRC Costs | $ | 110,198,100 | 41,323,072 | -63% |
| Net Benefits | $ | 246,028,703 | 182,086,825 | -26% |
| BCR | n/a | 3.23 | 5.41 | 67% |
| **C&I Small Retrofit** | | | | |
| TRC Benefits | $ | 65,302,225 | 46,837,926 | -28% |
| TRC Costs | $ | 22,872,540 | 14,553,811 | -36% |
| Net Benefits | $ | 42,429,685 | 32,284,114 | -24% |
| BCR | n/a | 2.86 | 3.22 | 13% |
| **Community Based Pilot** | | | | |
| TRC Benefits | $ | n/a | n/a | n/a |
| TRC Costs | $ | 118,250 | - | -100% |
| Net Benefits | $ | n/a | n/a | n/a |
| BCR | n/a | n/a | n/a | n/a |
| **Hard-to-Measure Initiatives** | | | | |
| TRC Costs | $ | 1,794,788 | 698,829 | -61% |
| **TOTAL** | | | | |
| TRC Benefits | $ | 528,763,548 | 398,391,870 | -25% |
| TRC Costs | $ | 167,149,884 | 74,553,069 | -55% |
| Net Benefits | $ | 361,613,664 | 323,838,801 | -10% |
| BCR | n/a | 3.16 | 5.34 | 69% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

During 2011, the Program Administrators built upon existing C&I programs and significantly expanded initiatives to increase participation across all C&I programs. Selected highlights are presented below:

- **Gas/Electric Integration** – Building on the transition which took place in 2010, gas and electric integration continued to grow and run more smoothly. Program Administrators identified multi-fuel leads and worked closely with their counterparts in the same service territory to develop combined gas and electric projects for their customers. With these advancements, the Program Administrators realized increased savings and participation in this program as vendors became more comfortable identifying and installing both electric and gas measures.

- **Memorandum of Understanding (MOU) Agreements** – The use of these innovative agreements, focused on long-term energy savings with large C&I customers, continued to expand across the Commonwealth in 2011. The adoption of MOUs by an increased number of customers in 2011 will serve to yield energy savings in years to come as the agreements ramp up, lifting performance of both New Construction/Major Renovation and Large Retrofit projects.

- **Upstream Initiative** – New Construction program savings were bolstered during the fourth quarter of 2011 largely due to the introduction of the Upstream Lighting initiative, which was launched in September of 2011. In just a few months, over $5 million of customer incentives were applied to support the installation of over 340,000 High Performance T8, High Output T5, and LED lamps by the end of the year. Overall, the emergence and advancement of LED products helped programs evolve in 2011, as costs came down and products became more readily available and reliable.

- **Retrofit Sector Strategy** – Responding to the maturity of the Large Retrofit Program, the Program Administrators began to test new strategies focused on specific customer segments. These segment-specific offerings included an expanded variety of cost-effective solutions, many of which were non-lighting measures that, in addition to energy savings, provided additional customer benefits.

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

## 2. C&I Programs

### a. C&I New Construction and Major Renovation

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

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

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

**Targeted End-Uses:**

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

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

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

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

| Table II.C.4: C&I New Construction and Major Renovation | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 28,315,668 | | | 13,214,505 | | -53% |
| Performance Incentive | $ | 1,394,196 | | | 1,851,634 | | 33% |
| Participants | Accounts | 905 | | | 678 | | -25% |
| Program Cost / Participant | $ | 31,288 | | | 19,490 | | -38% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 754,660 | 669,838 | -11% | 783,302 | 17% | 4% |
| Annualized | MWh | 50,083 | 44,141 | -12% | 51,432 | 17% | 3% |
| Average Measure Life | yrs | 15 | 15 | 1% | 15 | 0% | 1% |
| Demand | | | | | | | |
| Lifetime | kW | 164,890 | 140,506 | -15% | 170,593 | 21% | 3% |
| Annualized | | | | | | | |
| Summer | | 10,940 | 9,500 | -13% | 11,449 | 21% | 5% |
| Winter | | 8,346 | 8,379 | 0% | 9,162 | 9% | 10% |
| Average Measure Life | yrs | 15 | 15 | | 15 | | |
| NEB (Lifetime) | $ | 192,373 | 18,323,984 | 9425% | 19,311,314 | 5% | 9938% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 107,234,520 | | | 128,144,047 | | 19% |
| TRC Costs | $ | 32,899,481 | | | 17,606,195 | | -46% |
| Net Benefits | $ | 74,335,040 | | | 110,537,852 | | 49% |
| BCR | n/a | 3.26 | | | 7.28 | | 123% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary NEB values were significantly higher than planned values for this program. The variance was attributable to a large, custom process project that accounted for 37% of the program's annual preliminary savings. The project also had associated water, waste, labor and transportation cost savings accounted for as Non-Energy Benefits (NEBs). These NEBs were not originally planned for and explain the large variance in preliminary NEBs relative to the planned values.

Total program costs are 53% less than planned due to lower than anticipated participation.

Evaluated energy annualized savings increased 17% from preliminary year-end estimates and demand savings increased 21%. This increase is due to the combined affects of the results of impact evaluations described below.

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

- *National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study*
  The results of this study vary for each end-use category within the program. The net affect of these results is to increase program savings. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109

- *2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo:* This study produced realization rates for annual kWh, therms, and fuel impacts for those CHP projects in the CHP end-use category. 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 decrease energy savings for this program. The study is discussed in more detail in Section III, Study19.
- *Impact Evaluation of 2008 and 2009 Custom CDA Installations*
  There is no effect on energy savings as the resulting realization rate on energy equaled the realization rate from our previous studies. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.
- *Impact Evaluation of 2009 Custom HVAC Installations*
  The net effect of this study is to increase both energy and demand savings for this program. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.
- *Impact Evaluation of 2010 Custom Process and Compressed Air Installations*
  This study produced realization rates for annual kWh, summer on-peak and seasonal peak kW, and winter on-peak and seasonal peak kW for those custom projects in the Process and Compressed Air end-use category. The net effect on each PA's program is dependent on the previous realization rates being incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to decrease energy savings for this program. The study is discussed in more detail in Section III, Study20.
- *Impact Evaluation of 2010 Custom Lighting Installations*
  This study produced realization rates for annual kWh, summer on-peak and seasonal peak kW, and winter on-peak and seasonal peak kW for those custom projects in the Lighting end-use category. The net effect on each PA's C&I New Construction and C&I Retrofit programs is dependent on the previous realization rates being incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to decrease energy savings for this program.The study is discussed in more detail in Section III, Study21.
- *HBL Market Effects Study Project 1A New Construction Market Characterization - Massachusetts Energy Efficiency Programs' Large Commercial & Industrial Evaluation:* This study estimated the energy savings associated with the changes to a high bay lighting market in Massachusetts and assessed the attribution of these changes (i.e. market effects) to the Program Administrators' energy efficiency programs. The results of this study were applicable to the 2010 program year only; therefore the results were removed for the 2011 program year results. The net effect of this is to decrease both energy and demand savings for this program. Please refer to section III.D of the 2010 Annual Report for additional information.
- *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 or 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, Study22.

- *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, Study23.The Company is still reviewing program performance and the results of the described evaluations to determine what, if any, changes to the program design or implementation may result in future years.

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 7.28.

### b. C&I Large Retrofit

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

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

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

**Targeted End-Uses:**

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

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

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

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

| Table II.C.5: C&I Large Retrofit | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 62,353,681 | | | 29,090,312 | | -53% |
| Performance Incentive | $ | 4,421,710 | | | 2,904,876 | | -34% |
| Participants | Accounts | 759 | | | 860 | | 13% |
| Program Cost / Participant | $ | 82,152 | | | 33,826 | | -59% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 2,464,927 | 2,364,488 | -4% | 2,014,151 | -15% | -18% |
| Annualized | MWh | 201,681 | 152,993 | -24% | 132,943 | -13% | -34% |
| Average Measure Life | yrs | 12 | 15 | 26% | 15 | -2% | 24% |
| Demand | | | | | | | |
| Lifetime | kW | 453,214 | 298,870 | -34% | 282,080 | -6% | -38% |
| Annualized | kW | | | | | | |
| Summer | | 37,322 | 19,545 | -48% | 18,551 | -5% | -50% |
| Winter | | 30,134 | 21,063 | -30% | 18,875 | -10% | -37% |
| Average Measure Life | yrs | 12 | 15 | | 15 | | |
| NEB (Lifetime) | $ | 8,847,212 | (32,072,842) | -463% | (28,921,217) | -10% | -427% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 356,226,803 | | | 223,409,897 | | -37% |
| TRC Costs | $ | 110,198,100 | | | 41,323,072 | | -63% |
| Net Benefits | $ | 246,028,703 | | | 182,086,825 | | -26% |
| BCR | n/a | 3.23 | | | 5.41 | | 67% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

Preliminary annual MWh savings are 24% lower than planned while preliminary lifetime MWh savings are only 4% lower than planned. There was a shortfall in retrofit project savings in relation to the planning estimate. This shortfall was somewhat offset by completing projects with longer measure lives than planned.

Total costs were 53% lower than planned for two main reasons. First, the Company completed a number of CHP ("Combined Heat & Power") projects in 2011. The cost of a CHP project is significantly lower than traditional custom retrofit projects and allowed the Company to achieve 47% of preliminary savings for 26% of total spent dollars. The Company did not plan that such a large amount of its savings would result from CHP projects. Second, the Company had budgeted approximately $5.25 million in order to secure outside financing in 2011 but was unable to do so.

Preliminary NEB values were 463% lower than planned. This variance was also due to CHP projects, which ultimately require higher natural gas inputs, which translates into negative gas savings and benefits.

Evaluated savings decreased 15% from preliminary year-end estimates. This decrease is due to the combined affects of the results of impact evaluations described below.

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

- *National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study*
  The results of this study vary for each end-use category within the program. The net affect of these results is to increase program savings. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109
- *Impact Evaluation of 2008 and 2009 Custom CDA Installations*
  There is no effect on energy savings as the resulting realization rate on energy equaled the realization rate from our previous studies. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.
- *Impact Evaluation of 2009 Custom HVAC Installations*
  The net effect of this study is to increase both energy and demand savings for this program. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109.
- *2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo*
  This study produced realization rates for annual kWh, therms, and fuel impacts for those CHP projects in the CHP end-use category.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 decrease energy savings for this program.The study is discussed in more detail in Section III, Study19.
- *Impact Evaluation of 2010 Custom Process and Compressed Air Installations*
  This study produced realization rates for annual kWh, summer on-peak and seasonal peak kW, and winter on-peak and seasonal peak kW for those custom projects in the Process and Compressed Air end-use category.The net effect on each PA's program is dependent on the previous realization rates being incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to decrease energy savings for this program.The study is discussed in more detail in Section III, Study20.
- *Impact Evaluation of 2010 Custom Lighting Installations*
  This study produced realization rates for annual kWh, summer on-peak and seasonal peak kW, and winter on-peak and seasonal peak kW for those custom projects in the Lighting end-use category. The net effect on each PA's C&I New Construction and C&I Retrofit programs is dependent on the previous realization rates being incorporated into each PA's screening tool, and may therefore differ. The net effect for the Company was to decrease energy savings for this program.The study is discussed in more detail in Section III, Study 21.
- *HBL Market Effects Study Project 1A New Construction Market Characterization - Massachusetts Energy Efficiency Programs' Large Commercial & Industrial Evaluation:*
  This study estimated the energy savings associated with the changes to a high bay lighting market in Massachusetts and assessed the attribution of these changes (i.e. market effects) to the Program Administrators' energy efficiency programs. The results of this study were applicable to the 2010 program year only; therefore the results were removed for the 2011 program year results. The net effect of this is to decrease both energy and demand savings for this program. Please refer to section III.D of the 2010 Annual Report for additional information.

- *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, Study22.
- *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, Study23.

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 5.41.

c. C&I Small Retrofit

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

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

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

**Targeted End-Uses:**

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

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

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

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

| Table II.C.6: C&I Small Retrofit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 16,216,312 | | | 11,706,320 | | -28% |
| Performance Incentive | $ | 902,768 | | | 563,713 | | -38% |
| Participants | Accounts | 1,664 | | | 1,975 | | 19% |
| Program Cost / Participant | $ | 9,745 | | | 5,927 | | -39% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | 384,383 | 338,353 | -12% | 346,857 | 3% | -10% |
| Annualized | MWh | 32,032 | 28,176 | -12% | 28,838 | 2% | -10% |
| Average Measure Life | yrs | 12 | 12 | 0% | 12 | 0% | 0% |
| Demand | | | | | | | |
| Lifetime | kW | 92,185 | 75,994 | -18% | 72,434 | -5% | -21% |
| Annualized | kW | | | | | | |
| Summer | | 7,682 | 6,301 | -18% | 6,002 | -5% | -22% |
| Winter | | 3,928 | 3,688 | -6% | 4,175 | 13% | 6% |
| Average Measure Life | yrs | 12 | 12 | | 12 | | |
| NEB (Lifetime) | $ | 5,126,919 | (1,344,982) | -126% | (2,118,523) | 58% | -141% |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | 65,302,225 | | | 46,837,926 | | -28% |
| TRC Costs | $ | 22,872,540 | | | 14,553,811 | | -36% |
| Net Benefits | $ | 42,429,685 | | | 32,284,114 | | -24% |
| BCR | n/a | 2.86 | | | 3.22 | | 13% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

C&I Small Retrofit did not spend its entire 2011 budget primarily because the program did not reach its 2011 savings goals. In addition, a total of 123 projects completed in late December 2011, representing $823,721 in customer incentives, were paid in January 2012.

Evaluated savings increased 2% for energy and decreased 5% for summer demand from preliminary year-end estimates. The 2% increase in energy savings is mainly due to the increase in the energy realization rate for non-controlled lighting measures. The decrease in demand savings is mainly due to the decrease in the Summer Coincidence factor.

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

- *National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study*
  The results of this study vary for each end-use category within the program. This study was previously filed in National Grid (electric) D.P.U. 11-108 and National Grid (Gas), D.P.U. 11 – 109
- *Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study*
  This study improved on the 2010 impact evaluation of annual energy savings and peak demand impacts for the retrofit installation of high-efficiency lighting fixtures through the C&I Small Retrofit programs. Results from extended 2011 summer metering were added to winter metering from the 2010 study. Combining the two impact evaluations

produced revised energy kWh and connected kW realization rates, summer and winter coincidence factors and HVAC interaction factors. The net effect for the Company was to increase energy savings for this program and decrease demand savings. The study is discussed in more detail in Section III, Study 18.

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 Small Retrofit Program is cost-effective with a BCR of 3.22.

3. C&I Pilot Programs

a. 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 Program Administrators and local communities designed to harness the power of community-based outreach to achieve broader participation in the Commonwealth's energy efficiency programs. The Company partnered with various community groups to implement community mobilization initiatives.

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

**Targeted Customers:** The Program Administrators and interested stakeholders selected communities with the greatest opportunities for success, based on an assessment of the proposal submitted. Targeted customers varied by pilot, but in general included small commercial customers with an electric demand of less than 300 kW.

**Definition of Pilot Program Participant:** Participants in this pilot are counted as participants in other programs such as Small Retrofit program.

**Targeted End-Uses**: The end-uses targeted by the community based pilots included the same end-uses addressed under the Company's existing Small Retrofit programs.

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

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

**How Achievement of the Pilot's Stated Goal was Measured:** A multi-year evaluation of community based pilots was conducted by Opinion Dynamics Corporation to assess the effectiveness of these pilots and determine their potential for replication. This process evaluation 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.C.7: Community Based Pilot | | | | | | | |
|---|---|---|---|---|---|---|---|
| Performance Category | Units | Planned Value | Preliminary Year-End Results | | Evaluated Results | | |
| | | | Value | % Change from Planned | Value | % Change from Preliminary | % Change from Planned |
| **Expenses** | | | | | | | |
| Total Program Costs | $ | 118,250 | | | - | | -100% |
| Participants | TBD | | | | - | | 0% |
| Program Cost / Participant | $ | - | | | - | | 0% |
| **Savings & Benefits** | | | | | | | |
| Energy | | | | | | | |
| Lifetime | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | MWh | n/a | n/a | n/a | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| Demand | | | | | | | |
| Lifetime | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Annualized | kW | n/a | n/a | n/a | n/a | n/a | n/a |
| Summer | | | | | n/a | n/a | n/a |
| Winter | | | | | n/a | n/a | n/a |
| Average Measure Life | yrs | n/a | n/a | n/a | n/a | n/a | n/a |
| NEB (Lifetime) | $ | n/a | n/a | n/a | n/a | n/a | n/a |
| **Cost-Effectiveness** | | | | | | | |
| TRC Benefits | $ | n/a | | | n/a | | n/a |
| TRC Costs | $ | 118,250 | | | - | | -100% |
| Net Benefits | $ | n/a | | | n/a | | n/a |
| BCR | n/a | n/a | | | n/a | | n/a |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

The CMI pilot was designed to include the Direct Install Program, but after the failure to achieve cost-effective pricing for direct install measures in both Chinatown and Chelsea, the decision was made to proceed in Lynn with a residential only pilot.

EM&V studies included in the Annual Report that 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-scaleimplementation 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.

### 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
- Residential Education Program
- Heat Loan Program
- Workforce Development
- Statewide Marketing & Education
- EEAC Consultants
- DOER Assessments
- Sponsorships and Subscriptions

The costs for these initiatives are located in Table II.A.3 for residential programs; Table II.B.3 for low-income programs and Table II.C.3 for Commercial and Industrial programs.

## III. Evaluation Measurement and Verification Activities

It should be noted that the Evaluation, Measurement and Verification Activities section is the same for both the electric and gas annual reports. Therefore information may be referenced in this section but not included in this report.

### A. *Summary*

The Massachusetts Program Administrators 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 electric Program Administrators 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
- Demand Impact Model User Manual
- Massachusetts Mini Baseline Study of Homes Built at the End of the 2006 IECC Cycle
- Massachusetts Multifamily Program Impact Analysis
- 2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, D.P.U. 11-108. 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 Program Administrators because the results varied by measure. This study is discussed in more detail in Appendix C, Study 17.

*The Demand Impact Model and User Manual* updated previous demand impact factors to reflect the most recent 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 Program Administrators and by program. This study had no impact on electric savings; it only changed demand and capacity factors. This study is discussed in more detail in Appendix C, Study 9.

*The Massachusetts Mini Baseline Study of Homes Built at the End of the 2006 IECC Cycle* 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. The report provides a preliminary assessment of how new single-family residential building characteristics compare to the current User Defined Reference Home baseline. The study compared efficiency lighting levels, building practices, equipment efficiencies, and other characteristics in custom versus spec built homes. The results from this study significantly reduced the electric savings based on the penetration rates of high efficiency lighting and appliances with NTG ratios between 79 percent and 11 percent. This study is discussed in more detail in Appendix C, Study 3.

*The Massachusetts Multifamily Program Impact Analysis* provides a set of savings approaches that can be used by all of the PAs as well as program attribution information. These objectives were accomplished by interviewing key stakeholders, analyzing the results, and offering recommendations for future program improvement. The overall impact of the report resulted in 2011 savings decreasing due to the 18 percent free-ridership number derived from this study. This study is discussed in more detail in Appendix C, Study 8.

*The 2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo* was intended to determine kWh realization rates, thermal realization rates, and fuel impact realization rates at both the Program Administrator and statewide level. The kWh realization rate will inform the net savings calculations and the thermal realization rates and fuel impact realization will inform implementation and engineering accuracy of the project screening process. With the new impact results, the resulting realization rate for NSTAR Electric will increase net savings while the resulting realization rate for National Grid will decrease net savings. This study is discussed in more detail in Appendix C, Study 19.

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

| Table III.A: Evaluation Studies in Annual Report | | | |
|---|---|---|---|
| **Studies** | **Location of Complete Study in Annual Report** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Implemented as Approved? (yes/no)** |
| **Residential Program Studies** | | | |
| 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 | |

| Table III.A: Evaluation Studies in Annual Report | | | |
|---|---|---|---|
| **Studies** | **Location of Complete Study in Annual Report** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Implemented as Approved? (yes/no)** |
| 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 | |
| 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 | |
| Brushless Fan Motors Impact Evaluation | App. C, Study 8 | Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150 | |
| 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 | |
| Massachusetts Consumer Survey Results 2011 | App. C, Study 10 | 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 | |

| Table III.A: Evaluation Studies in Annual Report | | | |
|---|---|---|---|
| **Studies** | **Location of Complete Study in Annual Report** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Implemented as Approved? (yes/no)** |
| **Residential 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 | |
| Solar Hot Water Pilot Program Evaluation | App. C, Study 15 | Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116 | |
| **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 |

| Table III.A: Evaluation Studies in Annual Report | | | |
|---|---|---|---|
| **Studies** | **Location of Complete Study in Annual Report** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Implemented as Approved? (yes/no)** |
| 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 | |
| **Commercial & Industrial Program Studies** | | | |
| Non-Controls Lighting Evaluation for the Massachusetts Small Business Direct Install Program: Multi-Season Study | App. C, Study 18 | 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 |
| 2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo | App. C, Study 19 | Study is pending approval of the 2011 MTM, D.P.U. 10-140 through D.P.U. 10-150 | |
| Impact Evaluation of 2010 Custom Process and Compressed Air Installations | App. C, Study 20 | 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 | |
| Impact Evaluation of 2010 Custom Lighting Installations | App. C, Study 21 | 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 | |

| Table III.A: Evaluation Studies in Annual Report | | | |
|---|---|---|---|
| **Studies** | **Location of Complete Study in Annual Report** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Implemented as Approved? (yes/no)** |
| 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 | |
| HVAC Market Characterization and Penetration Analysis | App. C, Study 23 | 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 | |

| Table III.A: Evaluation Studies in Annual Report | | | |
|---|---|---|---|
| **Studies** | **Location of Complete Study in Annual Report** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Implemented as Approved? (yes/no)** |
| 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. |

| # | Finding |
|---|---|
| 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. |

| # | Finding |
|---|---|
| 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 net-to-gross ("NTG") values for several of the measures installed in the Home Energy Services program using information gathered from program tracking systems, participant surveys, and non-participant surveys.

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

- Mass Save (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 Mass Save 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 net-to-gross 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 Installation, Persistence, and Freeridership**

| 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 |

| Measure | PA Data Source | Installation Rate | Persistence Rate | FR (Weighted) | FR (n) |
|---|---|---|---|---|---|
| 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; | | | | | |

| | |
|---|---|
| (green) | **Based on PM Survey Responses** |
| (blue) | **Based on Tenant/Condo Owner Survey Responses** |

**Summary of Proposed Savings Approaches**

| Measure Category | Primary Algorithm | Alternative Approach |
|---|---|---|
| Lighting – CFLs | $\Delta kWh = \frac{N \times (Watts_{pre} - Watts_{post}) \times Hrs}{1{,}000} X ISR$ | $\Delta kWh = \frac{N * (Watts_{post}) \times \Delta WattsMult \times}{1{,}000}$ |
| Lighting – Linear Fluorescents | $\Delta kWh = \frac{(\Sigma(N_{pre} * Watts_{pre}) - \Sigma(N_{post} * Watts_{post})) \times Hrs}{1{,}000}$ | Same algorithm, but deemed values are provided for baseline wattage and operational hours. |
| Lighting – LED Exit Signs | $\Delta kWh = \frac{n \times (Watts_{pre} - Watts_{post}) \times Hrs}{1{,}000}$ | Same algorithm but, some deemed input values are provided. |
| Lighting – Metal Halides | $\Delta kWh = \frac{(\Sigma(N_{pre} * Watts_{pre}) - \Sigma(N_{post} * Watts_{post})) \times Hrs}{1{,}000}$ | Same algorithm, but deemed values are provided for baseline wattage and operational hours. |
| Lighting – Occupancy Sensors | $\Delta kWh = \frac{(Watts_{controlled}) \times Hrs \times svg}{1{,}000}$ | Same algorithm, but some deemed input values are provided. |

| Measure Category | Primary Algorithm | Alternative Approach |
| --- | --- | --- |
| Refrigerators | *Refrigerator Recycling*<br>$\Delta kWh = \left[\left(\left(kWh_{pre} - kWh_{std}\right)\right) \times \frac{(12-8)}{12} + \left(\left(kWh_{std} - kWh_{ES}\right)\right.\right.$<br>*No Recycling*<br>$\Delta kWh = \left(kWh_{std} - kWh_{ES}\right) \times F_{see}$ | Same algorithm, but some deemed input values are provided. |
| Attic Insulation<br><br>Basement Insulation<br><br>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<br><br>Basement Insulation<br><br>Wall Insulation<br><br>(electric) | *Air Conditioning Savings:*<br>$kWh_{annual} \frac{\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) \times CDH \times DUA \times Area}{1{,}000 \frac{Btu}{kBtu} \times \eta_{cool}}$<br><br>*Electric Heating Savings:*<br>$kWh_{annual} \frac{\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) \times HDD \times 24 \times Area}{1{,}000{,}000 \times \eta_{heat}} \times 293.1$ | Same algorithm, but some deemed input values are provided. |
| 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 |

| Measure Category | Primary Algorithm | Alternative Approach |
|---|---|---|
| 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 | $kWh = tons \times 12 \frac{kBtuh}{ton} \times \left( \frac{1}{SEER} \times Hours_{cooling} + \frac{1}{HSPF} \times Hours_{heating} \right.$<br>$kWh = kBtuh \times \left( \frac{1}{SEER} \times Hours_{cooling} + \frac{1}{HSPF} \times Hours_{heating} \right) \times \%_{sav}$ | ΔkWhdwelling = 180 kWh<br>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 PAs), 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

**Type of Study:** Impact

**Objective of the Study:** To identify energy savings associated with BFM retrofits in residential HVAC applications, as installed through the Cool Smart program.

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

- Residential Cooling and Heating Equipment (Electric)

**Results of the Study and How the Study Determined those Results:** This evaluation used on-site spot measurement and long-term metering of BFM retrofits to determine statistically significant savings (±18% at an estimated 90% confidence interval) for a sample of 26 pilot participants.

The summer demand coincidence factor was calculated using ISO-NE definitions of peak period. Both energy and demand savings included the cooling interactive effect. The following table summarizes the results.

**Brushless Furnace Motor Fan Motor Results**

| Item | Evaluated Savings |
|---|---|
| Annual kWh motor savings | 246 kWh |
| Direct motor savings kWh | 219 kWh |
| Interactive cooling savings kWh | 27 kWh |
| Interactive heating penalty (mmbtu) | -0.676 mmBtu |
| Connected kW | 0.182 kW |
| CF – summer | 0.26 |
| CF – winter | 0.25 |
| Summer demand savings (kW) | 0.047 |
| Winter demand savings (kW) | 0.038 |
| Annual Equivalent Full Load Hr | 1,493hrsmeasured |

**How the Results of the Study Impact each Identified Program's Savings:** Please refer to the tables in Sections II.A.5 for the program listed above.

**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 8.

## 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)
- Mass Save (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 Lighting Consumer Survey Report

**Type of Study:** Market Assessment

**Objective of the Study:** The objective of the study was to understand the market for energy-efficient light bulbs, with particular emphasis on establishing a baseline at the onset of the changes in lighting standards resulting from the Energy Independence and Security Act of 2007 (EISA), which went into effect on January 1, 2012.

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

- Massachusetts ENERGY STAR Lighting Program (Electric)

**Recommendations Derived from the Study:**

| # | Recommendation |
|---|---|
| 1a | The team will continue to track satisfaction with CFLs in the next two waves of the survey to be completed in mid- and late-2012. The evaluation team will continue to inquire what both satisfied and dissatisfied respondents like and do not like about CFLs in order to provide a more complete understanding of CFL satisfaction. The evaluation team will also ask respondents if they have recently shifted their opinion about CFLs and why. |
| 1b | The PAs have little direct control over the persistent concerns about CFLs. The fact that they contain mercury, cannot dim as well as other bulb types, emit a different quality of light, and take a while to warm up represents limitations of the technology. However, at least for dimmability, warm-up time, and light quality, some bulbs suffer from these problems more than others. The PAs may want to continue to work with the program partners to support the highest quality CFLs on the market, perhaps holding additional focus groups or doing other types of consumer research to identify which bulbs those might be. |
| 1c | At this time, the LEDs on the market meant to replace 40 Watt and 60 Watt incandescents do not save much more energy than CFLs, but they do address at least some of the concerns with them, including concerns about mercury, dimmability, and warm-up time. Of course, they also cost more than CFLs. Therefore, in trying to increase adoption of LEDs, the PAs may want to consider educational materials that highlight these advantages of LEDs, but in a manner that does not add to the denigration of CFLs. |
| 2a | The PAs may consider increasing consumer education efforts regarding covered CFLs, as they are more difficult to distinguish from incandescents when simply looking at bulbs in the lighting aisle of the store. For example, signage at the point of purchase could note that the bulb is a CFL and that it can be used with a wider variety of fixtures. |

| # | Recommendation |
|---|---|
| 2b | The PAs may also want to consider reclassifying this bulb from "specialty" to "covered standard". Although the covered CFL is not the most common design, it does not have any "specialty" functions, such as being dimmable or fitting into a candelabra base. In fact, the covered CFL may offer the best opportunity to capture those customers who reject spirals for aesthetic or "fit in fixture" reasons. From an incentive and implementation perspective, the switch in classification may just be a matter of semantics, but from an evaluation and energy-savings perspective, the covered CFL is most accurately grouped with other A-line bulbs and not with specialty bulbs, because, at least in the short-term, covered CFLs will usually replace A-line incandescents—and perhaps spiral CFLs—and not specialty incandescents. |
| 3 | Satisfaction with the dimming capabilities of CFLs has been a persistent concern among consumers and many program administrators as well. Current indications are that screw-in LEDs dim more consistently and to a greater degree than dimmable CFLs. Therefore, the PAs may consider removing dimmable CFLs from the list of products they support, and turn instead to LEDs as their preferred dimmable technology. |
| 4 | The PAs may want to consider placing a consumer education campaign that helps consumers make more informed bulb choices, rather than simply defaulting to the incandescent bulb with which they are most familiar. The best choice may not always be the most efficient one, but perhaps consumers who are considering stockpiling will learn that efficient bulb options to replace incandescents exist for nearly all of their lighting needs. Moreover, PA education on EISA standards and alternative bulb types may encourage consumers to choose efficient options over stockpiling or buying halogen bulbs. |
| 5 | The PAs may want to continue their efforts at helping consumers make the transition from thinking about Watts to thinking about lumens. Educational materials and point-of-purchase displays that show typical uses based on lumens provide one example. |

**How the Study Came to the Recommended Conclusions:** The recommendations were based on information gathered during the data collection activities for the market assessment. This included an in-depth consumer surveys to track key indicators of the market for compact fluorescent lamps ("CFLs"), light emitting diodes ("LEDs"), and halogens as well as the impact of EISA. The survey was timed to coincide with the EISA-mandated onset of the phase-out of 100 Watt incandescent bulbs. The results provide a baseline understanding of these important indicators at the earliest stages of EISA; the evaluation team will field two additional surveys later in 2012 to track changes that may occur as EISA implementation continues.

**Explain Whether or Not the PA Decided to Adopt Recommendations from the Study, and Why:** Program Administrators plan to incorporate recommendation on continuing consumer education of more efficient light bulbs and supporting LED technology when applicable. Future studies will focus on analyzing the trend in CFL dissatisfaction to see if this is a persistence issues, but no changes will be made until more data is provided. Program Administrators will fully incorporate appropriate lighting strategies based on the findings from the additional survey waves planned for 2013 as more EISA standards go into effect.

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

## 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 Home Energy Services 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. |

| # | Recommendation |
|---|---|
| 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 Home Energy Services 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:**

- Mass Save (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) | 957-2,664 [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

**Type of Study:** Pilot Evaluation

**Objective of the Study:** The objective was to evaluate this pilot program through billing analyses, surveys, on-site validations, and engineering reviews.

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

- Residential Building Practices and Demonstration Program

**Results of the Study and How the Study Determined those Results:** Key findings of this evaluation include:

| # | Finding |
|---|---|
| 1 | The SHW pilot program gross gas savings, based on engineering estimates and modeling, is predicted to be approximately 701 MMBTU/yr, with average savings of approximately 14.2 MMBTU/yr per program participant. |
| 2 | The SHW pilot program net gas savings, based on a billing analysis to account for takeback and other effects, is approximately 512 MMBTU/yr, with average savings of approximately 10.9 MMBtu/yr per program participant. |
| 3 | Site visits confirmed the quality of SHW installations, with the only consistent problem being the lack of a UV-resistant jacket over the foam insulation on outdoor piping. The most common non-plumbing issue observed was excessive shading of solar collectors. |
| 4 | The cost-effectiveness of SHW systems installed through this program is low, with simple post-rebate payback periods to customers of 50 years, on average. Some well loaded and well sited systems, however, achieved simple payback periods of 10 years. However, including O&M costs could extend these payback periods of a well loaded system to over 100 years and of a well sited system to over 20 years, respectively. |

Data for this report were obtained through billing analyses, customer surveys, site visits, and engineering reviews of solar hot water systems installed through this program over the past several years.

**How the Results of the Study Impact each Identified Program's Savings:** The Solar Hot Water Pilot program is a pilot program and is not currently reporting savings. As part of this evaluation, total program natural gas savings were calculated to be approximately 701 MMBTU/year.

**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:** N/A

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

## 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 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:<br><br>Clearly articulate the objectives of multiple QA/QC visits to a participant's home.<br><br>Establish the value of agencies conducting 100% post inspections versus redirecting resources to serve more homes.<br><br>Determine where the objectives of the DHCD and CRI inspections align and identify if there are opportunities for collaboration and coordination.<br><br>Assess how changes in federal funding levels are expected to affect DHCD inspections and what affect that has on collaboration or coordination opportunities.<br><br>Findings from this discussion should be clearly documented and action items to improve QA/QC process should be adopted. |

| # | 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:**

| # | Recommendation | PA Response |
|---|---|---|
| 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. | 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. |

| # | Recommendation | PA Response |
|---|---|---|
| 2 | PAs should establish a system that does not cause significant delays to 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. | The PAs are always willing to work with the DPU to establish a regulatory approval system that does not cause significant delays in program delivery. |
| 3 | Through the Best Practices working group, standardize a streamlined approval process for repairs that works for the agencies and PAs. | 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 | 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. | 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. |

| # | Recommendation | PA Response |
|---|---|---|
| 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. | 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 | 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. | 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. |

| # | Recommendation | PA Response |
|---|---|---|
| 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:<br><br>Clearly articulate the objectives of multiple QA/QC visits to a participant's home.<br><br>Establish the value of agencies conducting 100% post inspections versus redirecting resources to serve more homes.<br><br>Determine where the objectives of the DHCD and CRI inspections align and identify if there are opportunities for collaboration and coordination.<br><br>Assess how changes in federal funding levels are expected to affect DHCD inspections and what affect that has on collaboration or coordination opportunities.<br><br>Findings from this discussion should be clearly documented and action items to improve QA/QC process should be adopted. | 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:**

| # | Recommendation | PA Response |
|---|---|---|
| 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. | 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 | Identify one single representative program to remain involved with during the entire participation process with building managers. Consider looking to the | This recommendation is being considered for adoption at this time. The |

| | | |
|---|---|---|
| | Multi-Family Market Integrator used in the market rate multi-family program as a model. | PAs have not formally adopted or rejected any recommendations that require changes to program design and operations. |
| 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. | 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 | 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. | 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) |

| Category | Measure | Natural Gas (Therms/year) | Electric (kWh/year) | Oil (MMBTUs/ year) |
|---|---|---|---|---|
| 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. *Commercial and Industrial Program Studies*

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

**Type of Study:** Impact Evaluation

**Objective of the Study:** The impact evaluation was conducted to provide independent estimates of annual energy savings and peak demand impacts for the retrofit installation of high-efficiency lighting fixtures through the C&I Small Retrofit programs. The impact evaluation focused on savings due to the equipment change only and does not include savings due to the installation of lighting controls.[4]

Through extended metering of lighting time-of-use, the study determined program realization rates for the following savings parameters:

- Annual energy savings (kWh)
- Annual energy savings during energy on-peak period (%)
- Summer and winter peak period demand reduction (kW)
- Annual heating gas and oil impact (MMBtu)

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

- C&I Small Retrofit (Electric Only)

**Results of the Study and How the Study Determined those Results:** The impact factors for the statewide program are provided in Table 1. The table includes factors for adjusting the gross energy and peak demand savings and for estimating the gas and oil impacts of lighting fixtures measures implemented through the C&I Small Retrofit program.

Impact factors are provided separately for WMECO due to a difference in the methodology for estimating gross savings for the 2010 and 2011 programs.

The impact factors are based on post-retrofit verification, metering, and analysis performed at 126 participant sites statewide. Metering was performed at all 126 sample sites during winter 2010-2011 and at 26 sites with expected seasonal variation (e.g., schools and summer camps) during summer-fall 2011.

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[4] The impact evaluation of lighting control installations was conducted in *Small Business Direct Install Program: Pre/Post Lighting Controls Study*. June 2012.

**Impact Factors:**

| Factor | Description | Statewide | WMECO |
|---|---|---|---|
| kWh RR | Energy realization rate[i] | 96% | 72% |
| $HVAC_{ELEC}$ | HVAC interaction factor, electric heat | 106% | 102% |
| *Total combined energy realization rate (kWh RR x $HVAC_{ELEC}$)* | | 102% | 73%[iv] |
| %kWh On-Peak | Percent energy savings on-peak | 69% | 70% |
| kW RR | Connected kW realization rate[i] | 99% | 98% |
| $CF_{SP}$ | Coincidence factor, summer peak[i,ii] | 66% | 60% |
| $CF_{WP}$ | Coincidence factor, winter peak[i,ii] | 44% | 43% |
| $HVAC_{SP}$ | HVAC demand interaction factor, summer on-peak | 110% | 111% |
| $HVAC_{WP}$ | HVAC demand interaction factor, winter on-peak | 100% | 97% |
| *Total combined summer kW realization rate (kW RR x $CF_{SP}$ x $HVAC_{SP}$)* | | 72% | 65% |
| *Total combined winter kW realization rate (kW RR x $CF_{WP}$ x $HVAC_{WP}$)* | | 44% | 41% |
| $HVAC_{GAS}$ | HVAC interaction factor, gas heat (MMBtu/kWh)[iii] | -0.001075 | -0.000522 |
| $HVAC_{OIL}$ | HVAC interaction factor, oil heat (MMBtu/kWh)[iii] | -0.000120 | -0.000252 |

[i] Includes lighting impacts only; does not include HVAC interaction impacts.
[ii] Statewide coincidence factors are for on-peak capacity periods; WMECO coincidence factors are for seasonal peak periods.
[iii] HVAC gas and oil impacts are negative values because the reduction in lighting operation reduces waste heat generated in the space and results in an increase the space heating load.
[iv] The combined energy realization rate for WMECO is lower than the statewide average due to a different methodology for estimating HVAC interactive impacts. If WMECO changes its methodology to match that of the other PAs, this energy realization rate is no longer valid.

**How the Results of the Study Impact each Identified Program's Savings:** Results of the study will be applied to update existing impact factors used in calculating small business program lighting fixture electric energy and demand savings. As applied the results will marginally decrease energy and summer demand savings and marginally increase winter demand savings.

**Formulas Necessary to Understand the Impact of the Study on the PA's Program(s):** Program adjusted gross impacts are calculated by applying the total combined energy and demand realization rates to the program gross energy and demand tracking estimates, respectively:

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

$$Adjusted\ Gross\ kWh = Tracking\ Gross\ kWh * kWh\ RR * HVAC_{ELEC}$$

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

$$Summer\ Peak\ kW = Tracking\ Gross\ kW * kW\ RR * CF_{SP} * HVAC_{SP}$$

$$Winter\ Peak\ kW = Tracking\ Gross\ kW * kW\ RR * CF_{WP} * HVAC_{WP}$$

The statewide coincidence factors are based on the ISO-NE on-peak capacity periods; the WMECO coincidence factors are based on the ISO-NE seasonal peak capacity periods. A detailed description of the formulas for applying the impact factors in Table 1 is provided in the full report (see pages 3-4).

**If the Results of the Study Are Not Adopted by the PA, Fully Explain Why:** Results of the study have been adopted by MA Program Administrators

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

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

**Type of Study:** Impact Evaluation

**Objective of the Study:** The study was intended to produce kWh realization rates, thermal realization rates, and fuel impact realization rates at both the PA and statewide level. The kWh realization rate was meant to inform evaluation departments' net savings calculations while the thermal realization rates and fuel impact realization rates were produced to inform PA implementation and engineering departments regarding the accuracy of their project screening process.

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

- C&I Retrofit (Electric Only)

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

| Summary of Realization Rates Program Administrator | Weighted Mean kWh Realization Rate | Weighted Mean Thermal Realization Rate | Weighted Mean Fuel Impact Realization Rate |
|---|---|---|---|
| National Grid | *0.86 ± .08* | *1.01 ± .11* | *0.87* |
| NSTAR | *1.15 ± .16* | *1.03 ± .08* | *1.06* |
| Prgm Avg | *0.93 ± .07* | *1.01 ± .08* | *0.90* |

The study determined realization rates at the PA level and statewide level. A combination of onsite equipment verification, examination of operating conditions, interviews with site personnel, and equipment metering of 15 individual projects completed during 2010 was performed to inform modeling assumptions and determine realization rates. Metering was performed over a 6 month period, with at least 1 month of summer and 1 month of winter metering required for site inclusion in the evaluation. The results were extrapolated over the remainder of the 12 months to determine evaluated savings. PAs represented in the study sample were NSTAR and National Grid.

**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. Since this is the first time CHP has been evaluated, program administrators had been assuming a 100% kWh realization rate. With the new impact results, the resulting realization rate for NSTAR will increase net savings while the resulting realization rate for National Grid will decrease net savings.

**Formulas Necessary to Understand the Impact of the Study on the PA's Program(s):** Net Savings = Gross kWh 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 both NSTAR and National Grid.

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

5 Realization rate determined by this study.

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

**Type of Study:** Impact Evaluation

**Objective of the Study:** The study's objective was to produce both energy (kWh) and demand (kW) realization rates for program administrators' custom process and compressed air projects. A 90% confidence interval was set for energy and an 80% confidence interval was set for demand 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 (Electric Only)
- C&I Retrofit (Electric Only)

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

| Overall Process Results | Annual MWh | % On-Peak MWh | On-Peak MWh | On-Peak Summer kW | On-Peak Winter kW | Summer Season Peak kW | Winter Season Peak kW |
|---|---|---|---|---|---|---|---|
| Total Tracking Savings | 22,888 | - | - | 2,833 | 2,883 | 2,833 | 2,883 |
| Total Measured Savings | 17,434 | - | - | 2,324 | 2,531 | 2,381 | 2,573 |
| Realization Rate | 76.2% | - | - | 82.0% | 87.8% | 84.0% | 89.3% |
| Relative Precision at 90% Confidence | 14.9% | - | - | | | | |
| Error Bound at 90% Confidence | 2,602 | - | - | | | | |
| Relative Precision at 80% Confidence | | | | 24.0% | 20.4% | 24.3% | 20.6% |
| Error Bound at 80% Confidence | | | | 558 | 516 | 578 | 531 |
| Error Ratio | 0.74 | - | - | 1.30 | 1.23 | 1.26 | 1.21 |

| Overall Compressed Air Results | Annual MWh | % On-Peak MWh | On-Peak MWh | On-Peak Summer kW | On-Peak Winter kW | Summer Season Peak kW | Winter Season Peak kW |
|---|---|---|---|---|---|---|---|
| Total Tracking Savings | 6,064 | - | - | 756 | 746 | 756 | 746 |
| Total Measured Savings | 5,168 | - | - | 577 | 553 | 569 | 560 |
| Realization Rate | 85.2% | - | - | 76.3% | 74.1% | 75.2% | 75.1% |
| Relative Precision at 90% Confidence | 24.6% | - | - | | | | |
| Error Bound at 90% Confidence | 1,274 | - | - | | | | |
| Relative Precision at 80% Confidence | | | | 28.6% | 30.9% | 27.8% | 30.0% |
| Error Bound at 80% Confidence | | | | 165 | 171 | 158 | 168 |
| Error Ratio | 0.57 | - | - | 0.84 | 0.92 | 0.83 | 0.89 |

| Compressed Air Results by PA | Annual MWh | % On-Peak MWh | On-Peak MWh | On-Peak Summer kW | On-Peak Winter kW | Summer Season Peak kW | Winter Season Peak kW |
|---|---|---|---|---|---|---|---|
| **National Grid** | | | | | | | |
| Total Tracking Savings | 3,936 | 48.1% | 1,893 | 485 | 476 | 485 | 476 |
| Total Measured Savings | 3,507 | 44.9% | 1,575 | 381 | 395 | 367 | 402 |
| Realization Rate | 89.1% | 93.4% | 83.2% | 78.6% | 83.0% | 75.6% | 84.4% |
| Relative Precision at 90% Confidence | 34.0% | - | 33.8% | | | | |
| Error Bound at 90% Confidence | 1,191 | - | 532 | | | | |
| Relative Precision at 80% Confidence | | | | 40.3% | 40.5% | 39.9% | 39.1% |
| Error Bound at 80% Confidence | | | | 154 | 160 | 146 | 157 |
| Error Ratio | 0.57 | - | 0.51 | 0.88 | 0.89 | 0.87 | 0.86 |
| **NSTAR** | | | | | | | |
| Total Tracking Savings | 1,170 | - | - | 143 | 144 | 143 | 144 |
| Total Measured Savings | 913 | - | - | 117 | 114 | 117 | 115 |
| Realization Rate | 78.0% | - | - | 81.6% | 79.2% | 81.6% | 79.6% |
| Relative Precision at 90% Confidence | 45.1% | - | - | | | | |
| Error Bound at 90% Confidence | 412,081 | - | - | | | | |
| Relative Precision at 80% Confidence | | | | 34.6% | 37.1% | 34.7% | 36.7% |
| Error Bound at 80% Confidence | | | | 40 | 42 | 41 | 42 |
| Error Ratio | 0.74 | - | 0.72 | 0.75 | 0.81 | 0.76 | 0.80 |
| **WMECO** | | | | | | | |
| Total Tracking Savings | 958 | - | - | 128 | 126 | 128 | 126 |
| Total Measured Savings | 747 | - | - | 78 | 44 | 85 | 43 |
| Realization Rate | 78.0% | - | - | 61.3% | 34.7% | 66.8% | 34.5% |
| Relative Precision at 90% Confidence | 24.6% | - | - | | | | |
| Error Bound at 90% Confidence | 184 | - | - | | | | |
| Relative Precision at 80% Confidence | | | | 55.0% | 95.9% | 52.5% | 98.0% |
| Error Bound at 80% Confidence | | | | 43 | 42 | 45 | 43 |
| Error Ratio | 0.32 | - | - | 0.80 | 1.42 | 0.75 | 1.43 |

The study determined realization rates at the PA level and statewide level. A combination of onsite equipment verification, examination of operating conditions, interviews with site personnel, and equipment metering of 28 custom process and 11 custom compressed air projects completed during 2010 was performed to inform modeling assumptions and determine realization rates. Metering was performed over a 3 month period, with the resulting data being extrapolated over the remainder of the 12 months to determine evaluated savings. PAs represented in the study sample were National Grid, NSTAR, Unitil and WMECO.

**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[6] 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.

6 Realization rate determined by this study.

**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 20.

## 21. Impact Evaluation of 2010 Custom Lighting Installations

**Type of Study:** Impact Evaluation

**Objective of the Study:** The study's objective was to produce both energy (kWh) and demand (kW) realization rates for program administrators' custom lighting projects. A 90% confidence interval was set for energy and an 80% confidence interval was set for demand 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 (Electric Only)
- C&I Retrofit (Electric Only)

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

| Statistic | Annual MWh | On-Peak Summer kW | On-Peak Winter kW | Summer Season Peak kW | Winter Season Peak kW |
|---|---|---|---|---|---|
| Total Tracking Savings | 46,463 | 7,659 | 8,061 | 7,659 | 8,061 |
| Total Measured Savings | 45,696 | 7,166 | 7,392 | 7,056 | 7,056 |
| Realization Rate | 98.3% | 93.6% | 91.7% | 92.1% | 87.5% |
| Relative Precision at 90% Confidence | 9.3% | 9.3% | 13.1% | 9.7% | 13.1% |
| Error Bound at 90% Confidence | 4,259 | 669 | 966 | 685 | 923 |
| Relative Precision at 80% Confidence | 7.3% | 7.3% | 10.2% | 7.6% | 10.2% |
| Error Bound at 80% Confidence | 3,319 | 521 | 752 | 534 | 719 |
| Error Ratio | 0.30 | 0.38 | 0.58 | 0.40 | 0.58 |

| Statistic | Annual MWh | % On-Peak MWh | On-Peak MWh | On-Peak Summer kW | On-Peak Winter kW | Summer Season Peak kW | Winter Season Peak kW |
|---|---|---|---|---|---|---|---|
| **Cape Light Compact** | | | | | | | |
| Total Tracking Savings | 31 | - | - | - | - | - | - |
| Total Measured Savings | 25 | - | - | - | - | - | - |
| Realization Rate | 79.5% | - | - | - | - | - | - |
| Relative Precision at 90% Confidence | 0.0% | - | - | - | - | - | - |
| Error Bound at 90% Confidence | - | - | - | - | - | - | - |
| Relative Precision at 80% Confidence | 0.0% | - | - | - | - | - | - |
| Error Bound at 80% Confidence | - | - | - | - | - | - | - |
| Error Ratio | 0.00 | - | - | - | - | - | - |
| **National Grid** | | | | | | | |
| Total Tracking Savings | 9,109 | 44.3% | 4,036 | 1,886 | 2,250 | 1,886 | 2,250 |
| Total Measured Savings | 8,922 | 47.9% | 4,273 | 2,185 | 1,913 | 2,159 | 1,926 |
| Realization Rate | 97.9% | 108.1% | 105.9% | 115.9% | 85.0% | 114.5% | 85.6% |
| Relative Precision at 90% Confidence | 5.9% | - | 13.9% | 9.5% | 11.7% | 10.0% | 12.1% |
| Error Bound at 90% Confidence | 529 | - | 595 | 207 | 225 | 216 | 232 |
| Relative Precision at 80% Confidence | 4.6% | - | 10.9% | 7.4% | 9.2% | 7.8% | 9.4% |
| Error Bound at 80% Confidence | 412 | - | 464 | 207 | 225 | 216 | 232 |
| Error Ratio | 0.16 | - | 0.33 | 0.25 | 0.33 | 0.26 | 0.34 |
| **NSTAR** | | | | | | | |
| Total Tracking Savings | 30,375 | - | - | 4,628 | 5,127 | 4,628 | 5,127 |
| Total Measured Savings | 30,915 | - | - | 3,938 | 4,280 | 3,815 | 3,950 |
| Realization Rate | 101.8% | - | - | 85.1% | 83.5% | 82.4% | 77.0% |
| Relative Precision at 90% Confidence | 13.5% | - | - | 14.9% | 16.2% | 15.3% | 15.8% |
| Error Bound at 90% Confidence | 4,182 | - | - | 586 | 694 | 582 | 622 |
| Relative Precision at 80% Confidence | 10.5% | - | - | 11.6% | 12.6% | 11.9% | 12.3% |
| Error Bound at 80% Confidence | 3,259 | - | - | 457 | 541 | 454 | 485 |
| Error Ratio | 0.34 | - | - | 0.42 | 0.46 | 0.43 | 0.44 |
| **WMECO** | | | | | | | |
| Total Tracking Savings | 7,999 | - | - | 1,409 | 967 | 1,409 | 967 |
| Total Measured Savings | 7,139 | - | - | 1,351 | 1,385 | 1,364 | 1,346 |
| Realization Rate | 89.3% | - | - | 95.9% | 143.2% | 96.8% | 139.2% |
| Relative Precision at 90% Confidence | 8.7% | - | - | 19.4% | 45.7% | 21.7% | 47.6% |
| Error Bound at 90% Confidence | 619 | - | - | 262 | 633 | 296 | 640 |
| Relative Precision at 80% Confidence | 6.8% | - | - | 15.1% | 35.6% | 16.9% | 37.1% |
| Error Bound at 80% Confidence | 482 | - | - | 204 | 493 | 231 | 499 |
| Error Ratio | 0.24 | - | - | 0.48 | 1.21 | 0.53 | 1.25 |

The study determined realization rates at the PA level and statewide level. A combination of onsite equipment verification, examination of operating conditions, interviews with site personnel, and equipment metering of 45 individual projects completed during 2010 was performed to inform modeling assumptions and determine realization rates. Metering was performed over a 3 month period, with the resulting data being extrapolated over the remainder of the 12 months to determine evaluated savings. PAs represented in the study sample were Cape Light Compact, National Grid, NSTAR and WMECO.

**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[7] 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 21.

7 Realization rate determined by this study.

## 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 Commercial and Industrial 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 Energy Efficiency Advisory Council ("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. |

| # | Recommendation |
|---|---|
| 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 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. |
| 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

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

25. Impact Evaluation of 2010 Custom Gas Installations

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

## 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 Electric Results:

| PA | Cohort or Measure Name | Program Year | Base Usage | Annualized Net Savings per HH | Net Savings % | Total Evaluated Participants |
|---|---|---|---|---|---|---|
| National Grid | 2009 | PY2 | 10,825 kWh | 223 kWh | 2.06% | 23,309 |
| National Grid | 2010 | PY2 | 12,051 kWh | 196 kWh | 1.63% | 67,980 |

| PA | Cohort or Measure Name | Program Year | Base Usage | Annualized Net Savings per HH | Net Savings % | Total Evaluated Participants |
|---|---|---|---|---|---|---|
| National Grid | 2010 Add | PY1 | 15,008 kWh | 240 kWh | 1.60% | 23,557 |
| National Grid | 2011 | PY1 | 9,767 kWh | 134 kWh | 1.37% | 94,322 |

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 |
| NSTAR | Wave I | PY1 | 55.7 MMBTUs[a] | 0.53 MMBTU | 0.94% | 22,840 |
| NSTAR | Wave II | PY1 | 121.5 MMBTUs | 1.82 MMBTU | 1.50% | 22,108 |

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:<br><br>Waitlisted or delayed treatment participants should be used whenever possible to establish a comparison group.<br><br>In the absence of a waitlist or delayed treatment, Variability in Adoption ("VIA") designs are the most appropriate for quasi-experiments.<br><br>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).<br><br>Employ surveys and other qualitative research techniques to assess what customers would have done in the absence of the program.<br><br>Evaluation must also consider the effects of feedback in keeping customers on a trajectory.<br><br>Consider adjusting the impact models to account for self-selection bias. |
| 2 | Evaluating persistence:<br><br>Persistence should be examined in two ways: (1) with program treatment, and (2) without program treatment.<br><br>All behavioral programs should be continually evaluated for persistence; however opt-in models have little data to date that document persistence beyond one year.<br><br>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 Mass Save 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)
- Mass Save (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 Program Administrators, 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. | | | | | |

| Massachusetts – Electric Estimate | | | | |
|---|---|---|---|---|
| Increase in GSP (Billion $) (1) | Savings (GWh) (2) | Savings (kWh) (3) | Economic output per therm (4) | 11% for low income (5) (6) |
| 70 | 217,300 | 217,300,000,000 | $0.32 | $0.04 |
| (1) Energy Efficiency: Engine of Economic Growth; ENE; October 2009; page 47. | | | | |
| (2) Energy Efficiency in Massachusetts: Engine of Economic Growth; ENE; October 2009; page 2. | | | | |
| (3) GWh times 1,000,000 | | | | |
| (4) Calculated as Increase in GSP/Savings (kWh) | | | | |

| Massachusetts – Electric Estimate |
|---|
| (5) Multiply economic output per therm by 11%; assumes 11% inures to the benefit of low-income (the low-income fraction of population). |
| (6) Using an inflation rate of 1.85% from BCR models does not change the estimate of $0.04/kWh from 2008 to 2011$. |

**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

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

## 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 |
| 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 Lighting Consumer Survey Phase II | 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 |
| Residential Lighting Shelf Stocking Survey | 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 |
| Residential Lighting Supplier Interviews | Study is planned but not yet submitted for approval | Yes |
| Residential Lighting Onsite Saturation Study* | Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116 | 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)** |
| Lighting Sensitivity Analysis (EISA Baseline Study) 3YP Version* | Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116 | Yes |
| Consumer Electronics Potential Study | Study is pending approval of the 2012 MTM, D.P.U. 11-106 through D.P.U. 11-116 | Yes |
| Consumer Electronics Saturation Study* | Study is planned but not yet submitted for approval | 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 |
| 2012 Lighting Controls Pilot | Study is planned but not yet submitted for approval | Yes |
| **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 |
| Small C&I Lighting Controls Impact Study* | 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 |
| Large C&I - Prescriptive Measure Impact Evaluation (VSDs) | 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 |

| Table III.B: Evaluation Studies in Next Annual Report | | |
|---|---|---|
| **Studies** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Expected to be Implemented as Approved? (yes/no)** |
| Large C&I - 2011 CHP Impact Evaluation | Study is planned but not yet submitted for approval | Yes |
| Large C&I - Custom Electric Impact Evaluation (Refrigeration, Motor, Other) | Study is planned but not yet submitted for approval | Yes |
| Large C&I - Upstream Lighting Impact & Process 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 - Lighting Controls Study | 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 |
| Large C&I - Prescriptive Measure Impact Evaluation (Lighting)* | 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 |

| Table III.B: Evaluation Studies in Next Annual Report | | |
|---|---|---|
| **Studies** | **Docket & Exhibit Approving Planned Evaluation Studies** | **Expected to be Implemented as Approved? (yes/no)** |
| Community-Based Inititative: Northampton/Pittsfield | Study is planned but not yet submitted for approval | Yes |
| 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 Program Administrators to coordinate planning, the adoption of consistent programs and processes, program design, EM&V studies, statewide marketing, regulatory proceedings, and the development and sharing of all best practices. Sharing of these costs, which would otherwise be borne by each Program Administrator individually, resulted in economies of scale that reduced the cost for each Program Administrator. 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 Program Administrators 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 Program Administrators to maintain a skilled and dedicated administrative staff in order to ensure successful delivery of programs, compliance with the GCA, timely responses to the directives of the Council, Department, and DOER; and documentation and achievement of substantial savings. The Program Administrators 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 Program Administrator'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 Program Administrators' 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 GCA, however, is to seek administrative efficiencies, which is a continuous process that evolves along with energy efficiency planning and programming, whereas costs and administrative efficiency opportunities are always changing. The Program Administrators 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 Renovation | 222,355 | 13% | 58,453 | 4% | (163,902) | -10% |
| Residential Cooling & Heating Equipment | 218,621 | 9% | 175,720 | 7% | (42,901) | -2% |
| Multi-Family Retrofit | 314,065 | 3% | 245,905 | 4% | (68,160) | 1% |
| MassSAVE | 465,109 | 3% | 343,458 | 2% | (121,652) | 0% |
| Behavior/Feedback Program | 196,415 | 8% | 124,997 | 4% | (71,418) | -3% |
| ENERGY STAR Lighting | 319,719 | 4% | 282,433 | 3% | (37,286) | 0% |
| ENERGY STAR Appliances | 201,268 | 7% | 200,294 | 5% | (973) | -2% |
| Residential Education Program | 285,000 | 26% | 37,750 | 54% | (247,250) | 28% |
| Workforce Development | - | 0% | 0 | 0% | 0 | 0% |
| Heat Loan Program | 216,825 | 4% | 0 | 0% | (216,825) | -4% |
| R&D and Demonstration | 96,000 | 38% | 1 | 0% | (95,999) | -38% |
| Deep Energy Retrofit | 135,523 | 16% | 113,459 | 27% | (22,064) | 11% |
| Behavior/Feedback Pilot | - | 0% | - | 0% | - | 0% |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | 79,158 | 26% | 10,485 | 17% | (68,673) | -9% |
| Residential New Construction Multi Family (4-8 story) statewide pilot | 79,676 | 24% | 18,683 | 6% | (60,993) | -19% |
| Residential New Construction Lighting Design statewide pilot | 74,883 | 81% | 9,919 | 36% | (64,964) | -46% |
| Residential New Construction V3 Energy Star Homes statewide pilot | - | 0% | - | 0% | - | 0% |
| Heat Pump Water Heater Pilot | - | 0% | 0 | 100% | 0 | 100% |
| Residential Technical Development | - | 0% | - | 0% | - | 0% |
| Hot Roofs | - | 0% | - | 0% | - | 0% |
| Home Automation | - | 0% | - | 0% | - | 0% |
| Community based Pilot | 107,789 | 42% | 3,664 | 4% | (104,126) | -39% |
| Statewide Marketing & Education | - | 0% | 0 | 0% | 0 | 0% |
| EEAC Consultants | - | 0% | - | 0% | - | 0% |
| DOER Assessment | 270,861 | 100% | 351,597 | 100% | 80,735 | 0% |
| Sponsorships & Subscriptions | 294,874 | 100% | 60,787 | 100% | (234,087) | 0% |
| **Residential (Total)** | **3,578,142** | **6%** | **2,037,605** | **4%** | **(1,540,537)** | **-2%** |
| **Low-Income** | | | | | | |
| Low-Income Residential New Construction | 110,677 | 33% | 48,104 | 20% | (62,572) | -13% |
| Low-Income 1 to 4 Family Retrofit | 379,520 | 3% | 250,294 | 3% | (129,226) | 0% |
| Low-Income MultiFamily Retrofit | 217,251 | 3% | 118,667 | 4% | (98,584) | 1% |
| Statewide Marketing & Education | - | 0% | 0 | 0% | 0 | 0% |
| Low-Income Energy Affordability Network Funding | 433,469 | 100% | 0 | 0% | (433,469) | -100% |
| DOER Assessment | 116,083 | 100% | 149,975 | 100% | 33,892 | 0% |
| **Low Income (Total)** | **1,257,000** | **6%** | **567,041** | **4%** | **(689,959)** | **-2%** |
| **Commercial & Industrial** | | | | | | |
| C&I New Construction and Major Renovation | 1,647,058 | 6% | 1,623,129 | 12% | (23,928) | 6% |
| C&I Large Retrofit | 2,598,647 | 4% | 2,756,950 | 9% | 158,303 | 5% |
| C&I Small Retrofit | 406,058 | 3% | 305,819 | 3% | (100,239) | 0% |
| Community based Pilot | 27,500 | 11% | - | 0% | (27,500) | -11% |
| C&I New Construction and Major Renovation - Government | - | 0% | - | 0% | - | 0% |
| Large C&I Retrofit - Government | - | 0% | - | 0% | - | 0% |
| C&I Small Retrofit - Government | - | 0% | - | 0% | - | 0% |
| Statewide Marketing & Education | 244,822 | 100% | 0 | 0% | (244,822) | -100% |
| EEAC Consultants | - | 0% | - | 0% | - | 0% |
| DOER Assessment | 589,804 | 100% | 762,004 | 100% | 172,200 | 0% |
| Sponsorships & Subscriptions | 226,887 | 100% | 60,787 | 100% | (166,100) | 0% |
| **Commercial & Industrial (Total)** | **5,740,777** | **5%** | **5,508,689** | **10%** | **(232,087)** | **5%** |
| **GRAND TOTAL** | **10,575,918** | **6%** | **8,113,335** | **7%** | **(2,462,583)** | **1%** |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in <u>Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid</u> D.P.U. 10-148.

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 an increase greater than ten percent between planned and actual Program, Planning & Administration costs 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 Outsource | $ | % of Total Outsource | $ | % of Total Activities | | $ |
| **Residential** | | | | | | | | | | |
| Planned | 2,543,112 | 13% | 15,230,637 | 87% | 2,263,863 | 13% | 17,494,499 | 87% | | 20,037,611 |
| Actual | 1,442,473 | 10% | 11,272,569 | 86% | 1,766,157 | 14% | 13,038,726 | 90% | | 14,481,199 |
| % Difference from Planned to Actual | -43% | -3% | -26% | -1% | -22% | 1% | -25% | 3% | | -28% |
| **Low-Income** | | | | | | | | | | |
| Planned | 656,960 | 15% | 1,686,701 | 44% | 2,186,301 | 56% | 3,873,003 | 85% | | 4,529,963 |
| Actual | 260,259 | 8% | 754,589 | 27% | 2,049,119 | 73% | 2,803,708 | 92% | | 3,063,967 |
| % Difference from Planned to Actual | -60% | -6% | -55% | -17% | -6% | 17% | -28% | 6% | | -32% |
| **Commercial & Industrial** | | | | | | | | | | |
| Planned | 9,777,080 | 45% | 7,181,907 | 61% | 4,627,672 | 39% | 11,809,579 | 55% | | 21,586,659 |
| Actual | 5,465,097 | 41% | 3,877,141 | 48% | 4,117,799 | 52% | 7,994,940 | 59% | | 13,460,037 |
| % Difference from Planned to Actual | -44% | -5% | -46% | -12% | -11% | 12% | -32% | 5% | | -38% |
| **TOTAL** | | | | | | | | | | |
| Planned | 12,977,152 | 28% | 24,099,245 | 73% | 9,077,837 | 27% | 33,177,082 | 72% | | 46,154,233 |
| Actual | 7,167,828 | 23% | 15,904,299 | 67% | 7,933,076 | 33% | 23,837,374 | 77% | | 31,005,203 |
| % Difference from Planned to Actual | -45% | -5% | -34% | -6% | -13% | 6% | -28% | 5% | | -33% |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

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.

The amounts shown for Competitively Procured services for 2011 are only those services that were procured in 2011 for which funds were expended; the amounts do not include expenditures in 2011 for services that were competitively procured in prior years. The Company is not able to say at this time whether outsourced services paid for in 2011 which were procured prior to 2011 were competitively procured or not. If no information was available on the competitive procurement of the services, the expenditures have been reported as "Non-Competitively Procured" in Table IV.B.

## D. *Low-Income Spending*

| Table IV.C: Customer Sector Budget Allocation | | | | | | |
|---|---|---|---|---|---|---|
| **Customer Sector** | **Planned** | | **Actual** | | **Change from Planned to Actual** | |
| | Total Program Costs | % of Total Program Costs | Total Program Costs | % of Total Program Costs | Value | % Change |
| Residential | $ 57,610,395 | 31% | $ 47,880,166 | 41% | $ (9,730,229) | 10% |
| Low-Income | $ 19,979,831 | 11% | $ 13,132,996 | 11% | $ (6,846,836) | 1% |
| Commercial & Industrial | $ 108,065,425 | 58% | $ 55,081,127 | 47% | $ (52,984,297) | -11% |
| **TOTAL** | **$ 185,655,651** | **100%** | **$ 116,094,289** | **100%** | **$ (69,561,362)** | **0%** |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

While lower than budgeted, National Grid's actual low-income spending in 2011 met the statutory minimum of 10% of the amount expended for its electric energy efficiency programs.

## 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: Performance Incentives Summary**

| Incentive Components | Threshold | Design | Exemplary | Actual Incentive |
|---|---|---|---|---|
| Savings Mechanism | $ 3,816,331 | $ 5,088,441 | $ 6,360,552 | $ 4,331,361 |
| Value Mechanism | $ 2,720,956 | $ 3,627,941 | $ 4,534,927 | $ 3,545,307 |
| Performance Metrics | $ 1,434,665 | $ 1,912,887 | $ 2,391,109 | $ 1,548,801 |
| Total Incentive (before-tax) | $ 7,971,952 | $ 10,629,270 | $ 13,286,587 | $ 9,425,469 |
| Total Incentive (after-tax) | $ 4,844,954 | $ 6,459,939 | $ 8,074,923 | $ 5,728,329 |

The Planned Values were submitted to the Department as Attachment A to the Memorandum of Agreement on April 15, 2011 in Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148.

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 Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid D.P.U. 10-148 ("2011 MOA"). The tax rate used to calculate the before-tax total incentive is 60.775%.

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 both the Residential and Low Income sectors required the EM&V impact bandwidth of 25 % of preliminary results to be applied. Residential sector evaluated results were 127 % of preliminary results but were capped at 125 % of preliminary results. Low Income sector evaluated results were 54 % 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 percent EM&V impact bandwidth. The Company achieved 85% of its planned benefits and 98% 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. Using evaluated results results (subject to the +/- 25 percent impact bandwidth), the Company calculated the lifetime benefits and net benefits that each program achieved. The benefits were multiplied by the savings payout rate of $0.00659 and the net benefits were multiplied by the value payout rate of $0.00689, 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.

**National Grid 2011 Electric Performance Metrics Summary**[1]

| | Achievement Level | Actual Units/Task Achieved | Pre Tax Incentive |
|---|---|---|---|
| **Residential** | | | |
| RES #1 MassSAVE/Weatherization: Deeper Savings | Increase in # of Customers: **None** | **n/a** | $ - |
| | Increase in Savings: **Exemplary** | **19%** | $ 172,160 |
| Outreach | **Exemplary** | **Produced Report** | $ 344,320 |
| | | | |
| **Low Income** | | | |
| Low Income #1. Hard to Reach Landlords | **Threshold** | **See Low Income Metric 1** | $ 107,122 |
| Low Income #2. New Measures | **Exemplary** | **See Low Income Metric 2** | $ 178,536 |
| Low Income #3. Multi-family Building Inventory | **Exemplary** | **See Low Income Metric 3** | $ 178,536 |
| | | | |
| **Commercial and Industrial** | | | |
| C&I #1 Retrofit Depth of Savings | **None** | **n/a** | $ - |
| C&I #2 N/C Comprehensiveness and Depth of Savings | **Design** | **See C&I Metric 2** | $ 137,728 |
| C&I #3 Direct Install Electric and Gas Integration | **None** | **n/a** | $ - |
| C&I #4 Combined Heat & Power (CHP) | **None** | **n/a** | $ - |
| | | | |
| **All Sector** | | | |
| Other Financing Capital | **Threshold** | **See All Sector Metric 1** | $ 71,733 |
| Cost Efficiency | **Exemplary** | **128%** | $ 358,666 |
| **Total** | | | **$ 1,548,801** |

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 Program Administrator should earn the incentive associated with such metric.

## VI. Audits

Other than the National Grid Audit Report No. 0223 and National Grid Audit Report 0338 filed with the Company's 2010 Electric 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. Electric PA Budgets
1. Summary Table

| Program Administrator Budget, Planned (1) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Customer Sector / Program | Program Costs | | | | | | Performance Incentive (2) | TOTAL PA Budget (3,5) |
| | Program Planning and Administration | Marketing and Advertising | Participant Incentive | Sales, Technical Assistance & Training | Evaluation and Market Research | Total Program Costs | | |
| **Residential (total)** | **$3,578,142** | **$4,350,175** | **$36,158,338** | **$11,783,061** | **$1,740,680** | **$57,610,395** | **$2,744,105** | **$60,354,500** |
| Residential New Construction & Major Renovation | $222,355 | $159,877 | $830,110 | $456,362 | $32,011 | $1,700,715 | $30,080 | $1,730,794 |
| Residential Cooling & Heating Equipment | $218,621 | $358,428 | $1,397,175 | $504,383 | $37,560 | $2,516,166 | $41,847 | $2,558,013 |
| Multi-Family Retrofit | $314,065 | $302,600 | $7,161,550 | $2,227,519 | $198,737 | $10,204,471 | $257,153 | $10,461,624 |
| MassSAVE | $465,109 | $974,300 | $10,227,000 | $5,649,650 | $943,616 | $18,259,676 | $1,680,072 | $19,939,748 |
| Behavior/Feedback Program | $196,415 | $12,150 | $2,263,953 | $22,430 | $66,972 | $2,561,921 | $94,812 | $2,656,732 |
| ENERGY STAR Lighting | $319,719 | $874,300 | $6,149,000 | $1,073,052 | $305,199 | $8,721,269 | $562,625 | $9,283,895 |
| ENERGY STAR Appliances | $201,268 | $606,800 | $1,447,800 | $597,190 | $66,552 | $2,919,609 | $77,517 | $2,997,126 |
| Residential Education Program | $285,000 | $190,000 | $0 | $620,000 | $0 | $1,095,000 | $0 | $1,095,000 |
| Workforce Development | $0 | $0 | $0 | $150,000 | $0 | $150,000 | $0 | $150,000 |
| Heat Loan Program | $216,825 | $0 | $5,655,000 | $288,825 | $0 | $6,160,650 | $0 | $6,160,650 |
| R&D and Demonstration | $96,000 | $19,000 | $136,000 | $0 | $0 | $251,000 | $0 | $251,000 |
| Deep Energy Retrofit | $135,523 | $18,000 | $560,000 | $70,000 | $43,584 | $827,107 | $0 | $827,107 |
| Behavior/Feedback Pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $79,158 | $18,000 | $152,000 | $40,000 | $14,458 | $303,616 | $0 | $303,616 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $79,676 | $68,000 | $102,000 | $63,000 | $15,634 | $328,310 | $0 | $328,310 |
| Residential New Construction Lighting Design statewide pilot | $74,883 | $0 | $13,000 | $0 | $4,394 | $92,277 | $0 | $92,277 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Heat Pump Water Heater Pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Residential Technical Development | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Hot Roofs | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Home Automation | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Community Based Pilot | $107,789 | $51,625 | $63,750 | $20,650 | $11,964 | $255,778 | $0 | $255,778 |
| Statewide Marketing & Education | $0 | $697,095 | $0 | $0 | $0 | $697,095 | $0 | $697,095 |
| EEAC Consultants (4) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOER Assessment | $270,861 | $0 | $0 | $0 | $0 | $270,861 | $0 | $270,861 |
| Sponsorships & Subscriptions | $294,874 | $0 | $0 | $0 | $0 | $294,874 | $0 | $294,874 |
| **Low Income (total)** | **$1,257,000** | **$455,207** | **$14,825,004** | **$2,902,109** | **$540,511** | **$19,979,831** | **$1,166,492** | **$21,146,323** |
| Low-Income Residential New Construction | $110,677 | $0 | $190,332 | $30,000 | $5,221 | $336,230 | $6,386 | $342,616 |
| Low-Income 1 to 4 Family Retrofit | $379,520 | $350,000 | $10,090,012 | $877,150 | $323,761 | $12,020,443 | $670,455 | $12,690,898 |
| Low-Income MultiFamily Retrofit | $217,251 | $29,895 | $4,544,660 | $1,994,959 | $211,529 | $6,998,294 | $489,650 | $7,487,944 |
| Statewide Marketing & Education | $0 | $75,312 | $0 | $0 | $0 | $75,312 | $0 | $75,312 |
| Low-Income Energy Affordability Network Funding | $433,469 | $0 | $0 | $0 | $0 | $433,469 | $0 | $433,469 |
| DOER Assessment | $116,083 | $0 | $0 | $0 | $0 | $116,083 | $0 | $116,083 |
| **Commercial & Industrial (total)** | **$5,740,777** | **$1,615,874** | **$85,417,252** | **$10,540,000** | **$4,751,522** | **$108,065,425** | **$6,718,673** | **$114,784,098** |
| C&I New Construction and Major Renovation | $1,647,058 | $440,374 | $21,925,000 | $3,345,000 | $958,236 | $28,315,668 | $1,394,196 | $29,709,864 |
| C&I New Construction and Major Renovation - Government | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| C&I Large Retrofit | $2,598,647 | $831,000 | $48,629,276 | $7,090,000 | $3,204,758 | $62,353,681 | $4,421,710 | $66,775,391 |
| Large C&I Retrofit - Government | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| C&I Small Retrofit | $406,058 | $344,500 | $14,812,976 | $75,000 | $577,778 | $16,216,312 | $902,768 | $17,119,080 |
| C&I Small Retrofit - Government | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Community based Pilot | $27,500 | $0 | $50,000 | $30,000 | $10,750 | $118,250 | $0 | $118,250 |
| Statewide Marketing & Education | $244,822 | $0 | $0 | $0 | $0 | $244,822 | $0 | $244,822 |
| EEAC Consultants (4) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOER Assessment | $589,804 | $0 | $0 | $0 | $0 | $589,804 | $0 | $589,804 |
| Sponsorships & Subscriptions | $226,887 | $0 | $0 | $0 | $0 | $226,887 | $0 | $226,887 |
| **GRAND TOTAL** | **$10,575,918** | **$6,421,256** | **$136,400,594** | **$25,225,170** | **$7,032,713** | **$185,655,651** | **$10,629,270** | **$196,284,921** |

| Program Administrator Budget, Actual (1) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Program Costs | | | | | | Performance Incentive (2) | 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)** | **$2,037,605** | **$3,093,977** | **$33,385,912** | **$7,847,972** | **$1,514,700** | **$47,880,166** | **$3,019,761** | **$50,854,686** |
| Residential New Construction & Major Renovation | $58,453 | $57,844 | $882,789 | $476,372 | $189,365 | $1,664,823 | $83,580 | $1,748,403 |
| Residential Cooling & Heating Equipment | $175,720 | $97,441 | $1,733,871 | $351,664 | $89,125 | $2,447,821 | $100,819 | $2,548,640 |
| Multi-Family Retrofit | $245,905 | $45,965 | $4,725,455 | $1,188,479 | $298,877 | $6,504,681 | $477,869 | $6,982,550 |
| MassSAVE | $343,458 | $399,475 | $11,145,110 | $4,101,113 | $340,192 | $16,329,348 | $1,381,699 | $17,711,047 |
| Behavior/Feedback Program | $124,997 | $2,073 | $2,571,816 | $10,801 | $109,443 | $2,819,130 | $71,773 | $2,890,903 |
| ENERGY STAR Lighting | $282,433 | $1,050,503 | $6,073,058 | $939,431 | $281,268 | $8,626,692 | $794,804 | $9,421,496 |
| ENERGY STAR Appliances | $200,294 | $701,158 | $2,376,507 | $528,985 | $58,453 | $3,865,398 | $109,218 | $3,974,616 |
| Residential Education Program | $37,750 | $23,804 | $0 | $2,229 | $6,035 | $69,818 | $0 | $69,818 |
| Workforce Development | $0 | $0 | $0 | $15,437 | $0 | $15,437 | $0 | $15,437 |
| Heat Loan Program | $0 | $0 | $3,458,057 | $0 | $0 | $3,458,057 | $0 | $3,458,057 |
| R&D and Demonstration | $1 | $1,537 | $20,496 | $3,853 | $19,354 | $45,241 | $0 | |
| Deep Energy Retrofit | $113,459 | $8,668 | $217,671 | $33,917 | $41,327 | $415,042 | $0 | $415,042 |
| Behavior/Feedback Pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $10,485 | $1,553 | $17,641 | $28,937 | $1,676 | $60,292 | $0 | $60,292 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $18,683 | $3,810 | $161,690 | $142,188 | $1,692 | $328,062 | $0 | $328,062 |
| Residential New Construction Lighting Design statewide pilot | $9,919 | $672 | $1,750 | $14,017 | $1,547 | $27,904 | $0 | $27,904 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Heat Pump Water Heater Pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Residential Technical Development | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Hot Roofs | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Home Automation | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Community Based Pilot | $3,664 | $25,840 | $0 | $10,549 | $60,710 | $100,762 | $0 | $100,762 |
| Statewide Marketing & Education | $0 | $673,635 | $0 | $0 | $15,636 | $689,271 | $0 | $689,271 |
| EEAC Consultants | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOER Assessment | $351,597 | $0 | $0 | $0 | $0 | $351,597 | $0 | $351,597 |
| Sponsorships & Subscriptions | $60,787 | $0 | $0 | $0 | $0 | $60,787 | $0 | $60,787 |
| **Low Income (total)** | **$567,041** | **$79,057** | **$10,069,029** | **$2,144,094** | **$273,775** | **$13,132,996** | **$1,085,484** | **$14,218,480** |
| Low-Income Residential New Construction | $48,104 | $755 | $190,182 | $0 | $2,259 | $241,301 | $24,918 | $266,219 |
| Low-Income 1 to 4 Family Retrofit | $250,294 | $10,330 | $7,387,759 | $1,587,669 | $166,251 | $9,402,303 | $588,844 | $9,991,147 |
| Low-Income MultiFamily Retrofit | $118,667 | $2,068 | $2,491,088 | $378,804 | $105,265 | $3,095,892 | $471,722 | $3,567,614 |
| Statewide Marketing & Education | $0 | $65,903 | $0 | $0 | $0 | $65,903 | $0 | $65,903 |
| Low-Income Energy Affordability Network Funding | $0 | $0 | $0 | $177,621 | $0 | $177,622 | $0 | $177,622 |
| DOER Assessment | $149,975 | $0 | $0 | $0 | $0 | $149,976 | $0 | $149,976 |
| **Commercial & Industrial (total)** | **$5,508,689** | **$558,688** | **$41,914,839** | **$5,383,969** | **$1,714,942** | **$55,081,127** | **$5,320,223** | **$60,401,350** |
| C&I New Construction and Major Renovation | $1,623,129 | $106,590 | $8,240,870 | $2,816,307 | $427,609 | $13,214,505 | $1,851,634 | $15,066,139 |
| C&I New Construction and Major Renovation - Government | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| C&I Large Retrofit | $2,756,950 | $102,875 | $22,833,541 | $2,419,661 | $977,284 | $29,090,312 | $2,904,876 | $31,995,188 |
| Large C&I Retrofit - Government | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| C&I Small Retrofit | $305,819 | $95,838 | $10,840,427 | $148,000 | $316,236 | $11,706,320 | $563,713 | $12,270,033 |
| C&I Small Retrofit - Government | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Community Based Pilot | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Statewide Marketing & Education | $0 | $253,385 | $0 | $0 | -$6,187 | $247,198 | $0 | $247,198 |
| EEAC Consultants | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOER Assessment | $762,004 | $0 | $0 | $0 | $0 | $762,004 | $0 | $762,004 |
| Sponsorships & Subscriptions | $60,787 | $0 | $0 | $0 | $0 | $60,787 | $0 | $60,787 |
| **GRAND TOTAL** | **$8,113,335** | **$3,731,722** | **$85,369,779** | **$15,376,034** | **$3,503,418** | **$116,094,289** | **$9,425,469** | **$125,474,515** |

Massachusetts Electric Company & Nantucket Electric Company d/b/a National Grid

| Program Administrator Budget, Percent Variance (1) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Program Costs | | | | | | Performance Incentive (2) | 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)** | **-43%** | **-29%** | **-8%** | **-33%** | **-13%** | **-17%** | **10%** | **-16%** |
| Residential New Construction & Major Renovation | -74% | -64% | 6% | 4% | 492% | -2% | 178% | 1% |
| Residential Cooling & Heating Equipment | -20% | -73% | 24% | -30% | 137% | -3% | 141% | 0% |
| Multi-Family Retrofit | -22% | -85% | -34% | -47% | 50% | -36% | 86% | -33% |
| MassSAVE | -26% | -59% | 9% | -27% | -64% | -11% | -18% | -11% |
| Behavior/Feedback Program | -36% | -83% | 14% | -52% | 63% | 10% | -24% | 9% |
| ENERGY STAR Lighting | -12% | 20% | -1% | -12% | -8% | -1% | 41% | 1% |
| ENERGY STAR Appliances | 0% | 16% | 64% | -11% | -12% | 32% | 41% | 33% |
| Residential Education Program | -87% | -87% | 0% | -100% | 0% | -94% | 0% | -94% |
| Workforce Development | 0% | 0% | 0% | -90% | 0% | -90% | 0% | -90% |
| Heat Loan Program | -100% | 0% | -39% | -100% | 0% | -44% | 0% | -44% |
| R&D and Demonstration | -100% | -92% | -85% | 0% | 0% | -82% | 0% | -100% |
| Deep Energy Retrofit | -16% | -52% | -61% | -52% | -5% | -50% | 0% | -50% |
| Power Monitor Pilot | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | -87% | -91% | -88% | -28% | -88% | -80% | 0% | -80% |
| Residential New Construction Multi Family (4-8 story) statewide pilot | -77% | -94% | 59% | 126% | -89% | 0% | 0% | 0% |
| Residential New Construction Lighting Design statewide pilot | -87% | 0% | -87% | 0% | -65% | -70% | 0% | -70% |
| Residential New Construction V3 Energy Star Homes statewide pilot | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Heat Pump Water Heater Pilot | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Residential Technical Development | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Hot Roofs | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Home Automation | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Community based Pilot | -97% | -50% | -100% | -49% | 407% | -61% | 0% | -61% |
| Statewide Marketing & Education | 0% | -3% | 0% | 0% | 0% | -1% | 0% | -1% |
| EEAC Consultants | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| DOER Assessment | 30% | 0% | 0% | 0% | 0% | 30% | 0% | 30% |
| Sponsorships & Subscriptions | -79% | 0% | 0% | 0% | 0% | -79% | 0% | -79% |
| **Low Income (total)** | **-55%** | **-83%** | **-32%** | **-26%** | **-49%** | **-34%** | **-7%** | **-33%** |
| Low-Income Residential New Construction | -57% | 0% | 0% | -100% | -57% | -28% | 290% | -22% |
| Low-Income 1 to 4 Family Retrofit | -34% | -97% | -27% | 81% | -49% | -22% | -12% | -21% |
| Low-Income MultiFamily Retrofit | -45% | -93% | -45% | -81% | -50% | -56% | -4% | -52% |
| Statewide Marketing & Education | 0% | -12% | 0% | 0% | 0% | -12% | 0% | -12% |
| Low-Income Energy Affordability Network Funding | -100% | 0% | 0% | 0% | 0% | -59% | 0% | -59% |
| DOER Assessment | 29% | 0% | 0% | 0% | 0% | 29% | 0% | 29% |
| **Commercial & Industrial (total)** | **-4%** | **-65%** | **-51%** | **-49%** | **-64%** | **-49%** | **-21%** | **-47%** |
| C&I New Construction and Major Renovation | -1% | -76% | -62% | -16% | -55% | -53% | 33% | -49% |
| C&I New Construction and Major Renovation - Government | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| C&I Large Retrofit | 6% | -88% | -53% | -66% | -70% | -53% | -34% | -52% |
| Large C&I Retrofit - Government | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| C&I Small Retrofit | -25% | -72% | -27% | 97% | -45% | -28% | -38% | -28% |
| C&I Small Retrofit - Government | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Community based Pilot | -100% | 0% | -100% | -100% | -100% | -100% | 0% | -100% |
| Statewide Marketing & Education | -100% | 0% | 0% | 0% | 0% | 1% | 0% | 1% |
| EEAC Consultants | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| DOER Assessment | 29% | 0% | 0% | 0% | 0% | 29% | 0% | 29% |
| Sponsorships & Subscriptions | -73% | 0% | 0% | 0% | 0% | -73% | 0% | -73% |
| **GRAND TOTAL** | **-23%** | **-42%** | **-37%** | **-39%** | **-50%** | **-37%** | **-11%** | **-36%** |

**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 Total PA Budget is the sum of Total Program Costs and Performance Incentives.
(4) EEAC Consultants charges are shown as zero to reflect that those funds were paid with RGGI dollars for 2011.
(5) Total planned budget does not include Lost Based Revenue from the 2011 MTM filing.

IV.D. Cost Effectiveness

1. Summary Table

| Total Resource Cost Test, Planned | | | | |
|---|---|---|---|---|
| **Customer Sector** | **B/C Ratio** | **Net Benefits** | **Benefits** | **Costs (1)** |
| **Residential** | **2.76** | **$118,102,053** | **$185,210,771** | **$67,108,718** |
| Residential New Construction & Major Renovation | 1.26 | $735,225 | $3,574,065 | $2,838,840 |
| Residential Cooling & Heating Equipment | 1.54 | $1,490,205 | $4,225,774 | $2,735,569 |
| Multi-Family Retrofit | 2.10 | $11,568,513 | $22,117,450 | $10,548,937 |
| MassSAVE | 4.30 | $76,906,249 | $100,202,856 | $23,296,607 |
| Behavior/Feedback Program | 2.78 | $4,739,916 | $7,396,648 | $2,656,732 |
| ENERGY STAR Lighting | 3.93 | $30,224,932 | $40,542,706 | $10,317,775 |
| ENERGY STAR Appliances | 1.80 | $3,184,145 | $7,151,272 | $3,967,126 |
| Residential Education Program | n/a | n/a | n/a | $1,095,000 |
| Workforce Development | n/a | n/a | n/a | $150,000 |
| Heat Loan Program | n/a | n/a | n/a | $6,160,650 |
| Deep Energy Retrofit | n/a | n/a | n/a | $827,107 |
| R&D and Demonstration | n/a | n/a | n/a | $251,000 |
| Behavior/Feedback Pilot | n/a | n/a | n/a | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | n/a | n/a | n/a | $306,430 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | n/a | n/a | n/a | $342,310 |
| Residential New Construction Lighting Design statewide pilot | n/a | n/a | n/a | $96,027 |
| Residential New Construction V3 Energy Star Homes statewide pilot | n/a | n/a | n/a | $0 |
| Heat Pump Water Heater Pilot | n/a | n/a | n/a | $0 |
| Residential Technical Development | n/a | n/a | n/a | $0 |
| Hot Roofs | n/a | n/a | n/a | $0 |
| Home Automation | n/a | n/a | n/a | $0 |
| Community Based Pilot | n/a | n/a | n/a | $255,778 |
| Statewide Marketing & Education | n/a | n/a | n/a | $697,095 |
| EEAC Consultants | n/a | n/a | n/a | $0 |
| DOER Assessment | n/a | n/a | n/a | $270,861 |
| Sponsorships & Subscriptions | n/a | n/a | n/a | $294,874 |
| **Low Income** | **2.68** | **$ 35,742,201** | **$ 57,044,958** | **$ 21,302,758** |
| Low-Income Residential New Construction | 1.31 | $152,333 | $651,384 | $499,051 |
| Low-Income 1 to 4 Family Retrofit | 2.71 | $21,697,949 | $34,388,847 | $12,690,898 |
| Low-Income MultiFamily Retrofit | 2.94 | $14,516,783 | $22,004,727 | $7,487,944 |
| Statewide Marketing & Education | n/a | n/a | n/a | $75,312 |
| Low-Income Energy Affordability Network Funding | n/a | n/a | n/a | $433,469 |
| DOER Assessment | n/a | n/a | n/a | $116,083 |
| **Commercial & Industrial** | **3.16** | **$ 361,613,664** | **$ 528,763,548** | **$ 167,149,884** |
| C&I New Construction and Major Renovation | 3.26 | $74,335,040 | $107,234,520 | $32,899,481 |
| C&I New Construction and Major Renovation - Government | n/a | $0 | $0 | $0 |
| C&I Large Retrofit | 3.23 | $246,028,703 | $356,226,803 | $110,198,100 |
| Large C&I Retrofit - Government | n/a | $0 | $0 | $0 |
| C&I Small Retrofit | 2.86 | $42,429,685 | $65,302,225 | $22,872,540 |
| C&I Small Retrofit - Government | n/a | $0 | $0 | $0 |
| Community Based Pilot | n/a | n/a | n/a | $118,250 |
| Statewide Marketing & Education | n/a | n/a | n/a | $244,822 |
| EEAC Consultants | n/a | n/a | n/a | $0 |
| DOER Assessment | n/a | n/a | n/a | $589,804 |
| Sponsorships & Subscriptions | n/a | n/a | n/a | $226,887 |
| **GRAND TOTAL** | **3.02** | **$515,457,918** | **$771,019,277** | **$255,561,359** |

| Total Resource Cost Test, Evaluated | | | | |
|---|---|---|---|---|
| **Customer Sector** | **B/C Ratio** | **Net Benefits** | **Benefits** | **Costs (1)** |
| **Residential** | **3.19** | **$137,725,163** | **$200,576,453** | **$62,851,291** |
| Residential New Construction & Major Renovation | 2.62 | $3,921,017 | $6,340,313 | $2,419,297 |
| Residential Cooling & Heating Equipment | 2.91 | $4,871,504 | $7,420,144 | $2,548,640 |
| Multi-Family Retrofit | 4.53 | $25,005,320 | $32,092,424 | $7,087,103 |
| MassSAVE | 3.98 | $62,261,018 | $83,129,563 | $20,868,544 |
| Behavior/Feedback Program | 2.06 | $3,055,132 | $5,946,035 | $2,890,903 |
| ENERGY STAR Lighting | 3.35 | $39,632,693 | $56,522,195 | $16,889,501 |
| ENERGY STAR Appliances | 2.02 | $4,600,750 | $9,125,780 | $4,525,030 |
| Residential Education Program | n/a | n/a | n/a | $69,818 |
| Workforce Development | n/a | n/a | n/a | $15,437 |
| Heat Loan Program | n/a | n/a | n/a | $3,458,057 |
| Deep Energy Retrofit | n/a | n/a | n/a | $415,042 |
| R&D and Demonstration | n/a | n/a | n/a | $45,241 |
| Behavior/Feedback Pilot | n/a | n/a | n/a | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | n/a | n/a | n/a | $60,292 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | n/a | n/a | n/a | $328,062 |
| Residential New Construction Lighting Design statewide pilot | n/a | n/a | n/a | $27,904 |
| Residential New Construction V3 Energy Star Homes statewide pilot | n/a | n/a | n/a | $0 |
| Heat Pump Water Heater Pilot | n/a | n/a | n/a | $0 |
| Residential Technical Development | n/a | n/a | n/a | $0 |
| Hot Roofs | n/a | n/a | n/a | $0 |
| Home Automation | n/a | n/a | n/a | $0 |
| Community Based Pilot | n/a | n/a | n/a | $100,762 |
| Statewide Marketing & Education | n/a | n/a | n/a | $689,271 |
| EEAC Consultants | n/a | n/a | n/a | $0 |
| DOER Assessment | n/a | n/a | n/a | $351,597 |
| Sponsorships & Subscriptions | n/a | n/a | n/a | $60,787 |
| **Low Income** | **3.04** | **$ 28,968,902** | **$ 43,189,291** | **$ 14,220,390** |
| Low-Income Residential New Construction | 4.63 | $965,763 | $1,231,982 | $266,219 |
| Low-Income 1 to 4 Family Retrofit | 2.73 | $17,253,409 | $27,244,556 | $9,991,147 |
| Low-Income MultiFamily Retrofit | 4.12 | $11,143,229 | $14,712,753 | $3,569,524 |
| Statewide Marketing & Education | n/a | n/a | n/a | $65,903 |
| Low-Income Energy Affordability Network Funding | n/a | n/a | n/a | $177,622 |
| DOER Assessment | n/a | n/a | n/a | $149,976 |
| **Commercial & Industrial** | **5.34** | **$ 323,838,801** | **$ 398,391,870** | **$ 74,553,069** |
| C&I New Construction and Major Renovation | 7.28 | $110,537,852 | $128,144,047 | $17,606,195 |
| C&I New Construction and Major Renovation - Government | n/a | n/a | n/a | $0 |
| C&I Large Retrofit | 5.41 | $182,086,825 | $223,409,897 | $41,323,072 |
| Large C&I Retrofit - Government | n/a | n/a | n/a | $0 |
| C&I Small Retrofit | 3.22 | $32,284,114 | $46,837,926 | $14,553,811 |
| C&I Small Retrofit - Government | n/a | n/a | n/a | $0 |
| Community Based Pilot | n/a | n/a | n/a | $0 |
| Statewide Marketing & Education | n/a | n/a | n/a | $247,198 |
| EEAC Consultants | n/a | n/a | n/a | $0 |
| DOER Assessment | n/a | n/a | n/a | $762,004 |
| Sponsorships & Subscriptions | n/a | n/a | n/a | $60,787 |
| **GRAND TOTAL** | **4.24** | **$490,532,865** | **$642,157,614** | **$151,624,749** |

| Total Resource Cost Test, Percent Variance | | | | |
|---|---|---|---|---|
| **Customer Sector** | **B/C Ratio** | **Net Benefits** | **Benefits** | **Costs (1)** |
| **Residential** | **16%** | **17%** | **8%** | **-6%** |
| Residential New Construction & Major Renovation | 108% | 433% | 77% | -15% |
| Residential Cooling & Heating Equipment | 88% | 227% | 76% | -7% |
| Multi-Family Retrofit | 116% | 116% | 45% | -33% |
| MassSAVE | -7% | -19% | -17% | -10% |
| O Power | -26% | -36% | -20% | 9% |
| ENERGY STAR Lighting | -15% | 31% | 39% | 64% |
| ENERGY STAR Appliances | 12% | 44% | 28% | 14% |
| Residential Education Program | n/a | n/a | n/a | -94% |
| Workforce Development | n/a | n/a | n/a | -90% |
| Heat Loan Program | n/a | n/a | n/a | -44% |
| Deep Energy Retrofit | n/a | n/a | n/a | -50% |
| Power Monitor Pilot | n/a | n/a | n/a | 0% |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | n/a | n/a | n/a | -80% |
| Residential New Construction Multi Family (4-8 story) statewide pilot | n/a | n/a | n/a | -4% |
| Residential New Construction Lighting Design statewide pilot | n/a | n/a | n/a | -71% |
| Residential New Construction V3 Energy Star Homes statewide pilot | n/a | n/a | n/a | 0% |
| Heat Pump Water Heater Pilot | n/a | n/a | n/a | 0% |
| Residential Technical Development | n/a | n/a | n/a | 0% |
| Hot Roofs | n/a | n/a | n/a | 0% |
| Home Automation | n/a | n/a | n/a | 0% |
| Community based Pilot | n/a | n/a | n/a | -61% |
| Statewide Marketing & Education | n/a | n/a | n/a | -1% |
| EEAC Consultants | n/a | n/a | n/a | 0% |
| DOER Assessment | n/a | n/a | n/a | 30% |
| Sponsorships & Subscriptions | n/a | n/a | n/a | -79% |
| **Low Income** | **13%** | **-19%** | **-24%** | **-33%** |
| Low-Income Residential New Construction | 255% | 534% | 89% | -47% |
| Low-Income 1 to 4 Family Retrofit | 1% | -20% | -21% | -21% |
| Low-Income MultiFamily Retrofit | 40% | -23% | -33% | -52% |
| Statewide Marketing & Education | n/a | n/a | n/a | -12% |
| Low-Income Energy Affordability Network Funding | n/a | n/a | n/a | -59% |
| DOER Assessment | n/a | n/a | n/a | 29% |
| **Commercial & Industrial** | **69%** | **-10%** | **-25%** | **-55%** |
| C&I New Construction and Major Renovation | 123% | 49% | 19% | -46% |
| C&I New Construction and Major Renovation - Government | n/a | n/a | n/a | 0% |
| C&I Large Retrofit | 67% | -26% | -37% | -63% |
| Large C&I Retrofit - Government | n/a | n/a | n/a | 0% |
| C&I Small Retrofit | 13% | -24% | -28% | -36% |
| C&I Small Retrofit - Government | n/a | n/a | n/a | 0% |
| Community Based Pilot | n/a | n/a | n/a | -100% |
| Statewide Marketing & Education | n/a | n/a | n/a | 1% |
| EEAC Consultants | n/a | n/a | n/a | 0% |
| DOER Assessment | n/a | n/a | n/a | 29% |
| Sponsorships & Subscriptions | n/a | n/a | n/a | -73% |
| **GRAND TOTAL** | **40%** | **-5%** | **-17%** | **-41%** |

**Notes:**
(1) See Table IV.D.2.1 Total Resource Costs Summary for more information regarding TRC Test Costs.
(2) For purpose of determining cost-effectiveness, the benefits and costs of "hard to measure programs" are taken into account at the customer sector level. See DPU 08-50-A at 30-31.
(3) For the purpose of determining cost-effectiveness, General Support costs are taken into account at the customer sector level.

IV.D. Cost Effectiveness
2.1. Cost Summary Table

**TRC Costs Summary, Planned**

| | PA Costs | | Participant Costs | TOTAL Resource Costs (3) |
|---|---|---|---|---|
| | Program Costs (1) | Performance Incentive (2) | | |
| **Residential (total)** | **$57,610,395** | **$2,744,105** | **$6,754,217** | **$67,108,718** |
| Residential New Construction & Major Renovation | $1,700,715 | $30,080 | $1,108,045 | $2,838,840 |
| Residential Cooling & Heating Equipment | $2,516,166 | $41,847 | $177,556 | $2,735,569 |
| Multi-Family Retrofit | $10,204,471 | $257,153 | $87,312 | $10,548,937 |
| MassSAVE | $18,259,676 | $1,680,072 | $3,356,860 | $23,296,607 |
| Behavior/Feedback Program | $2,561,921 | $94,812 | $0 | $2,656,732 |
| ENERGY STAR Lighting | $8,721,269 | $562,625 | $1,033,880 | $10,317,775 |
| ENERGY STAR Appliances | $2,919,609 | $77,517 | $970,000 | $3,967,126 |
| Residential Education Program | $1,095,000 | $0 | $0 | $1,095,000 |
| Workforce Development | $150,000 | $0 | $0 | $150,000 |
| Heat Loan Program | $6,160,650 | $0 | $0 | $6,160,650 |
| Deep Energy Retrofit | $827,107 | $0 | $0 | $827,107 |
| R&D and Demonstration | $251,000 | $0 | $0 | $251,000 |
| Behavior/Feedback Pilot | $0 | $0 | $0 | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $303,616 | $0 | $2,814 | $306,430 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $328,310 | $0 | $14,000 | $342,310 |
| Residential New Construction Lighting Design statewide pilot | $92,277 | $0 | $3,750 | $96,027 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | $0 | $0 | $0 |
| Heat Pump Water Heater Pilot | $0 | $0 | $0 | $0 |
| Residential Technical Development | $0 | $0 | $0 | $0 |
| Hot Roofs | $0 | $0 | $0 | $0 |
| Home Automation | $0 | $0 | $0 | $0 |
| Community based Pilot | $255,778 | $0 | $0 | $255,778 |
| Statewide Marketing & Education | $697,095 | $0 | $0 | $697,095 |
| EEAC Consultants (2) | $0 | $0 | $0 | $0 |
| DOER Assessment | $270,861 | $0 | $0 | $270,861 |
| Sponsorships & Subscriptions | $294,874 | $0 | $0 | $294,874 |
| **Low Income (total)** | **$19,979,831** | **$1,166,492** | **$156,435** | **$21,302,758** |
| Low-Income Residential New Construction | $336,230 | $6,386 | $156,435 | $499,051 |
| Low-Income 1 to 4 Family Retrofit | $12,020,443 | $670,455 | $0 | $12,690,898 |
| Low-Income MultiFamily Retrofit | $6,998,294 | $489,650 | $0 | $7,487,944 |
| Statewide Marketing & Education | $75,312 | $0 | $0 | $75,312 |
| Low-Income Energy Affordability Network Funding | $433,469 | $0 | $0 | $433,469 |
| DOER Assessment | $116,083 | $0 | $0 | $116,083 |
| **Commercial & Industrial (total)** | **$108,065,425** | **$6,718,673** | **$52,365,786** | **$167,149,884** |
| C&I New Construction and Major Renovation | $28,315,668 | $1,394,196 | $3,189,617 | $32,899,481 |
| C&I New Construction and Major Renovation - Government | $0 | $0 | $0 | $0 |
| C&I Large Retrofit | $62,353,681 | $4,421,710 | $43,422,709 | $110,198,100 |
| Large C&I Retrofit - Government | $0 | $0 | $0 | $0 |
| C&I Small Retrofit | $16,216,312 | $902,768 | $5,753,460 | $22,872,540 |
| C&I Small Retrofit - Government | $0 | $0 | $0 | $0 |
| Community Based Pilot | $118,250 | $0 | $0 | $118,250 |
| Statewide Marketing & Education | $244,822 | $0 | $0 | $244,822 |
| EEAC Consultants (2) | $0 | $0 | $0 | $0 |
| DOER Assessment | $589,804 | $0 | $0 | $589,804 |
| Sponsorships & Subscriptions | $226,887 | $0 | $0 | $226,887 |
| **GRAND TOTAL** | **$185,655,651** | **$10,629,270** | **$59,276,438** | **$255,561,359** |

| TRC Costs Summary, Actual | | | | |
|---|---|---|---|---|
| | PA Costs | | Participant Costs | TOTAL Resource Costs (3) |
| | Program Costs (1) | Performance Incentive (2) | | |
| **Residential (total)** | **$47,880,166** | **$3,019,761** | **$11,951,363** | **$62,851,291** |
| Residential New Construction & Major Renovation | $1,664,823 | $83,580 | $670,894 | $2,419,297 |
| Residential Cooling & Heating Equipment | $2,447,821 | $100,819 | $0 | $2,548,640 |
| Multi-Family Retrofit | $6,504,681 | $477,869 | $104,553 | $7,087,103 |
| MassSAVE | $16,329,348 | $1,381,699 | $3,157,497 | $20,868,544 |
| Behavior/Feedback Program | $2,819,130 | $71,773 | $0 | $2,890,903 |
| ENERGY STAR Lighting | $8,626,692 | $794,804 | $7,468,005 | $16,889,501 |
| ENERGY STAR Appliances | $3,865,398 | $109,218 | $550,414 | $4,525,030 |
| Residential Education Program | $69,818 | $0 | $0 | $69,818 |
| Workforce Development | $15,437 | $0 | $0 | $15,437 |
| Heat Loan Program | $3,458,057 | $0 | $0 | $3,458,057 |
| Deep Energy Retrofit | $415,042 | $0 | $0 | $415,042 |
| Behavior/Feedback Pilot | $0 | $0 | $0 | $0 |
| R&D and Demonstration | $45,241 | $0 | $0 | $45,241 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $60,292 | $0 | $0 | $60,292 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $328,062 | $0 | $0 | $328,062 |
| Residential New Construction Lighting Design statewide pilot | $27,904 | $0 | $0 | $27,904 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | $0 | $0 | $0 |
| Heat Pump Water Heater Pilot | $0 | $0 | $0 | $0 |
| Residential Technical Development | $0 | $0 | $0 | $0 |
| Hot Roofs | $0 | $0 | $0 | $0 |
| Home Automation | $0 | $0 | $0 | $0 |
| Community Based Pilot | $100,762 | $0 | $0 | $100,762 |
| Statewide Marketing & Education | $689,271 | $0 | $0 | $689,271 |
| EEAC Consultants | $0 | $0 | $0 | $0 |
| DOER Assessment | $351,597 | $0 | $0 | $351,597 |
| Sponsorships & Subscriptions | $60,787 | $0 | $0 | $60,787 |
| **Low Income (total)** | **$13,132,996** | **$1,085,484** | **$1,910** | **$14,220,390** |
| Low-Income Residential New Construction | $241,301 | $24,918 | $0 | $266,219 |
| Low-Income 1 to 4 Family Retrofit | $9,402,303 | $588,844 | $0 | $9,991,147 |
| Low-Income MultiFamily Retrofit | $3,095,892 | $471,722 | $1,910 | $3,569,524 |
| Statewide Marketing & Education | $65,903 | $0 | $0 | $65,903 |
| Low-Income Energy Affordability Network Funding | $177,622 | $0 | $0 | $177,622 |
| DOER Assessment | $149,976 | $0 | $0 | $149,976 |
| **Commercial & Industrial (total)** | **$55,081,127** | **$5,320,223** | **$14,151,718** | **$74,553,069** |
| C&I New Construction and Major Renovation | $13,214,505 | $1,851,634 | $2,540,056 | $17,606,195 |
| C&I New Construction and Major Renovation - Government | $0 | $0 | $0 | $0 |
| C&I Large Retrofit | $29,090,312 | $2,904,876 | $9,327,884 | $41,323,072 |
| Large C&I Retrofit - Government | $0 | $0 | $0 | $0 |
| C&I Small Retrofit | $11,706,320 | $563,713 | $2,283,778 | $14,553,811 |
| C&I Small Retrofit - Government | $0 | $0 | $0 | $0 |
| Community Based Pilot | $0 | $0 | $0 | $0 |
| Statewide Marketing & Education | $247,198 | $0 | $0 | $247,198 |
| EEAC Consultants | $0 | $0 | $0 | $0 |
| DOER Assessment | $762,004 | $0 | $0 | $762,004 |
| Sponsorships & Subscriptions | $60,787 | $0 | $0 | $60,787 |
| **GRAND TOTAL** | **$116,094,289** | **$9,425,469** | **$26,104,991** | **$151,624,749** |

| TRC Costs Summary, Percent Variance | | | | |
|---|---|---|---|---|
| | PA Costs | | Participant Costs | TOTAL Resource Costs (3) |
| | Program Costs (1) | Performance Incentive (2) | | |
| **Residential (total)** | **-17%** | **10%** | **77%** | **-6%** |
| Residential New Construction & Major Renovation | -2% | 178% | -39% | -15% |
| Residential Cooling & Heating Equipment | -3% | 141% | -100% | -7% |
| Multi-Family Retrofit | -36% | 86% | 20% | -33% |
| MassSAVE | -11% | -18% | -6% | -10% |
| Behavior/Feedback Program | 10% | -24% | 0% | 9% |
| ENERGY STAR Lighting | -1% | 41% | 622% | 64% |
| ENERGY STAR Appliances | 32% | 41% | -43% | 14% |
| Residential Education Program | -94% | 0% | 0% | -94% |
| Workforce Development | -90% | 0% | 0% | -90% |
| Heat Loan Program | -44% | 0% | 0% | -44% |
| Deep Energy Retrofit | -50% | 0% | 0% | -50% |
| Behavior/Feedback Pilot | -100% | 0% | 0% | -100% |
| R&D and Demonstration | 0% | 0% | 0% | 0% |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | -80% | 0% | -100% | -80% |
| Residential New Construction Multi Family (4-8 story) statewide pilot | 0% | 0% | -100% | -4% |
| Residential New Construction Lighting Design statewide pilot | -70% | 0% | -100% | -71% |
| Residential New Construction V3 Energy Star Homes statewide pilot | 0% | 0% | 0% | 0% |
| Heat Pump Water Heater Pilot | 0% | 0% | 0% | 0% |
| Residential Technical Development | 0% | 0% | 0% | 0% |
| Hot Roofs | 0% | 0% | 0% | 0% |
| Home Automation | 0% | 0% | 0% | 0% |
| Community Based Pilot | -61% | 0% | 0% | -61% |
| Statewide Marketing & Education | -1% | 0% | 0% | -1% |
| EEAC Consultants | 0% | 0% | 0% | 0% |
| DOER Assessment | 30% | 0% | 0% | 30% |
| Sponsorships & Subscriptions | -79% | 0% | 0% | -79% |
| **Low Income (total)** | **-34%** | **-7%** | **-99%** | **-33%** |
| Low-Income Residential New Construction | -28% | 290% | -100% | -47% |
| Low-Income 1 to 4 Family Retrofit | -22% | -12% | 0% | -21% |
| Low-Income MuiltiFamily Retrofit | -56% | -4% | 0% | -52% |
| Statewide Marketing & Education | -12% | 0% | 0% | -12% |
| Low-Income Energy Affordability Network Funding | -59% | 0% | 0% | -59% |
| DOER Assessment | 29% | 0% | 0% | 29% |
| **Commercial & Industrial (total)** | **-49%** | **-21%** | **-73%** | **-55%** |
| C&I New Construction and Major Renovation | -53% | 33% | -20% | -46% |
| C&I New Construction and Major Renovation - Government | 0% | 0% | 0% | 0% |
| C&I Large Retrofit | -53% | -34% | -79% | -63% |
| Large C&I Retrofit - Government | 0% | 0% | 0% | 0% |
| C&I Small Retrofit | -28% | -38% | -60% | -36% |
| C&I Small Retrofit - Government | 0% | 0% | 0% | 0% |
| Community Based Pilot | -100% | 0% | 0% | -100% |
| Statewide Marketing & Education | 1% | 0% | 0% | 1% |
| EEAC Consultants | 0% | 0% | 0% | 0% |
| DOER Assessment | 29% | 0% | 0% | 29% |
| Sponsorships & Subscriptions | -73% | 0% | 0% | -73% |
| **GRAND TOTAL** | **-37%** | **-11%** | **-56%** | **-41%** |

**Notes:**
(1) Program Costs include Program Planning and Administration, Marketing and Advertising, Program Incentive, Sales, Technical Assistance & Training, Evaluation and Market Research
(2) Values listed in this table represent pre-tax performance incentive amounts. See Section IV.H. Shareholder Performance Incentives for supporting calculations.
(3) This represents the total TRC Test costs, which does not include LBR.

Massachusetts Electric Company & Nantucket Electric Company d/b/a National Grid

IV.D Cost Effectiveness
3.1.i. Benefits Summary Table

| Program | Electric Benefits, Planned ($) | | | | | | | | | | | | Non-Electric Benefits, Planned ($) | | | | | | | | | TOTAL BENEFITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Capacity | | | | | | Energy | | | | | | Resource Benefits | | | | | | | Non- Resource Benefits (1) | TOTAL | |
| | Generation | | Trans. | Distrib. | DRIPE | TOTAL | Winter | | Summer | | DRIPE | TOTAL | Avoided Natural Gas | No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Water | Kerosene | | | |
| | Summer | Winter | | | | | Peak | Off Peak | Peak | Off Peak | | | | | | | | | | | | |
| **Residential (total)** | **5,812,024** | **-** | **3,096,078** | **16,954,712** | **3,062,962** | **28,925,775** | **18,434,930** | **20,678,541** | **11,749,688** | **10,717,157** | **19,176,608** | **80,756,925** | **8,235,526** | **55,352,085** | **-** | **4,426,184** | **-** | **4,201,378** | **-** | **3,312,897** | **75,528,071** | **185,210,771** |
| Residential New Construction & Major Renovation | 127,742 | - | 59,901 | 328,030 | 54,992 | 570,665 | 522,111 | 623,865 | 381,035 | 338,705 | 395,007 | 2,260,724 | 8,022 | 337,764 | - | 330,312 | - | 5,120 | - | 61,458 | 742,676 | 3,574,065 |
| Residential Cooling & Heating Equipment | 352,772 | - | 224,188 | 1,227,697 | 198,180 | 2,002,837 | 1,191,926 | 320,844 | 590,649 | 188,076 | 425,867 | 2,717,361 | (535,638) | - | - | - | - | - | - | 41,213 | (494,425) | 4,225,774 |
| Multi-Family Retrofit | 544,777 | - | 305,525 | 1,673,111 | 257,415 | 2,780,827 | 4,409,047 | 5,290,943 | 2,219,169 | 2,542,659 | 2,615,073 | 17,076,892 | - | - | - | - | - | 2,088,159 | - | 171,572 | 2,259,731 | 22,117,450 |
| MassSAVE | 3,484,431 | - | 1,629,639 | 8,924,215 | 1,256,852 | 15,295,138 | 2,437,688 | 2,872,054 | 3,628,470 | 2,141,702 | 3,237,737 | 14,317,651 | 8,763,141 | 55,014,321 | - | 4,095,872 | - | 2,108,099 | - | 608,634 | 70,590,068 | 100,202,856 |
| Behavior/Feedback Program | 192,562 | - | 74,578 | 408,402 | - | 675,542 | 1,237,693 | 1,387,982 | 614,239 | 658,738 | 2,822,454 | 6,721,106 | - | - | - | - | - | - | - | - | - | 7,396,648 |
| ENERGY STAR Lighting | 934,114 | - | 665,267 | 3,643,127 | 1,090,204 | 6,332,711 | 7,298,898 | 8,605,168 | 3,621,614 | 4,088,569 | 8,165,727 | 31,779,975 | - | - | - | - | - | - | - | 2,430,020 | 2,430,020 | 40,542,706 |
| ENERGY STAR Appliances | 175,626 | - | 136,980 | 750,130 | 205,319 | 1,268,056 | 1,337,567 | 1,577,684 | 694,513 | 758,708 | 1,514,743 | 5,883,216 | - | - | - | - | - | - | - | - | - | 7,151,272 |
| **Low Income (total)** | **671,356** | **-** | **401,714** | **2,199,863** | **379,916** | **3,652,849** | **4,988,557** | **5,968,304** | **2,502,988** | **2,860,226** | **3,446,991** | **19,767,066** | **28,102** | **8,015,451** | **-** | **26,849** | **-** | **2,219,336** | **-** | **23,335,305** | **33,625,043** | **57,044,958** |
| Low-Income Residential New Construction | 18,759 | - | 10,191 | 55,809 | 12,176 | 96,934 | 98,319 | 116,649 | 49,111 | 55,791 | 91,527 | 411,398 | 9,333 | 7,506 | - | 26,849 | - | 185 | - | 99,179 | 143,052 | 651,384 |
| Low-Income 1 to 4 Family Retrofit | 246,164 | - | 163,184 | 893,626 | 178,252 | 1,481,225 | 1,875,166 | 2,233,468 | 936,177 | 1,065,427 | 1,576,399 | 7,686,638 | 18,769 | 8,007,945 | - | - | - | 834,503 | - | 16,359,767 | 25,220,984 | 34,388,847 |
| Low-Income MultiFamily Retrofit | 406,433 | - | 228,339 | 1,250,429 | 189,488 | 2,074,689 | 3,015,072 | 3,618,186 | 1,517,700 | 1,739,008 | 1,779,065 | 11,669,031 | - | - | - | - | - | 1,384,648 | - | 6,876,359 | 8,261,007 | 22,004,727 |
| **Commercial & Industrial (total)** | **18,138,814** | **-** | **14,253,810** | **78,056,581** | **15,175,902** | **125,625,107** | **144,805,948** | **61,115,747** | **75,141,290** | **29,011,664** | **78,897,289** | **388,971,937** | **(2,842,774)** | **4,429,738** | **-** | **-** | **-** | **-** | **-** | **12,579,541** | **14,166,504** | **528,763,548** |
| C&I New Construction and Major Renovation | 4,347,794 | - | 3,269,107 | 17,902,252 | 2,967,654 | 28,486,807 | 29,391,186 | 13,561,029 | 15,278,825 | 6,465,460 | 13,858,841 | 78,555,341 | - | - | - | - | - | - | - | 192,373 | 192,373 | 107,234,520 |
| C&I New Construction and Major Renovation - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C&I Large Retrofit | 11,462,692 | - | 9,107,610 | 49,875,007 | 10,124,316 | 80,569,626 | 96,428,134 | 43,881,257 | 50,046,111 | 20,803,764 | 55,650,699 | 266,809,965 | (2,842,774) | 4,429,738 | - | - | - | - | - | 7,260,249 | 8,847,212 | 356,226,803 |
| Large C&I Retrofit - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C&I Small Retrofit | 2,328,328 | - | 1,877,094 | 10,279,322 | 2,083,931 | 16,568,674 | 18,986,628 | 3,673,461 | 9,816,355 | 1,742,440 | 9,387,749 | 43,606,632 | - | - | - | - | - | - | - | 5,126,919 | 5,126,919 | 65,302,225 |
| C&I Small Retrofit - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **GRAND TOTAL** | **24,622,194** | **-** | **17,751,602** | **97,211,156** | **18,618,779** | **158,203,731** | **168,229,435** | **87,762,592** | **89,393,967** | **42,589,047** | **101,520,888** | **489,495,928** | **5,420,854** | **67,797,273** | **-** | **4,453,033** | **-** | **6,420,714** | **-** | **39,227,743** | **123,319,617** | **771,019,277** |

| Program | Electric Benefits, Evaluated ($) | | | | | | | | | | | | Non-Electric Benefits, Evaluated ($) | | | | | | | | | TOTAL BENEFITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Capacity | | | | | | Energy | | | | | | Resource Benefits | | | | | | | Non- Resource Benefits (1) | TOTAL | |
| | Generation | | Trans. | Distrib. | DRIPE | TOTAL | Winter | | Summer | | DRIPE | TOTAL | Avoided Natural Gas | No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Water | Kerosene | | | |
| | Summer | Winter | | | | | Peak | Off Peak | Peak | Off Peak | | | | | | | | | | | | |
| **Residential (total)** | **2,668,134** | **-** | **1,767,898** | **9,681,333** | **2,451,110** | **16,568,474** | **25,192,521** | **17,337,972** | **12,187,157** | **8,150,628** | **21,171,382** | **84,039,660** | **1,066,267** | **35,688,176** | **-** | **3,897,507** | **-** | **1,814,876** | **-** | **57,501,493** | **99,968,319** | **200,576,453** |
| Residential New Construction & Major Renovation | 198,818 | - | 90,349 | 494,768 | 77,434 | 861,369 | 577,997 | 506,689 | 335,100 | 253,706 | 411,554 | 2,085,045 | (33,788) | 497,325 | - | 1,729,618 | - | 1,318 | - | 1,199,426 | 3,393,899 | 6,340,313 |
| Residential Cooling & Heating Equipment | 614,500 | - | 384,262 | 2,104,292 | 310,548 | 3,413,603 | 1,428,023 | 392,620 | 1,132,535 | 359,171 | 597,835 | 3,910,184 | (536,281) | - | - | - | - | - | - | 632,639 | 96,357 | 7,420,144 |
| Multi-Family Retrofit | 108,587 | - | 61,680 | 337,769 | 59,166 | 567,203 | 3,169,489 | 2,414,297 | 823,673 | 696,076 | 1,364,666 | 8,468,200 | - | - | - | - | - | 1,077,293 | - | 21,979,728 | 23,057,021 | 32,092,424 |
| MassSAVE | 251,567 | - | 191,686 | 1,049,708 | 353,639 | 1,846,601 | 3,600,079 | 2,568,811 | 1,613,998 | 1,051,388 | 3,306,426 | 12,140,702 | 1,636,336 | 35,190,852 | - | 2,167,889 | - | 736,265 | - | 29,410,919 | 69,142,260 | 83,129,563 |
| Behavior/Feedback Program | 151,725 | - | 58,762 | 321,792 | - | 532,279 | 996,711 | 1,117,932 | 494,605 | 530,473 | 2,274,036 | 5,413,756 | - | - | - | - | - | - | - | - | - | 5,946,035 |
| ENERGY STAR Lighting | 1,145,403 | - | 827,056 | 4,529,109 | 1,409,942 | 7,911,510 | 13,673,556 | 8,834,726 | 6,861,032 | 4,481,418 | 11,539,621 | 45,390,353 | - | - | - | - | - | - | - | 3,220,331 | 3,220,331 | 56,522,195 |
| ENERGY STAR Appliances | 197,532 | - | 154,103 | 843,894 | 240,381 | 1,435,910 | 1,746,666 | 1,502,899 | 926,215 | 778,396 | 1,677,245 | 6,631,420 | - | - | - | - | - | - | - | 1,058,450 | 1,058,450 | 9,125,780 |
| **Low Income (total)** | **360,615** | **-** | **230,214** | **1,260,692** | **243,732** | **2,095,253** | **3,454,798** | **2,766,950** | **1,430,471** | **1,099,894** | **1,903,550** | **10,655,663** | **219,036** | **12,820,285** | **-** | **79,221** | **-** | **730,600** | **-** | **16,589,233** | **30,438,376** | **43,189,291** |
| Low-Income Residential New Construction | 12,898 | - | 7,102 | 38,895 | 7,836 | 66,731 | 82,780 | 52,601 | 44,524 | 29,854 | 57,840 | 267,598 | 208,354 | - | - | 79,221 | - | 467 | - | 609,610 | 897,653 | 1,231,982 |
| Low-Income 1 to 4 Family Retrofit | 249,501 | - | 166,223 | 910,270 | 187,287 | 1,513,282 | 1,868,775 | 1,586,919 | 949,215 | 750,869 | 1,196,361 | 6,352,139 | 10,682 | 12,820,285 | - | - | - | 377,504 | - | 6,170,664 | 19,379,136 | 27,244,556 |
| Low-Income MultiFamily Retrofit | 98,215 | - | 56,888 | 311,528 | 48,609 | 515,240 | 1,503,243 | 1,127,431 | 436,733 | 319,170 | 649,349 | 4,035,926 | - | - | - | - | - | 352,629 | - | 9,808,959 | 10,161,588 | 14,712,753 |
| **Commercial & Industrial (total)** | **13,263,123** | **1,469,414** | **16,993,353** | **50,650,260** | **22,504,283** | **104,880,433** | **94,384,871** | **75,668,963** | **47,085,570** | **39,753,213** | **48,347,245** | **305,239,862** | **(64,067,241)** | **25,359,644** | **-** | **-** | **-** | **1,839,761** | **-** | **25,139,411** | **(11,728,426)** | **398,391,870** |
| C&I New Construction and Major Renovation | 4,704,246 | - | 3,399,545 | 18,616,534 | 3,152,624 | 29,872,948 | 25,114,091 | 18,817,401 | 12,526,525 | 8,880,440 | 13,621,327 | 78,959,784 | (1,423,349) | (508,938) | - | - | - | 156 | - | 21,243,446 | 19,311,314 | 128,144,047 |
| C&I New Construction and Major Renovation - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C&I Large Retrofit | 8,558,878 | - | 5,547,028 | 30,376,546 | 5,102,703 | 49,585,155 | 63,650,349 | 49,480,148 | 31,891,756 | 22,974,839 | 34,748,868 | 202,745,959 | (59,494,910) | 26,677,727 | - | - | - | 1 | - | 3,895,965 | (28,921,217) | 223,409,897 |
| Large C&I Retrofit - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C&I Small Retrofit | - | 1,469,414 | 8,046,781 | 1,657,180 | 14,248,956 | 25,422,331 | 5,620,431 | 7,371,414 | 2,667,290 | 7,897,934 | (22,950) | 23,534,118 | (3,148,983) | (809,146) | - | - | - | 1,839,605 | - | - | (2,118,523) | 46,837,926 |
| C&I Small Retrofit - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **GRAND TOTAL** | **16,291,872** | **1,469,414** | **18,991,465** | **61,592,284** | **25,199,126** | **123,544,160** | **123,032,190** | **95,773,885** | **60,703,198** | **49,003,734** | **71,422,177** | **399,935,184** | **(62,781,938)** | **73,868,105** | **-** | **3,976,728** | **-** | **4,385,237** | **-** | **99,230,137** | **118,678,270** | **642,157,614** |

| Program | Electric Benefits, Percent Variance ($) | | | | | | | | | | | | Non-Electric Benefits, Percent Variance ($) | | | | | | | | | TOTAL BENEFITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Capacity | | | | | | Energy | | | | | | Resource Benefits | | | | | | | Non- Resource Benefits (1) | TOTAL | |
| | Generation | | Trans. | Distrib. | DRIPE | TOTAL | Winter | | Summer | | DRIPE | TOTAL | Avoided Natural Gas | No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Water | Kerosene | | | |
| | Summer | Winter | | | | | Peak | Off Peak | Peak | Off Peak | | | | | | | | | | | | |
| **Residential (total)** | **-54%** | **0%** | **-43%** | **-43%** | **-20%** | **-43%** | **37%** | **-16%** | **4%** | **-24%** | **10%** | **4%** | **-87%** | **-36%** | **0%** | **-12%** | **0%** | **-57%** | **0%** | **1636%** | **32%** | **8%** |
| Residential New Construction & Major Renovation | 56% | 0% | 51% | 51% | 41% | 51% | 11% | -19% | -12% | -25% | 4% | -8% | -521% | 47% | 0% | 424% | 0% | -74% | 0% | 1852% | 357% | 77% |
| Residential Cooling & Heating Equipment | 74% | 0% | 71% | 71% | 57% | 70% | 20% | 22% | 92% | 91% | 40% | 44% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 1435% | -119% | 76% |
| Multi-Family Retrofit | -80% | 0% | -80% | -80% | -77% | -80% | -28% | -54% | -63% | -73% | -48% | -50% | 0% | 0% | 0% | 0% | 0% | -48% | 0% | 12711% | 920% | 45% |
| MassSAVE | -93% | 0% | -88% | -88% | -72% | -88% | 48% | -11% | -56% | -51% | 2% | -15% | -81% | -36% | 0% | -47% | 0% | -65% | 0% | 4732% | -2% | -17% |
| Behavior/Feedback Program | -21% | 0% | -21% | -21% | 0% | -21% | -19% | -19% | -19% | -19% | -19% | -19% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | -20% |
| ENERGY STAR Lighting | 23% | 0% | 24% | 24% | 29% | 25% | 87% | 3% | 89% | 10% | 41% | 43% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 33% | 33% | 39% |
| ENERGY STAR Appliances | 12% | 0% | 12% | 12% | 17% | 13% | 31% | -5% | 33% | 3% | 11% | 13% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 28% |
| **Low Income (total)** | **-46%** | **0%** | **-43%** | **-43%** | **-36%** | **-43%** | **-31%** | **-54%** | **-43%** | **-62%** | **-45%** | **-46%** | **679%** | **60%** | **0%** | **195%** | **0%** | **-67%** | **0%** | **-29%** | **-9%** | **-24%** |
| Low-Income Residential New Construction | -31% | 0% | -30% | -30% | -36% | -31% | -16% | -55% | -9% | -46% | -37% | -35% | 2132% | -100% | 0% | 195% | 0% | 152% | 0% | 515% | 528% | 89% |
| Low-Income 1 to 4 Family Retrofit | 1% | 0% | 2% | 2% | 5% | 2% | 0% | -29% | 1% | -30% | -24% | -17% | -43% | 60% | 0% | 0% | 0% | -55% | 0% | -62% | -23% | -21% |
| Low-Income MultiFamily Retrofit | -76% | 0% | -75% | -75% | -74% | -75% | -50% | -69% | -71% | -82% | -64% | -65% | 0% | 0% | 0% | 0% | 0% | -75% | 0% | 43% | 23% | -33% |
| **Commercial & Industrial (total)** | **-27%** | **0%** | **19%** | **-35%** | **48%** | **-17%** | **-35%** | **24%** | **-37%** | **37%** | **-39%** | **-22%** | **2154%** | **472%** | **0%** | **0%** | **0%** | **0%** | **0%** | **100%** | **-183%** | **-25%** |
| C&I New Construction and Major Renovation | 8% | 0% | 4% | 4% | 6% | 5% | -15% | 39% | -18% | 37% | -2% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 10943% | 9938% | 19% |
| C&I New Construction and Major Renovation - Government | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| C&I Large Retrofit | -25% | 0% | -39% | -39% | -50% | -38% | -34% | 13% | -36% | 10% | -38% | -24% | 1993% | 502% | 0% | 0% | 0% | 0% | 0% | -46% | -427% | -37% |
| Large C&I Retrofit - Government | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| C&I Small Retrofit | -100% | 0% | 329% | -84% | 584% | 53% | -70% | 101% | -73% | 353% | -100% | -46% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | -100% | -141% | -28% |
| C&I Small Retrofit - Government | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **GRAND TOTAL** | **-34%** | **0%** | **7%** | **-37%** | **35%** | **-22%** | **-27%** | **9%** | **-32%** | **15%** | **-30%** | **-18%** | **-1258%** | **9%** | **0%** | **-11%** | **0%** | **-32%** | **0%** | **153%** | **-4%** | **-17%** |

**Notes:**
(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.
(2) Include any hard to measure programs with quantifiable benefits.
See Section IV.D.3.2. Saving Summary for information on the savings used to determine the benefits in these tables.
See Section IV.D.3.3. for the Avoided Cost Factors used to determine the benefits in these tables

Massachusetts Electric Company & Nantucket Electric Company d/b/a National Grid

IV.D. Cost Effectiveness
3.2.i. Savings Summary Table

| Program | # of Participants | Electric Savings, Planned | | | | | | | | | Non Electric Resources, Planned | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Capacity (kW) | | | Energy (MWh) | | | | | | MMBTU | | | | | | Gallons |
| | | Annualized | | Lifetime | Summer (Annualized) | | Winter (Annualized) | | Total Annualized MWh | Lifetime | Avoided Natural Gas | No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Kerosene | Water |
| | | Summer | Winter | | Peak | Off Peak | Peak | Off Peak | | | | | | | | | |
| **Residential (total)** | **662,107** | **14,774** | **27,788** | **158,841** | **17,402** | **25,010** | **33,567** | **48,899** | **124,878** | **760,284** | **35,318** | **122,479** | **-** | **6,626** | **-** | **-** | **45,296,924** |
| Residential New Construction & Major Renovation | 646 | 203 | 328 | 3,153 | 262 | 349 | 444 | 657 | 1,712 | 22,685 | 57 | 671 | - | 438 | - | - | 51,802 |
| Residential Cooling & Heating Equipment | 5,256 | 807 | 246 | 11,425 | 390 | 167 | 722 | 240 | 1,518 | 26,082 | (2,410) | - | - | - | - | - | - |
| Multi-Family Retrofit | 11,355 | 954 | 2,731 | 15,806 | 1,373 | 2,113 | 2,852 | 4,226 | 10,564 | 177,450 | - | - | - | - | - | - | 15,551,646 |
| MassSAVE | 19,000 | 4,663 | 2,273 | 86,688 | 2,854 | 3,155 | 3,616 | 5,356 | 14,981 | 133,702 | 37,671 | 121,807 | - | 6,189 | - | - | 29,693,476 |
| Behavior/Feedback Program | 200,000 | 3,330 | 13,275 | 3,330 | 6,762 | 10,404 | 14,045 | 20,807 | 52,018 | 52,018 | - | - | - | - | - | - | - |
| ENERGY STAR Lighting | 398,550 | 4,019 | 8,039 | 31,905 | 4,860 | 7,477 | 10,094 | 14,954 | 37,384 | 294,094 | - | - | - | - | - | - | - |
| ENERGY STAR Appliances | 27,300 | 798 | 896 | 6,533 | 901 | 1,345 | 1,795 | 2,659 | 6,700 | 54,253 | - | - | - | - | - | - | - |
| **Low Income (total)** | **12,611** | **1,429** | **3,375** | **20,494** | **1,851** | **2,848** | **3,845** | **5,696** | **14,240** | **200,630** | **542** | **19,997** | **-** | **37** | **-** | **-** | **22,245,494** |
| Low-Income Residential New Construction | 204 | 45 | 82 | 518 | 54 | 82 | 111 | 165 | 412 | 3,955 | 285 | 15 | - | 37 | - | - | 1,874 |
| Low-Income 1 to 4 Family Retrofit | 4,006 | 682 | 1,511 | 8,149 | 863 | 1,328 | 1,792 | 2,655 | 6,638 | 75,330 | 257 | 19,982 | - | - | - | - | 11,754,330 |
| Low-Income MultiFamily Retrofit | 8,401 | 702 | 1,782 | 11,826 | 935 | 1,438 | 1,941 | 2,876 | 7,190 | 121,344 | - | - | - | - | - | - | 10,489,290 |
| **Commercial & Industrial (total)** | **3,328** | **55,943** | **42,408** | **710,288** | **62,042** | **32,617** | **123,871** | **65,266** | **283,796** | **3,603,971** | **(12,609)** | **23,030** | **-** | **-** | **-** | **-** | **-** |
| C&I New Construction and Major Renovation | 905 | 10,940 | 8,346 | 164,890 | 10,649 | 6,045 | 21,298 | 12,091 | 50,083 | 754,660 | - | - | - | - | - | - | - |
| C&I New Construction and Major Renovation - Government | - | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| C&I Large Retrofit | 759 | 37,322 | 30,134 | 453,214 | 42,781 | 24,506 | 85,349 | 49,045 | 201,681 | 2,464,927 | (12,609) | 23,030 | - | - | - | - | - |
| Large C&I Retrofit - Government | - | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| C&I Small Retrofit | 1,664 | 7,682 | 3,928 | 92,185 | 8,612 | 2,065 | 17,224 | 4,130 | 32,032 | 384,383 | - | - | - | - | - | - | - |
| C&I Small Retrofit - Government | - | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| **GRAND TOTAL** | **678,046** | **72,146** | **73,572** | **889,623** | **81,295** | **60,474** | **161,283** | **119,861** | **422,914** | **4,564,884** | **23,251** | **165,506** | **-** | **6,664** | **-** | **-** | **67,542,418** |

| Program | # of Participants | Electric Savings, Evaluated | | | | | | | | | Non Electric Resources, Evaluated | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Capacity (kW) | | | Energy (MWh) | | | | | | MMBTU | | | | | | Gallons |
| | | Annual | | Lifetime | Summer (Annual) | | Winter (Annual) | | Total Annual MWh | Lifetime | Avoided Natural Gas | No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Kerosene | Water |
| | | Summer | Winter | | Peak | Off Peak | Peak | Off Peak | | | | | | | | | |
| **Residential (total)** | **1,076,337** | **11,545** | **26,492** | **86,299** | **-** | **-** | **35,350** | **22,152** | **122,268** | **753,648** | **7,807** | **101,941** | **101,941** | **6,545** | **-** | **1,066,267** | **25,556,410** |
| Residential New Construction & Major Renovation | 919 | 280 | 325 | 4,798 | - | - | 1,123 | 76 | 1,741 | 20,123 | 223 | 941 | 941 | 2,265 | - | (33,788) | 13,339 |
| Residential Cooling & Heating Equipment | 4,179 | 1,128 | 398 | 19,826 | - | - | 474 | 159 | 2,105 | 37,641 | (2,990) | - | - | - | - | (536,281) | - |
| Multi-Family Retrofit | 9,148 | 214 | 1,329 | 3,139 | - | - | 15,875 | 6,105 | 5,386 | 85,435 | - | - | - | - | - | - | 15,173,146 |
| MassSAVE | 17,893 | 1,317 | 2,839 | 9,018 | - | - | 17,878 | 11,533 | 14,504 | 105,731 | 10,574 | 101,000 | 101,000 | 4,280 | - | 1,636,336 | 10,369,925 |
| Behavior/Feedback Program | 268,799 | 2,624 | 10,462 | 2,624 | - | - | - | - | 41,901 | 41,901 | - | - | - | - | - | - | - |
| ENERGY STAR Lighting | 739,745 | 5,107 | 10,213 | 39,516 | - | - | - | 3,220 | 49,390 | 402,064 | - | - | - | - | - | - | - |
| ENERGY STAR Appliances | 35,654 | 874 | 925 | 7,378 | - | - | - | 1,058 | 7,241 | 60,753 | - | - | - | - | - | - | - |
| **Low Income (total)** | **8,746** | **884** | **1,394** | **11,603** | **-** | **-** | **13,424** | **3,165** | **7,515** | **105,258** | **885** | **31,475** | **31,475** | **110** | **-** | **219,036** | **10,288,295** |
| Low-Income Residential New Construction | 139 | 28 | 49 | 363 | - | - | 595 | 14 | 243 | 2,502 | 739 | - | - | 110 | - | 208,354 | 4,730 |
| Low-Income 1 to 4 Family Retrofit | 4,318 | 679 | 824 | 8,300 | - | - | 4,118 | 2,052 | 4,730 | 62,183 | 147 | 31,475 | 31,475 | - | - | 10,682 | 5,316,960 |
| Low-Income MultiFamily Retrofit | 4,289 | 176 | 522 | 2,941 | - | - | 8,711 | 1,098 | 2,542 | 40,573 | - | - | - | - | - | - | 4,966,605 |
| **Commercial & Industrial (total)** | **3,513** | **36,002** | **32,211** | **525,107** | **36,998** | **32,580** | **76,770** | **66,866** | **213,214** | **3,144,310** | **(325,790)** | **60,550** | **-** | **-** | **-** | **-** | **2,213,910** |
| C&I New Construction and Major Renovation | 678 | 11,449 | 9,162 | 170,593 | 8,675 | 8,156 | 18,099 | 16,503 | 51,432 | 783,302 | (5,410) | (1,713) | - | - | - | - | 2,178,022 |
| C&I New Construction and Major Renovation - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C&I Large Retrofit | 860 | 18,551 | 18,875 | 282,080 | 21,879 | 21,257 | 45,780 | 44,027 | 132,943 | 2,014,151 | (293,682) | 66,012 | - | - | - | - | 29,886 |
| Large C&I Retrofit - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C&I Small Retrofit | 1,975 | 6,002 | 4,175 | 72,434 | 6,444 | 3,167 | 12,891 | 6,335 | 28,838 | 346,857 | (26,698) | (3,749) | - | - | - | - | 6,002 |
| C&I Small Retrofit - Government | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **GRAND TOTAL** | **1,088,596** | **48,431** | **60,097** | **623,009** | **36,998** | **32,580** | **125,544** | **92,183** | **342,996** | **4,003,217** | **(317,097)** | **193,966** | **133,416** | **6,655** | **-** | **1,285,303** | **38,058,615** |

| Program | # of Participants | Electric Savings, Percent Variance | | | | | | | | | Non Electric Resources, Percent Variance | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Capacity (kW) | | | Energy (MWh) | | | | | | MMBTU | | | | | | Gallons |
| | | Annual | | Lifetime | Summer (Annual) | | Winter (Annual) | | Total Annual MWh | Lifetime | Avoided Natural Gas | No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Kerosene | Water |
| | | Summer | Winter | | Peak | Off Peak | Peak | Off Peak | | | | | | | | | |
| **Residential (total)** | **63%** | **-22%** | **-5%** | **-46%** | **-100%** | **-100%** | **5%** | **-55%** | **-2%** | **-1%** | **-78%** | **-17%** | **0%** | **-1%** | **0%** | **0%** | **-44%** |
| Residential New Construction & Major Renovation | 42% | 38% | -1% | 52% | -100% | -100% | 153% | -88% | 2% | -11% | 292% | 40% | 0% | 418% | 0% | 0% | -74% |
| Residential Cooling & Heating Equipment | -20% | 40% | 62% | 74% | -100% | -100% | -34% | -34% | 39% | 44% | 24% | 0% | 0% | 0% | 0% | 0% | 0% |
| Multi-Family Retrofit | -19% | -78% | -51% | -80% | -100% | -100% | 457% | 44% | -49% | -52% | 0% | 0% | 0% | 0% | 0% | 0% | -2% |
| MassSAVE | -6% | -72% | 25% | -90% | -100% | -100% | 394% | 115% | -3% | -21% | -72% | -17% | 0% | -31% | 0% | 0% | -65% |
| Behavior/Feedback Program | 34% | -21% | -21% | -21% | -100% | -100% | -100% | -100% | -19% | -19% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| ENERGY STAR Lighting | 86% | 27% | 27% | 24% | -100% | -100% | -100% | -78% | 32% | 37% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| ENERGY STAR Appliances | 31% | 10% | 3% | 13% | -100% | -100% | -100% | -60% | 8% | 12% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Low Income (total)** | **-31%** | **-38%** | **-59%** | **-43%** | **-100%** | **-100%** | **249%** | **-44%** | **-47%** | **-48%** | **63%** | **57%** | **0%** | **194%** | **0%** | **0%** | **-54%** |
| Low-Income Residential New Construction | -32% | -37% | -41% | -30% | -100% | -100% | 435% | -91% | -41% | -37% | 159% | -100% | 0% | 194% | 0% | 0% | 152% |
| Low-Income 1 to 4 Family Retrofit | 8% | 0% | -45% | 2% | -100% | -100% | 130% | -23% | -29% | -17% | -43% | 58% | 0% | 0% | 0% | 0% | -55% |
| Low-Income MultiFamily Retrofit | -49% | -75% | -71% | -75% | -100% | -100% | 349% | -62% | -65% | -67% | 0% | 0% | 0% | 0% | 0% | 0% | -53% |
| **Commercial & Industrial (total)** | **6%** | **-36%** | **-24%** | **-26%** | **-40%** | **0%** | **-38%** | **2%** | **-25%** | **-13%** | **2484%** | **163%** | **0%** | **0%** | **0%** | **0%** | **0%** |
| C&I New Construction and Major Renovation | -25% | 5% | 10% | 3% | -19% | 35% | -15% | 36% | 3% | 4% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| C&I New Construction and Major Renovation - Government | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| C&I Large Retrofit | 13% | -50% | -37% | -38% | -49% | -13% | -46% | -10% | -34% | -18% | 2229% | 187% | 0% | 0% | 0% | 0% | 0% |
| Large C&I Retrofit - Government | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| C&I Small Retrofit | 19% | -22% | 6% | -21% | -25% | 53% | -25% | 53% | -10% | -10% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| C&I Small Retrofit - Government | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| **GRAND TOTAL** | **61%** | **-33%** | **-18%** | **-30%** | **-54%** | **-46%** | **-22%** | **-23%** | **-19%** | **-12%** | **-1464%** | **17%** | **0%** | **0%** | **0%** | **0%** | **-44%** |

IV.D. Cost Effectiveness

3.3.i. Avoided Cost Factors Summary Table

| Avoided Cost Factors | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Capacity ($/kW-yr) (1) | | Energy ($/kWh) (1) | | | | Non-Electric (1) | | | | | | | | | | | Distribution ($/kW) (2) | Transmission ($/kW) |
| | | | Winter | | Summer | | $/MMBTU | | | | | | | | | | $/Gallon | | |
| | Summer | Winter | Peak | Off Peak | Peak | Off Peak | Residential Heating Natural Gas | Residential DHW Natural Gas | C&I Heating Natural Gas | C&I DHW Natural Gas | Residential No. 2 Distillate | Commercial No. 2 Distillate | No. 4 Fuel Oil | Propane | Wood | Kerosene | Water | | |
| 2011 | $ 52.46 | $ - | $ 0.08 | $ 0.06 | $ 0.09 | $ 0.06 | $ 13.23 | $ 10.42 | $ 11.69 | $ 9.54 | $ 16.95 | $ 14.91 | $ 14.48 | $ 25.84 | | $ 16.47 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2012 | $ 37.07 | $ - | $ 0.09 | $ 0.07 | $ 0.09 | $ 0.07 | $ 13.73 | $ 11.00 | $ 12.18 | $ 10.12 | $ 18.62 | $ 16.55 | $ 16.16 | $ 27.84 | | $ 18.09 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2013 | $ 17.48 | $ - | $ 0.09 | $ 0.07 | $ 0.09 | $ 0.07 | $ 13.75 | $ 11.02 | $ 12.21 | $ 10.13 | $ 20.04 | $ 18.03 | $ 17.68 | $ 30.17 | | $ 19.46 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2014 | $ 17.48 | $ - | $ 0.09 | $ 0.08 | $ 0.09 | $ 0.07 | $ 13.84 | $ 11.10 | $ 12.30 | $ 10.22 | $ 21.70 | $ 19.66 | $ 19.31 | $ 32.46 | | $ 21.07 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2015 | $ 18.82 | $ - | $ 0.09 | $ 0.08 | $ 0.10 | $ 0.07 | $ 13.95 | $ 11.19 | $ 12.40 | $ 10.31 | $ 23.49 | $ 21.31 | $ 20.97 | $ 34.88 | | $ 22.81 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2016 | $ 20.16 | $ - | $ 0.09 | $ 0.08 | $ 0.10 | $ 0.07 | $ 14.10 | $ 11.33 | $ 12.56 | $ 10.45 | $ 25.26 | $ 22.93 | $ 22.56 | $ 37.49 | | $ 24.54 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2017 | $ 20.16 | $ - | $ 0.10 | $ 0.08 | $ 0.10 | $ 0.08 | $ 14.31 | $ 11.52 | $ 12.76 | $ 10.64 | $ 26.93 | $ 24.45 | $ 24.07 | $ 40.02 | | $ 26.15 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2018 | $ 21.51 | $ - | $ 0.10 | $ 0.08 | $ 0.10 | $ 0.08 | $ 14.54 | $ 11.75 | $ 13.00 | $ 10.87 | $ 26.99 | $ 24.55 | $ 24.20 | $ 40.15 | | $ 26.21 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2019 | $ 21.51 | $ - | $ 0.10 | $ 0.09 | $ 0.11 | $ 0.08 | $ 14.64 | $ 11.91 | $ 13.10 | $ 11.03 | $ 27.16 | $ 24.71 | $ 24.38 | $ 40.35 | | $ 26.37 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2020 | $ 22.85 | $ - | $ 0.10 | $ 0.09 | $ 0.11 | $ 0.08 | $ 14.46 | $ 11.74 | $ 12.91 | $ 10.86 | $ 27.22 | $ 24.69 | $ 24.34 | $ 40.27 | | $ 26.44 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2021 | $ 24.20 | $ - | $ 0.10 | $ 0.09 | $ 0.10 | $ 0.08 | $ 14.31 | $ 11.55 | $ 12.77 | $ 10.67 | $ 27.30 | $ 24.82 | $ 24.49 | $ 40.50 | | $ 26.52 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2022 | $ 25.54 | $ - | $ 0.10 | $ 0.09 | $ 0.11 | $ 0.08 | $ 14.41 | $ 11.64 | $ 12.86 | $ 10.76 | $ 27.52 | $ 25.09 | $ 24.75 | $ 40.74 | | $ 26.73 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2023 | $ 26.89 | $ - | $ 0.10 | $ 0.09 | $ 0.11 | $ 0.09 | $ 14.64 | $ 11.81 | $ 13.09 | $ 10.93 | $ 27.39 | $ 24.92 | $ 24.58 | $ 40.50 | | $ 26.60 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2024 | $ 28.23 | $ - | $ 0.11 | $ 0.09 | $ 0.12 | $ 0.09 | $ 15.05 | $ 12.22 | $ 13.51 | $ 11.34 | $ 27.74 | $ 25.22 | $ 24.86 | $ 40.65 | | $ 26.94 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2025 | $ 41.67 | $ - | $ 0.11 | $ 0.09 | $ 0.12 | $ 0.09 | $ 15.18 | $ 12.34 | $ 13.64 | $ 11.46 | $ 28.25 | $ 25.70 | $ 25.34 | $ 41.34 | | $ 27.44 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2026 | $ 55.12 | $ - | $ 0.11 | $ 0.10 | $ 0.12 | $ 0.09 | $ 15.31 | $ 12.46 | $ 13.77 | $ 11.58 | $ 28.78 | $ 26.18 | $ 25.82 | $ 42.05 | | $ 27.95 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2027 | $ 68.56 | $ - | $ 0.12 | $ 0.10 | $ 0.12 | $ 0.10 | $ 15.44 | $ 12.59 | $ 13.90 | $ 11.71 | $ 29.32 | $ 26.68 | $ 26.31 | $ 42.77 | | $ 28.47 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2028 | $ 82.00 | $ - | $ 0.12 | $ 0.10 | $ 0.13 | $ 0.10 | $ 15.57 | $ 12.71 | $ 14.03 | $ 11.83 | $ 29.86 | $ 27.18 | $ 26.82 | $ 43.51 | | $ 29.00 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2029 | $ 95.45 | $ - | $ 0.12 | $ 0.10 | $ 0.13 | $ 0.10 | $ 15.70 | $ 12.83 | $ 14.16 | $ 11.96 | $ 30.42 | $ 27.69 | $ 27.33 | $ 44.25 | | $ 29.54 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2030 | $ 107.55 | $ - | $ 0.12 | $ 0.10 | $ 0.13 | $ 0.10 | $ 15.84 | $ 12.96 | $ 14.30 | $ 12.08 | $ 30.99 | $ 28.22 | $ 27.85 | $ 45.01 | | $ 30.10 | $ 0.01 | $ 111.27 | $ 20.32 |
| 2031 | $ 107.55 | $ - | $ 0.13 | $ 0.11 | $ 0.14 | $ 0.11 | $ 15.97 | $ 13.09 | $ 14.44 | $ 12.21 | $ 31.57 | $ 28.75 | $ 28.38 | $ 45.78 | | $ 30.66 | $ 0.01 | $ 111.27 | $ 20.32 |

**Notes:**

(1) Source: Avoided Energy Supply Costs in New England: 2009 Report by Synapse Energy Economics Inc., August 21, 2009

Massachusetts Electric Company & Nantucket Electric Company d/b/a National Grid

V.D. Outsourced/Competitive Procured Services
1. Summary Table

## Program Planning and Administration

**Planned**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | $2,050,710 | 68% | $185,852 | 19% | $775,844 | 81% | $961,696 | 32% | $3,012,406 |
| Residential New Construction & Major Renovation | $181,463 | 82% | $0 | 0% | $40,892 | 100% | $40,892 | 18% | $222,355 |
| Residential Cooling & Heating Equipment | $193,189 | 88% | $12,716 | 50% | $12,716 | 50% | $25,432 | 12% | $218,621 |
| Multi-family Retrofit | $229,703 | 73% | $42,181 | 50% | $42,181 | 50% | $84,363 | 27% | $314,065 |
| MassSave | $299,807 | 64% | $82,651 | 50% | $82,651 | 50% | $165,302 | 36% | $465,109 |
| Behavior/Feedback Program | $116,639 | 59% | $0 | 0% | $79,776 | 100% | $79,776 | 41% | $196,415 |
| ENERGY STAR Lighting | $250,342 | 78% | $34,688 | 50% | $34,688 | 50% | $69,376 | 22% | $319,719 |
| ENERGY STAR Appliances | $174,036 | 86% | $13,616 | 50% | $13,616 | 50% | $27,231 | 14% | $201,268 |
| Residential Education Program | $0 | 0% | $0 | 0% | $285,000 | 100% | $285,000 | 100% | $285,000 |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Loan Program | $84,479 | 39% | $0 | 0% | $132,346 | 100% | $132,346 | 61% | $216,825 |
| R&D and Demonstration | $96,000 | 70% | $0 | 0% | $0 | 100% | $0 | 0% | $96,000 |
| Deep Energy Retrofit | $94,445 | 70% | $0 | 0% | $41,078 | 100% | $41,078 | 30% | $135,523 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $74,433 | 94% | $0 | 0% | $4,725 | 100% | $4,725 | 6% | $79,158 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $74,433 | 93% | $0 | 0% | $5,243 | 100% | $5,243 | 7% | $79,676 |
| Residential New Construction Lighting Design statewide pilot | $74,433 | 99% | $0 | 0% | $450 | 100% | $450 | 1% | $74,883 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $107,308 | 100% | $0 | 0% | $482 | 100% | $482 | 0% | $107,789 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $563,075 | 80% | $0 | 0% | $144,373 | 100% | $144,373 | 20% | $707,448 |
| Low-Income Residential New Construction | $87,115 | 79% | $0 | 0% | $23,562 | 100% | $23,562 | 21% | $110,677 |
| Low-Income 1 to 4 Family Retrofit | $281,534 | 74% | $0 | 0% | $97,986 | 100% | $97,986 | 26% | $379,520 |
| Low-Income Multifamily Retrofit | $194,426 | 89% | $0 | 0% | $22,825 | 100% | $22,825 | 11% | $217,251 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $3,449,834 | 74% | $0 | 0% | $1,229,430 | 100% | $1,229,430 | 26% | $4,679,263 |
| C&I New Construction and Major Renovation | $1,340,368 | 81% | $0 | 0% | $306,689 | 100% | $306,689 | 19% | $1,647,058 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $1,829,714 | 70% | $0 | 0% | $768,933 | 100% | $768,933 | 30% | $2,598,647 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $252,252 | 62% | $0 | 0% | $153,807 | 100% | $153,807 | 38% | $406,058 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $27,500 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $27,500 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $6,063,619 | 72% | $185,852 | 8% | $2,149,647 | 92% | $ 2,335,499 | 28% | $8,399,117 |

**Actual**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | $1,189,749 | 73% | $0 | 0% | $431,809 | 100% | $431,809 | 27% | $1,621,558 |
| Residential New Construction & Major Renovation | $40,883 | 70% | $0 | 0% | $17,569 | 100% | $17,569 | 30% | $58,453 |
| Residential Cooling & Heating Equipment | $151,921 | 86% | $0 | 0% | $23,799 | 100% | $23,799 | 14% | $175,720 |
| Multi-family Retrofit | $166,836 | 68% | $0 | 0% | $79,069 | 100% | $79,069 | 32% | $245,905 |
| MassSave | $179,399 | 52% | $0 | 0% | $164,059 | 100% | $164,059 | 48% | $343,458 |
| Behavior/Feedback Program | $102,533 | 82% | $0 | 0% | $22,464 | 100% | $22,464 | 18% | $124,997 |
| ENERGY STAR Lighting | $192,550 | 68% | $0 | 0% | $89,883 | 100% | $89,883 | 32% | $282,433 |
| ENERGY STAR Appliances | $167,707 | 84% | $0 | 0% | $32,587 | 100% | $32,587 | 16% | $200,294 |
| Residential Education Program | $37,750 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $37,750 |
| Workforce Development | $0 | 36% | $0 | 0% | $0 | 0% | $0 | 64% | $0 |
| Heat Loan Program | $0 | 36% | $0 | 0% | $0 | 0% | $0 | 64% | $0 |
| R&D and Demonstration | $0 | 26% | $0 | 0% | $0 | 0% | $0 | 74% | $0 |
| Deep Energy Retrofit | $111,083 | 98% | $0 | 0% | $2,376 | 100% | $2,376 | 2% | $113,459 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $10,485 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $10,485 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $18,683 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $18,683 |
| Residential New Construction Lighting Design statewide pilot | $9,919 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $9,919 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 26% | $0 | 0% | $0 | 0% | $0 | 74% | $0 |
| Heat Pump Water Heater Pilot | $0 | 26% | $0 | 0% | $0 | 0% | $0 | 74% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $3,664 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $3,664 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $351,597 | 100% | $351,597 | 100% | $351,597 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 100% | $60,787 | 100% | $60,787 |
| **Low Income (total)** | $228,055 | 40% | $0 | 0% | $338,985 | 100% | $338,985 | 60% | $567,041 |
| Low-Income Residential New Construction | $45,234 | 94% | $0 | 0% | $2,870 | 100% | $2,870 | 6% | $48,104 |
| Low-Income 1 to 4 Family Retrofit | $138,365 | 55% | $0 | 0% | $111,929 | 100% | $111,929 | 45% | $250,294 |
| Low-Income Multifamily Retrofit | $44,456 | 37% | $0 | 0% | $74,211 | 100% | $74,211 | 63% | $118,667 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $149,975 | 100% | $149,975 | 100% | $149,975 |
| **Commercial & Industrial (total)** | $3,720,772 | 68% | $323,872 | 18% | $1,464,045 | 82% | $1,787,917 | 32% | $5,508,690 |
| C&I New Construction and Major Renovation | $1,394,753 | 86% | $0 | 0% | $228,376 | 100% | $228,376 | 14% | $1,623,129 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $2,278,341 | 83% | $80,706 | 17% | $397,903 | 83% | $478,609 | 17% | $2,756,950 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $47,678 | 16% | $243,166 | 94% | $14,975 | 6% | $258,141 | 84% | $305,819 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 64% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 64% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $762,004 | 100% | $762,004 | 100% | $762,004 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 100% | $60,787 | 100% | $60,787 |
| **TOTAL** | $5,138,576 | 67% | $ 323,872 | 13% | $2,234,839 | 87% | $2,558,712 | 33% | $7,697,288 |

**Percent Variance**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | ($860,961) | -42% | ($185,852) | -100% | ($344,035) | -44% | ($529,887) | -55% | ($1,390,848) |
| Residential New Construction & Major Renovation | ($140,580) | -77% | $0 | 0% | ($23,322) | -57% | ($23,322) | -57% | ($163,902) |
| Residential Cooling & Heating Equipment | ($41,268) | -21% | ($12,716) | -100% | $11,083 | 87% | ($1,633) | -6% | ($42,901) |
| Multi-family Retrofit | ($62,866) | -27% | ($42,181) | -100% | $36,888 | 87% | ($5,294) | -6% | ($68,160) |
| MassSave | ($120,409) | -40% | ($82,651) | -100% | $81,408 | 98% | ($1,243) | -1% | ($121,652) |
| Behavior/Feedback Program | ($14,106) | -12% | $0 | 0% | ($57,313) | -72% | ($57,313) | -72% | ($71,418) |
| ENERGY STAR Lighting | ($57,792) | -23% | ($34,688) | -100% | $55,195 | 159% | $20,506 | 30% | ($37,286) |
| ENERGY STAR Appliances | ($6,329) | -4% | ($13,616) | -100% | $18,971 | 139% | $5,356 | 20% | ($973) |
| Residential Education Program | $37,750 | 0% | $0 | 0% | ($285,000) | -100% | ($285,000) | -100% | ($247,250) |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Loan Program | ($84,479) | -100% | $0 | 0% | ($132,346) | -100% | ($132,346) | -100% | ($216,825) |
| R&D and Demonstration | ($96,000) | -100% | $0 | 0% | $0 | 0% | $0 | 0% | ($96,000) |
| Deep Energy Retrofit | $16,638 | 18% | $0 | 0% | ($38,702) | -94% | ($38,702) | -94% | ($22,064) |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | ($63,948) | -86% | $0 | 0% | ($4,725) | -100% | ($4,725) | -100% | ($68,673) |
| Residential New Construction Multi Family (4-8 story) statewide pilot | ($55,750) | -75% | $0 | 0% | ($5,243) | -100% | ($5,243) | -100% | ($60,993) |
| Residential New Construction Lighting Design statewide pilot | ($64,514) | -87% | $0 | 0% | ($450) | -100% | ($450) | -100% | ($64,964) |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($103,644) | -97% | $0 | 0% | ($482) | -100% | ($482) | -100% | ($104,126) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $351,597 | 0% | $351,597 | 0% | $351,597 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 0% | $60,787 | 0% | $60,787 |
| **Low Income (total)** | ($335,019) | -59% | $0 | 0% | $194,613 | 135% | $194,613 | 135% | ($140,407) |
| Low-Income Residential New Construction | ($41,881) | -48% | $0 | 0% | ($20,692) | -88% | ($20,692) | -88% | ($62,572) |
| Low-Income 1 to 4 Family Retrofit | ($143,169) | -51% | $0 | 0% | $13,943 | 14% | $13,943 | 14% | ($129,226) |
| Low-Income Multifamily Retrofit | ($149,970) | -77% | $0 | 0% | $51,386 | 225% | $51,386 | 225% | ($98,584) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $149,975 | 0% | $149,975 | 0% | $149,975 |
| **Commercial & Industrial (total)** | $270,939 | 8% | $323,872 | 0% | $234,615 | 19% | $558,488 | 45% | $829,426 |
| C&I New Construction and Major Renovation | $54,385 | 4% | $0 | 0% | ($78,314) | -26% | ($78,314) | -26% | ($23,928) |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $448,627 | 25% | $80,706 | 0% | ($371,031) | -48% | ($290,324) | -38% | $158,303 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | ($204,574) | -81% | $243,166 | 0% | ($138,831) | -90% | $104,335 | 68% | ($100,239) |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($27,500) | -100% | $0 | 0% | $0 | 0% | $0 | 0% | ($27,500) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $762,004 | 0% | $762,004 | 0% | $762,004 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 0% | $60,787 | 0% | $60,787 |
| **TOTAL** | ($925,042) | -15% | $138,020 | 74% | $85,193 | 4% | $223,213 | 10% | ($701,829) |

## Marketing and Advertising

**Planned**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | $242,875 | 7% | $3,088,451 | 91% | $321,754 | 9% | $3,410,205 | 93% | $3,653,080 |
| Residential New Construction & Major Renovation | $24,300 | 15% | $135,577 | 100% | $0 | 0% | $135,577 | 85% | $159,877 |
| Residential Cooling & Heating Equipment | $24,300 | 7% | $297,374 | 89% | $36,754 | 11% | $334,128 | 93% | $358,428 |
| Multi-family Retrofit | $48,600 | 16% | $254,000 | 100% | $0 | 0% | $254,000 | 84% | $302,600 |
| MassSave | $24,300 | 2% | $855,000 | 90% | $95,000 | 10% | $950,000 | 98% | $974,300 |
| Behavior/Feedback Program | $12,150 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $12,150 |
| ENERGY STAR Lighting | $24,300 | 3% | $850,000 | 100% | $0 | 0% | $850,000 | 97% | $874,300 |
| ENERGY STAR Appliances | $24,300 | 4% | $582,500 | 100% | $0 | 0% | $582,500 | 96% | $606,800 |
| Residential Education Program | $0 | 0% | $0 | 0% | $190,000 | 100% | $190,000 | 100% | $190,000 |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Loan Program | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| R&D and Demonstration | $0 | 0% | $19,000 | 100% | $0 | 0% | $19,000 | 0% | $19,000 |
| Deep Energy Retrofit | $9,000 | 50% | $9,000 | 100% | $0 | 0% | $9,000 | 50% | $18,000 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | $18,000 | 100% | $0 | 0% | $18,000 | 100% | $18,000 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | $68,000 | 100% | $0 | 0% | $68,000 | 100% | $68,000 |
| Residential New Construction Lighting Design statewide pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $51,625 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $51,625 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $12,150 | 3% | $367,213 | 100% | $532 | 0% | $367,745 | 97% | $379,895 |
| Low-Income Residential New Construction | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income 1 to 4 Family Retrofit | $0 | 0% | $350,000 | 100% | $0 | 0% | $350,000 | 100% | $350,000 |
| Low-Income Multifamily Retrofit | $12,150 | 41% | $17,213 | 97% | $532 | 3% | $17,745 | 59% | $29,895 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $65,000 | 4% | $956,675 | 62% | $594,199 | 38% | $1,550,874 | 96% | $1,667,499 |
| C&I New Construction and Major Renovation | $15,000 | 3% | $0 | 0% | $425,374 | 100% | $425,374 | 97% | $440,374 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $35,000 | 4% | $676,600 | 85% | $119,400 | 15% | $796,000 | 96% | $831,000 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $15,000 | 4% | $280,075 | 85% | $49,425 | 15% | $329,500 | 96% | $344,500 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $51,625 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $51,625 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $320,025 | 6% | $4,412,339 | 83% | $916,485 | 17% | $ 5,328,824 | 94% | $5,700,474 |

**Actual**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | $98,953 | 4% | $2,033,246 | 89% | $260,698 | 11% | $2,293,943 | 96% | $2,392,896 |
| Residential New Construction & Major Renovation | $4,560 | 8% | $49,697 | 93% | $3,587 | 7% | $53,283 | 92% | $57,844 |
| Residential Cooling & Heating Equipment | $6,348 | 7% | $69,511 | 76% | $21,582 | 24% | $91,093 | 93% | $97,441 |
| Multi-family Retrofit | $5,854 | 13% | $5,851 | 15% | $34,260 | 85% | $40,111 | 87% | $45,965 |
| MassSave | $22,760 | 6% | $219,254 | 58% | $157,460 | 42% | $376,715 | 94% | $399,475 |
| Behavior/Feedback Program | $1,776 | 86% | $0 | 0% | $297 | 100% | $297 | 14% | $2,073 |
| ENERGY STAR Lighting | $50,999 | 5% | $984,018 | 98% | $15,485 | 2% | $999,503 | 95% | $1,050,503 |
| ENERGY STAR Appliances | $0 | 0% | $701,158 | 100% | $0 | 0% | $701,158 | 100% | $701,158 |
| Residential Education Program | $3,533 | 15% | $0 | 0% | $20,271 | 100% | $20,271 | 85% | $23,804 |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Loan Program | $0 | 67% | $0 | 0% | $0 | 0% | $0 | 33% | $0 |
| R&D and Demonstration | $55 | | $0 | 0% | $1,140 | 100% | $1,140 | | $1,195 |
| Deep Energy Retrofit | $2,380 | 27% | $0 | 0% | $6,288 | 100% | $6,288 | 73% | $8,668 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | $804 | 100% | $0 | 0% | $804 | 100% | $804 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | $2,953 | 100% | $0 | 0% | $2,953 | 100% | $2,953 |
| Residential New Construction Lighting Design statewide pilot | $672 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $672 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 68% | $0 | 0% | $0 | 100% | $0 | 32% | $0 |
| Heat Pump Water Heater Pilot | $16 | 5% | $0 | 0% | $326 | 100% | $326 | 95% | $342 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $236 | 1% | $0 | 0% | $25,604 | 100% | $25,604 | 99% | $25,840 |
| Statewide Marketing & Education* | $0 | 0% | $671,075 | 100% | $2,560 | 0% | $673,635 | 100% | $673,635 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $5,210 | 40% | $0 | 0% | $7,943 | 11% | $73,846 | 561% | $13,154 |
| Low-Income Residential New Construction | $755 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $755 |
| Low-Income 1 to 4 Family Retrofit | $2,945 | 29% | $0 | 0% | $7,385 | 100% | $7,385 | 71% | $10,330 |
| Low-Income Multifamily Retrofit | $1,510 | 73% | $0 | 0% | $559 | 100% | $559 | 27% | $2,068 |
| Statewide Marketing & Education* | $0 | 0% | $65,902 | 100% | $0 | 0% | $65,903 | 100% | $65,903 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $49,506 | 16% | $38,370 | 8% | $217,426 | 43% | $509,181 | 167% | $305,302 |
| C&I New Construction and Major Renovation | $17,307 | 16% | $0 | 0% | $89,283 | 100% | $89,283 | 84% | $106,590 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $25,118 | 24% | $4,022 | 5% | $73,735 | 95% | $77,757 | 76% | $102,875 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $7,082 | 7% | $34,348 | 39% | $54,408 | 61% | $88,756 | 93% | $95,838 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Statewide Marketing & Education* | $0 | 0% | $253,202 | 100% | $183 | 0% | $253,385 | 100% | $253,385 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $153,670 | 6% | $ 2,071,616 | 72% | $486,067 | 17% | $2,876,970 | 106% | $2,711,352 |

**Percent Variance**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | ($143,922) | -59% | ($1,055,205) | 34% | ($61,056) | 19% | ($1,116,262) | 33% | ($1,260,184) |
| Residential New Construction & Major Renovation | ($19,740) | -81% | ($85,880) | 63% | $3,587 | 0% | ($82,294) | 61% | ($102,033) |
| Residential Cooling & Heating Equipment | ($17,952) | -74% | ($227,863) | 77% | ($15,172) | 41% | ($243,035) | 73% | ($260,987) |
| Multi-family Retrofit | ($42,746) | -88% | ($248,149) | 98% | $34,260 | 0% | ($213,889) | 84% | ($256,635) |
| MassSave | ($1,540) | -6% | ($635,746) | 74% | $62,460 | 66% | ($573,285) | 60% | ($574,825) |
| Behavior/Feedback Program | ($10,374) | -85% | $0 | 0% | $297 | 0% | $297 | 0% | ($10,077) |
| ENERGY STAR Lighting | $26,699 | 110% | $134,018 | 16% | $15,485 | 0% | $149,503 | 18% | $176,203 |
| ENERGY STAR Appliances | ($24,300) | -100% | $118,658 | 20% | $0 | 0% | $118,658 | 20% | $94,358 |
| Residential Education Program | $3,533 | 0% | $0 | 0% | ($169,729) | 89% | ($169,729) | 89% | ($166,196) |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Loan Program | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| R&D and Demonstration | $55 | 0% | ($19,000) | 100% | $1,140 | 0% | ($17,860) | 94% | ($17,805) |
| Deep Energy Retrofit | ($6,620) | -74% | ($9,000) | 100% | $6,288 | 0% | ($2,712) | 30% | ($9,332) |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | ($17,196) | 96% | $0 | 0% | ($17,196) | 96% | ($17,196) |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | ($65,047) | 96% | $0 | 0% | ($65,047) | 96% | ($65,047) |
| Residential New Construction Lighting Design statewide pilot | $672 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $672 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $16 | 0% | $0 | 0% | $326 | 0% | $326 | 0% | $342 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($51,389) | -100% | $0 | 0% | $25,604 | 0% | $25,604 | 0% | ($25,785) |
| Statewide Marketing & Education* | $0 | 0% | $671,075 | 0% | $2,560 | 0% | $673,635 | 0% | $673,635 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | ($6,940) | -57% | ($367,213) | 100% | $7,411 | 1392% | ($293,899) | 80% | ($366,741) |
| Low-Income Residential New Construction | $755 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $755 |
| Low-Income 1 to 4 Family Retrofit | $2,945 | 0% | ($350,000) | 100% | $7,385 | 0% | ($342,615) | 98% | ($339,670) |
| Low-Income Multifamily Retrofit | ($10,640) | -88% | ($17,213) | 100% | $26 | 5% | ($17,186) | 97% | ($27,827) |
| Statewide Marketing & Education* | $0 | 0% | $65,902 | 0% | $0 | 0% | $65,903 | 0% | $65,903 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | ($15,494) | -24% | ($918,305) | 96% | ($376,773) | 63% | ($1,041,693) | 67% | ($1,362,197) |
| C&I New Construction and Major Renovation | $2,307 | 15% | $0 | 0% | ($336,091) | 79% | ($336,091) | 79% | ($333,784) |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | ($9,882) | -28% | ($672,578) | 99% | ($45,665) | 38% | ($718,243) | 90% | ($728,125) |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | ($7,918) | -53% | ($245,727) | 88% | $4,983 | 10% | ($240,744) | 73% | ($248,662) |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($51,625) | -100% | $0 | 0% | $0 | 0% | $0 | 0% | ($51,625) |
| Statewide Marketing & Education* | $0 | 0% | $253,202 | 0% | $183 | 0% | $253,385 | 0% | $253,385 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | ($166,355) | -52% | ($2,340,723) | 53% | ($430,419) | 47% | ($2,451,854) | 46% | ($2,989,122) |

## Sales, Technical Assistance & Training

**Planned**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | $143,930 | 1% | $10,560,991 | 91% | $1,078,140 | 9% | $11,639,131 | 99% | $11,783,061 |
| Residential New Construction & Major Renovation | $12,150 | 3% | $444,212 | 100% | $0 | 0% | $444,212 | 97% | $456,362 |
| Residential Cooling & Heating Equipment | $30,375 | 6% | $469,268 | 99% | $4,740 | 1% | $474,008 | 94% | $504,383 |
| Multi-family Retrofit | $12,150 | 1% | $2,215,369 | 100% | $0 | 0% | $2,215,369 | 99% | $2,227,519 |
| MassSave | $12,150 | 0% | $5,637,500 | 100% | $0 | 0% | $5,637,500 | 100% | $5,649,650 |
| Behavior/Feedback Program | $2,430 | 11% | $0 | 0% | $20,000 | 100% | $20,000 | 89% | $22,430 |
| ENERGY STAR Lighting | $24,300 | 2% | $1,048,752 | 100% | $0 | 0% | $1,048,752 | 98% | $1,073,052 |
| ENERGY STAR Appliances | $24,300 | 4% | $572,890 | 100% | $0 | 0% | $572,890 | 96% | $597,190 |
| Residential Education Program | $0 | 0% | $0 | 0% | $620,000 | 100% | $620,000 | 100% | $620,000 |
| Workforce Development | $0 | 0% | $0 | 0% | $150,000 | 100% | $150,000 | 100% | $150,000 |
| Heat Loan Program | $6,075 | 2% | $0 | 0% | $282,750 | 100% | $282,750 | 98% | $288,825 |
| R&D and Demonstration | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Deep Energy Retrofit | $0 | 0% | $70,000 | 100% | $0 | 0% | $70,000 | 100% | $70,000 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | $40,000 | 100% | $0 | 0% | $40,000 | 100% | $40,000 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | $63,000 | 100% | $0 | 0% | $63,000 | 100% | $63,000 |
| Residential New Construction Lighting Design statewide pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $20,000 | 97% | $0 | 0% | $650 | 100% | $650 | 3% | $20,650 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $24,300 | 1% | $865,000 | 30% | $2,012,809 | 70% | $2,877,809 | 99% | $2,902,109 |
| Low-Income Residential New Construction | $0 | 0% | $0 | 0% | $30,000 | 100% | $30,000 | 100% | $30,000 |
| Low-Income 1 to 4 Family Retrofit | $12,150 | 1% | $865,000 | 100% | $0 | 0% | $865,000 | 99% | $877,150 |
| Low-Income Multifamily Retrofit | $12,150 | 1% | $0 | 0% | $1,982,809 | 100% | $1,982,809 | 99% | $1,994,959 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $6,080,000 | 58% | $2,759,750 | 62% | $1,700,250 | 38% | $4,430,650 | 42% | $10,510,650 |
| C&I New Construction and Major Renovation | $1,790,000 | 54% | $0 | 0% | $1,555,000 | 100% | $1,555,000 | 46% | $3,345,000 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $4,290,000 | 61% | $2,660,000 | 95% | $140,000 | 5% | $2,800,000 | 39% | $7,090,000 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $0 | 0% | $71,250 | 95% | $3,750 | 5% | $75,000 | 100% | $75,000 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $20,000 | 97% | $0 | 0% | $650 | 100% | $650 | 3% | $20,650 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $6,248,230 | 25% | $14,185,741 | 75% | $4,791,199 | 25% | $ 18,947,590 | 75% | $25,195,820 |

**Actual**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | $2,229 | 0% | $7,327,901 | 93% | $7,327,901 | 93% | $7,842,850 | 100% | $7,837,423 |
| Residential New Construction & Major Renovation | $0 | 0% | $436,927 | 92% | $39,445 | 8% | $476,372 | 100% | $476,372 |
| Residential Cooling & Heating Equipment | $0 | 0% | $329,571 | 94% | $22,093 | 6% | $351,664 | 100% | $351,664 |
| Multi-family Retrofit | $0 | 0% | $1,117,655 | 94% | $70,824 | 6% | $1,188,479 | 100% | $1,188,479 |
| MassSave | $0 | 0% | $3,895,472 | 95% | $205,641 | 5% | $4,101,113 | 100% | $4,101,113 |
| Behavior/Feedback Program | $0 | 0% | $0 | 0% | $10,801 | 100% | $10,801 | 100% | $10,801 |
| ENERGY STAR Lighting | $0 | 0% | $661,976 | 70% | $277,455 | 30% | $939,431 | 100% | $939,431 |
| ENERGY STAR Appliances | $0 | 0% | $701,158 | 133% | ($172,173) | -33% | $528,985 | 100% | $528,985 |
| Residential Education Program | $2,229 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $2,229 |
| Workforce Development | $0 | 0% | $0 | 0% | $15,437 | 100% | $15,437 | 100% | $15,437 |
| Heat Loan Program | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| R&D and Demonstration | $0 | 0% | $0 | 0% | $3,853 | 100% | $3,853 | 100% | $3,853 |
| Deep Energy Retrofit | $0 | 0% | $0 | 0% | $33,917 | 100% | $33,917 | 100% | $33,917 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | $28,937 | 0% | $0 | 0% | $28,937 | 0% | $28,937 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | $142,188 | 100% | $0 | 0% | $142,188 | 100% | $142,188 |
| Residential New Construction Lighting Design statewide pilot | $0 | 0% | $14,017 | 0% | $0 | 0% | $14,017 | 100% | $14,017 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $2,893 | 27% | $0 | 0% | $7,656 | 100% | $7,656 | 73% | $10,549 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $0 | 0% | $449,958 | 21% | $1,516,515 | 71% | $2,144,094 | 109% | $1,966,473 |
| Low-Income Residential New Construction | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income 1 to 4 Family Retrofit | $0 | 0% | $172,015 | 11% | $1,415,654 | 89% | $1,587,669 | 100% | $1,587,669 |
| Low-Income Multifamily Retrofit | $0 | 0% | $277,942 | 73% | $100,861 | 27% | $378,804 | 100% | $378,804 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $177,621 | 100% | $177,621 | 100% | $177,621 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $1,358,132 | 24% | $2,119,629 | 49% | $2,205,011 | 51% | $4,324,640 | 76% | $5,682,772 |
| C&I New Construction and Major Renovation | $1,246,615 | 44% | $813,879 | 52% | $755,813 | 48% | $1,569,692 | 56% | $2,816,307 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $0 | 0% | $1,270,051 | 47% | $1,448,414 | 53% | $2,718,465 | 100% | $2,718,465 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $111,517 | 75% | $35,698 | 98% | $784 | 2% | $36,483 | 25% | $148,000 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $1,360,361 | 9% | $ 9,897,487 | 69% | $11,049,427 | 77% | $14,311,584 | 92% | $15,486,668 |

**Percent Variance**

| Program | In-House Activities $ | In-House Activities % of Total | Competitively Procured $ | Competitively Procured % of Outsource | Non-Competitively Procured $ | Non-Competitively Procured % of Outsource | Total Outsourced Activities $ | Total Outsourced Activities % of Total | TOTAL $ |
|---|---|---|---|---|---|---|---|---|---|
| **Residential (total)** | ($141,701) | -98% | ($3,233,090) | 31% | $6,249,761 | 580% | ($3,796,281) | 33% | ($3,945,638) |
| Residential New Construction & Major Renovation | ($12,150) | -100% | ($7,285) | 2% | $436,927 | 0% | $32,160 | 7% | $20,010 |
| Residential Cooling & Heating Equipment | ($30,375) | -100% | ($139,697) | 30% | $324,831 | 6853% | ($122,344) | 26% | ($152,719) |
| Multi-family Retrofit | ($12,150) | -100% | ($1,097,714) | 50% | $1,117,655 | 0% | ($1,026,891) | 46% | ($1,039,041) |
| MassSave | ($12,150) | -100% | ($1,742,028) | 31% | $3,895,472 | 0% | ($1,536,387) | 27% | ($1,548,537) |
| Behavior/Feedback Program | ($2,430) | -100% | $0 | 0% | ($20,000) | 100% | ($9,199) | 46% | ($11,629) |
| ENERGY STAR Lighting | ($24,300) | -100% | ($386,776) | 37% | $661,976 | 0% | ($109,321) | 10% | ($133,621) |
| ENERGY STAR Appliances | ($24,300) | -100% | $128,268 | 22% | $701,158 | 0% | ($43,905) | 8% | ($68,205) |
| Residential Education Program | $2,229 | 0% | $0 | 0% | ($620,000) | 100% | ($620,000) | 100% | ($617,771) |
| Workforce Development | $0 | 0% | $0 | 0% | ($150,000) | 100% | ($134,563) | 90% | ($134,563) |
| Heat Loan Program | ($6,075) | -100% | $0 | 0% | ($282,750) | 100% | ($282,750) | 100% | ($288,825) |
| R&D and Demonstration | $0 | 0% | $0 | 0% | $0 | 0% | $3,853 | 0% | $3,853 |
| Deep Energy Retrofit | $0 | 0% | ($70,000) | 100% | $0 | 0% | ($36,083) | 52% | ($36,083) |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | ($11,063) | 28% | $28,937 | 0% | ($11,063) | 28% | ($11,063) |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | $79,188 | 126% | $142,188 | 0% | $79,188 | 126% | $79,188 |
| Residential New Construction Lighting Design statewide pilot | $0 | 0% | $14,017 | 0% | $14,017 | 0% | $14,017 | 0% | $14,017 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($17,107) | -86% | $0 | 0% | ($650) | 100% | $7,006 | 1078% | ($10,101) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | ($24,300) | -100% | ($415,042) | 48% | ($496,294) | 25% | ($733,715) | 25% | ($935,636) |
| Low-Income Residential New Construction | $0 | 0% | $0 | 0% | ($30,000) | 100% | ($30,000) | 100% | ($30,000) |
| Low-Income 1 to 4 Family Retrofit | ($12,150) | -100% | ($692,985) | 80% | $1,415,654 | 0% | $722,669 | 84% | $710,519 |
| Low-Income Multifamily Retrofit | ($12,150) | -100% | $277,942 | 0% | ($1,881,948) | 95% | ($1,604,005) | 81% | ($1,616,155) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $177,621 | 0% | $177,621 | 0% | $177,621 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | ($4,721,868) | -78% | ($640,121) | 23% | $504,761 | 30% | ($106,010) | 2% | ($4,827,878) |
| C&I New Construction and Major Renovation | ($543,385) | -30% | $813,879 | 0% | ($799,187) | 51% | $14,692 | 1% | ($528,693) |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | ($4,290,000) | -100% | ($1,389,949) | 52% | $1,308,414 | 935% | ($81,535) | 3% | ($4,371,535) |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $111,517 | 0% | ($35,552) | 50% | ($2,966) | 79% | ($38,517) | 51% | $73,000 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($20,000) | -100% | $0 | 0% | ($650) | 100% | ($650) | 100% | ($20,650) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | ($4,887,869) | -78% | ($4,288,253) | 30% | $6,258,228 | 131% | ($4,636,006) | 24% | ($9,709,152) |

Massachusetts Electric Company & Nantucket Electric Company d/b/a National Grid

## Evaluation and Market Research

**Planned**

| Program | In-House Activities | | Outsourced Activities: Competitively Procured | | Outsourced Activities: Non-Competitively Procured | | Total Outsourced Activities | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | $ | % of Total | $ | % of Outsource | $ | % of Outsource | $ | % of Total | $ |
| **Residential (total)** | $180,030 | 10% | $1,467,077 | 94% | $93,572 | 5% | $1,560,650 | 90% | $1,740,680 |
| Residential New Construction & Major Renovation | $3,400 | 11% | $27,180 | 95% | $1,431 | 5% | $28,611 | 89% | $32,011 |
| Residential Cooling & Heating Equipment | $3,990 | 11% | $31,891 | 95% | $1,678 | 5% | $33,570 | 89% | $37,560 |
| Multi-family Retrofit | $21,118 | 11% | $168,738 | 95% | $8,881 | 5% | $177,619 | 89% | $198,737 |
| MassSave | $100,273 | 11% | $801,176 | 95% | $42,167 | 5% | $843,343 | 89% | $943,616 |
| Behavior/Feedback Program | $7,116 | 11% | $56,863 | 95% | $2,993 | 5% | $59,856 | 89% | $66,972 |
| ENERGY STAR Lighting | $32,432 | 11% | $259,128 | 95% | $13,638 | 5% | $272,767 | 89% | $305,199 |
| ENERGY STAR Appliances | $7,071 | 11% | $56,507 | 95% | $2,974 | 5% | $59,481 | 89% | $66,552 |
| Residential Education Program | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Loan Program | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| R&D and Demonstration | $0 | 0% | $0 | 95% | $0 | 5% | $0 | 0% | $0 |
| Deep Energy Retrofit | $4,630 | 11% | $37,006 | 95% | $1,948 | 5% | $38,954 | 89% | $43,584 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | $13,735 | 95% | $723 | 5% | $14,458 | 100% | $14,458 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $0 | 0% | $14,852 | 95% | $782 | 5% | $15,634 | 100% | $15,634 |
| Residential New Construction Lighting Design statewide pilot | $0 | 0% | $0 | 0% | $4,394 | 100% | $4,394 | 100% | $4,394 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $0 | 0% | $11,964 | 100% | $11,964 | 100% | $11,964 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $57,435 | 32% | $454,489 | 190% | $28,587 | 110% | $483,076 | 89% | $540,511 |
| Low-Income Residential New Construction | $554 | 11% | $0 | 0% | $4,667 | 100% | $4,667 | 89% | $5,221 |
| Low-Income 1 to 4 Family Retrofit | $34,404 | 11% | $274,889 | 95% | $14,468 | 5% | $289,357 | 89% | $323,761 |
| Low-Income Multifamily Retrofit | $22,477 | 11% | $179,600 | 95% | $9,453 | 5% | $189,052 | 89% | $211,529 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $182,246 | 4% | $3,465,482 | 76% | $1,103,794 | 24% | $4,569,276 | 96% | $4,751,522 |
| C&I New Construction and Major Renovation | $36,836 | 4% | $0 | 0% | $921,400 | 100% | $921,400 | 96% | $958,236 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $123,199 | 4% | $2,927,481 | 95% | $154,078 | 5% | $3,081,559 | 96% | $3,204,758 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $22,211 | 4% | $527,788 | 95% | $27,778 | 5% | $555,567 | 96% | $577,778 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $10,213 | 95% | $538 | 5% | $10,750 | 100% | $10,750 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $419,711 | 6% | $5,387,048 | 81% | $1,225,954 | 19% | $ 6,613,002 | 94% | $7,032,713 |

**Actual**

| Program | In-House Activities | | Outsourced Activities: Competitively Procured | | Outsourced Activities: Non-Competitively Procured | | Total Outsourced Activities | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | $ | % of Total | $ | % of Outsource | $ | % of Outsource | $ | % of Total | $ |
| **Residential (total)** | $143,448 | 10% | $1,165,441 | 86% | $118,153 | 9% | $1,358,500 | 95% | $1,427,042 |
| Residential New Construction & Major Renovation | $15,934 | 8% | $167,433 | 97% | $5,660 | 3% | $173,093 | 92% | $189,027 |
| Residential Cooling & Heating Equipment | $9,811 | 11% | $73,310 | 93% | $5,504 | 7% | $78,813 | 89% | $88,624 |
| Multi-family Retrofit | $13,363 | 5% | $271,365 | 96% | $12,007 | 4% | $283,372 | 95% | $296,734 |
| MassSave | $21,619 | 6% | $303,357 | 97% | $10,234 | 3% | $313,591 | 94% | $335,210 |
| Behavior/Feedback Program | $5,686 | 5% | $99,878 | 97% | $3,370 | 3% | $103,248 | 95% | $108,934 |
| ENERGY STAR Lighting | $47,110 | 17% | $218,936 | 94% | $13,488 | 6% | $232,424 | 83% | $279,534 |
| ENERGY STAR Appliances | $14,499 | 25% | $31,163 | 72% | $12,211 | 28% | $43,374 | 75% | $57,873 |
| Residential Education Program | $5,818 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $5,818 |
| Workforce Development | $0 | 33% | $0 | 0% | $0 | 100% | $0 | 0% | $0 |
| Heat Loan Program | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| R&D and Demonstration | $24 | 0% | $0 | 0% | $11,888 | 100% | $11,888 | | $11,912 |
| Deep Energy Retrofit | $4,799 | 12% | $0 | 0% | $36,363 | 100% | $36,363 | 88% | $41,162 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $1,616 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $1,616 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $1,626 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $1,626 |
| Residential New Construction Lighting Design statewide pilot | $1,529 | 100% | $0 | 0% | $0 | 0% | $0 | 0% | $1,529 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 43% | $0 | 0% | $0 | 0% | $0 | 57% | $0 |
| Heat Pump Water Heater Pilot | $15 | 0% | $0 | 0% | $7,428 | 100% | $7,428 | 100% | $7,442 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $1,301 | 2% | $59,409 | 100% | $0 | 0% | $59,409 | 98% | $60,710 |
| Statewide Marketing & Education* | $0 | 0% | $15,497 | 100% | $0 | 0% | $15,497 | 0% | $15,497 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 67% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 67% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 67% | $0 |
| **Low Income (total)** | $26,993 | 10% | $238,729 | 97% | $8,054 | 3% | $246,783 | 90% | $273,775 |
| Low-Income Residential New Construction | $2,259 | 100% | $0 | 0% | $0 | 100% | $0 | 0% | $2,259 |
| Low-Income 1 to 4 Family Retrofit | $19,322 | 12% | $142,134 | 97% | $4,795 | 3% | $146,929 | 88% | $166,251 |
| Low-Income Multifamily Retrofit | $5,411 | 5% | $96,595 | 97% | $3,259 | 3% | $99,854 | 95% | $105,265 |
| Statewide Marketing & Education* | $0 | 33% | $0 | 0% | $0 | 0% | $0 | 67% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | ($0) | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $336,685 | 20% | $1,142,067 | 83% | $231,134 | 17% | $1,373,202 | 80% | $1,709,886 |
| C&I New Construction and Major Renovation | $141,156 | 33% | $255,666 | 90% | $27,841 | 10% | $283,507 | 67% | $424,663 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $160,454 | 17% | $627,254 | 77% | $182,967 | 23% | $810,221 | 83% | $970,675 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $35,076 | 11% | $259,147 | 93% | $20,326 | 7% | $279,473 | 89% | $314,549 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 33% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 33% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 33% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $507,126 | 15% | $ 2,546,238 | 85% | $357,340 | 12% | $2,978,484 | 87% | $3,410,704 |

**Percent Variance**

| Program | In-House Activities | | Outsourced Activities: Competitively Procured | | Outsourced Activities: Non-Competitively Procured | | Total Outsourced Activities | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | $ | % of Total | $ | % of Outsource | $ | % of Outsource | $ | % of Total | $ |
| **Residential (total)** | ($36,582) | -20% | ($301,636) | 21% | $24,580 | 26% | ($202,150) | 13% | ($313,638) |
| Residential New Construction & Major Renovation | $12,534 | 369% | $140,253 | 516% | $4,229 | 296% | $144,482 | 505% | $157,016 |
| Residential Cooling & Heating Equipment | $5,821 | 146% | $41,418 | 130% | $3,825 | 228% | $45,244 | 135% | $51,065 |
| Multi-family Retrofit | ($7,755) | -37% | $102,627 | 61% | $3,126 | 35% | $105,753 | 60% | $97,997 |
| MassSave | ($78,654) | -78% | ($497,819) | 62% | ($31,933) | 76% | ($529,753) | 63% | ($608,406) |
| Behavior/Feedback Program | ($1,430) | -20% | $43,015 | 76% | $377 | 13% | $43,392 | 72% | $41,962 |
| ENERGY STAR Lighting | $14,678 | 45% | ($40,192) | 16% | ($150) | 1% | ($40,342) | 15% | ($25,664) |
| ENERGY STAR Appliances | $7,428 | 105% | ($25,344) | 45% | $9,237 | 311% | ($16,107) | 27% | ($8,679) |
| Residential Education Program | $5,818 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $5,818 |
| Workforce Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Loan Program | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| R&D and Demonstration | $24 | 0% | $0 | 0% | $11,888 | 0% | $11,888 | 0% | $11,912 |
| Deep Energy Retrofit | $169 | 4% | ($37,006) | 100% | $34,416 | 1767% | ($2,591) | 7% | ($2,422) |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $1,616 | 0% | ($13,735) | 100% | ($723) | 100% | ($14,458) | 100% | ($12,842) |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $1,626 | 0% | ($14,852) | 100% | ($782) | 100% | ($15,634) | 100% | ($14,007) |
| Residential New Construction Lighting Design statewide pilot | $1,529 | 0% | $0 | 0% | ($4,394) | 100% | ($4,394) | 100% | ($2,866) |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $15 | 0% | $0 | 0% | $7,428 | 0% | $7,428 | 0% | $7,442 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $1,301 | 0% | $59,409 | 0% | ($11,964) | 100% | $47,445 | 397% | $48,746 |
| Statewide Marketing & Education* | $0 | 0% | $15,497 | 0% | $0 | 0% | $15,497 | 0% | $15,497 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | ($30,442) | -53% | ($215,760) | 47% | ($20,534) | 72% | ($236,293) | 49% | ($266,736) |
| Low-Income Residential New Construction | $1,705 | 308% | $0 | 0% | ($4,667) | 100% | ($4,667) | 100% | ($2,962) |
| Low-Income 1 to 4 Family Retrofit | ($15,082) | -44% | ($132,755) | 48% | ($9,673) | 67% | ($142,428) | 49% | ($157,510) |
| Low-Income Multifamily Retrofit | ($17,066) | -76% | ($83,004) | 46% | ($6,194) | 66% | ($89,198) | 47% | ($106,264) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | ($0) | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $154,439 | 85% | ($2,323,415) | 67% | ($872,660) | 79% | ($3,196,074) | 70% | ($3,041,635) |
| C&I New Construction and Major Renovation | $104,320 | 283% | $255,666 | 0% | ($893,559) | 97% | ($637,893) | 69% | ($533,573) |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $37,255 | 30% | ($2,300,227) | 79% | $28,889 | 19% | ($2,271,338) | 74% | ($2,234,083) |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $12,865 | 58% | ($268,641) | 51% | ($7,452) | 27% | ($276,094) | 50% | ($263,229) |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | ($10,213) | 100% | ($538) | 100% | ($10,750) | 100% | ($10,750) |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $87,415 | 21% | ($2,840,810) | 53% | ($868,614) | 71% | ($3,634,518) | 55% | ($3,622,009) |

## TOTAL

**Planned**

| Program | In-House Activities | | Outsourced Activities: Competitively Procured | | Outsourced Activities: Non-Competitively | | Total Outsourced Activities | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | $ | % of Total | $ | % of Outsource | $ | % of Outsource | $ | % of Total | $ |
| **Residential (total)** | $2,543,112 | 13% | $15,230,637 | 87% | $2,263,863 | 13% | $17,494,499 | 87% | $20,037,611 |
| Residential New Construction & Major Renovation | $221,313 | 25% | $606,969 | 93% | $42,322 | 7% | $649,291 | 75% | $870,605 |
| Residential Cooling & Heating Equipment | $251,854 | 23% | $811,249 | 94% | $55,889 | 6% | $867,138 | 77% | $1,118,991 |
| Multi-family Retrofit | $311,571 | 10% | $2,680,288 | 98% | $51,062 | 2% | $2,731,351 | 90% | $3,042,921 |
| MassSave | $436,530 | 5% | $7,376,327 | 97% | $219,818 | 3% | $7,596,146 | 95% | $8,032,676 |
| Behavior/Feedback Program | $138,335 | 46% | $56,863 | 36% | $102,769 | 64% | $159,633 | 54% | $297,968 |
| ENERGY STAR Lighting | $331,374 | 13% | $2,192,568 | 98% | $48,327 | 2% | $2,240,895 | 87% | $2,572,269 |
| ENERGY STAR Appliances | $229,707 | 16% | $1,225,512 | 99% | $16,590 | 1% | $1,242,102 | 84% | $1,471,809 |
| Residential Education Program | $0 | 0% | $0 | 0% | $1,095,000 | 100% | $1,095,000 | 100% | $1,095,000 |
| Workforce Development | $0 | 0% | $0 | 0% | $150,000 | 100% | $150,000 | 100% | $150,000 |
| Heat Loan Program | $90,554 | 18% | $0 | 0% | $415,096 | 100% | $415,096 | 82% | $505,650 |
| R&D and Demonstration | $96,000 | 83% | $19,000 | 100% | $0 | 0% | $19,000 | 17% | $115,000 |
| Deep Energy Retrofit | $108,075 | 40% | $116,006 | 73% | $43,026 | 27% | $159,032 | 60% | $267,107 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $74,433 | 33% | $145,852 | 96% | $6,025 | 4% | $151,877 | 67% | $226,310 |
| Residential New Construction Lighting Design statewide pilot | $74,433 | 94% | $0 | 0% | $4,844 | 100% | $4,844 | 6% | $79,277 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Heat Pump Water Heater Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $178,933 | 93% | $0 | 0% | $13,095 | 100% | $13,095 | 7% | $192,028 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Low Income (total)** | $656,960 | 15% | $1,686,701 | 44% | $2,186,301 | 56% | $3,873,003 | 85% | $4,529,963 |
| Low-Income Residential New Construction | $87,669 | 60% | $0 | 0% | $58,229 | 100% | $58,229 | 40% | $145,898 |
| Low-Income 1 to 4 Family Retrofit | $328,088 | 17% | $1,489,889 | 93% | $112,454 | 7% | $1,602,343 | 83% | $1,930,431 |
| Low-Income Multifamily Retrofit | $241,203 | 10% | $196,812 | 9% | $2,015,619 | 91% | $2,212,431 | 90% | $2,453,634 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **Commercial & Industrial (total)** | $9,777,080 | 45% | $7,181,907 | 61% | $4,627,672 | 39% | $11,809,579 | 55% | $21,586,659 |
| C&I New Construction and Major Renovation | $3,182,204 | 50% | $0 | 0% | $3,208,463 | 100% | $3,208,463 | 50% | $6,390,668 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $6,277,913 | 46% | $6,264,081 | 84% | $1,182,411 | 16% | $7,446,492 | 54% | $13,724,405 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $289,463 | 21% | $879,113 | 79% | $234,760 | 21% | $1,113,874 | 79% | $1,403,336 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $178,933 | 93% | $0 | 0% | $13,095 | 100% | $13,095 | 7% | $192,028 |
| Statewide Marketing & Education* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| **TOTAL** | $12,977,152 | 28% | $24,099,245 | 73% | $9,077,837 | 27% | $ 33,177,082 | 72% | $46,154,233 |

**Actual**

| Program | In-House Activities | | Outsourced Activities: Competitively Procured | | Outsourced Activities: Non-Competitively Procured | | Total Outsourced Activities | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | $ | % of Total | $ | % of Outsource | $ | % of Outsource | $ | % of Total | $ |
| **Residential (total)** | $1,442,473 | 10% | $11,272,569 | 86% | $1,766,157 | 14% | $13,038,726 | 90% | $14,481,199 |
| Residential New Construction & Major Renovation | $61,378 | 8% | $654,057 | 91% | $66,261 | 9% | $720,317 | 92% | $781,695 |
| Residential Cooling & Heating Equipment | $168,079 | 24% | $472,392 | 87% | $72,978 | 13% | $545,370 | 76% | $713,450 |
| Multi-family Retrofit | $186,053 | 10% | $1,394,870 | 88% | $196,160 | 12% | $1,591,030 | 90% | $1,777,084 |
| MassSave | $223,778 | 4% | $4,418,084 | 89% | $537,394 | 11% | $4,955,478 | 96% | $5,179,256 |
| Behavior/Feedback Program | $109,996 | 45% | $99,878 | 73% | $36,932 | 27% | $136,810 | 55% | $246,805 |
| ENERGY STAR Lighting | $290,659 | 11% | $1,864,930 | 82% | $396,311 | 18% | $2,261,241 | 89% | $2,551,900 |
| ENERGY STAR Appliances | $182,206 | 12% | $1,433,479 | 110% | ($127,374) | -10% | $1,306,104 | 88% | $1,488,311 |
| Residential Education Program | $49,329 | 71% | $0 | 0% | $20,272 | 100% | $20,272 | 29% | $69,600 |
| Workforce Development | $0 | 0% | $0 | 0% | $15,437 | 100% | $15,437 | 100% | $15,437 |
| Heat Loan Program | $0 | 54% | $0 | 0% | $0 | 100% | $0 | 46% | $0 |
| R&D and Demonstration | $79 | | $0 | 0% | $16,881 | | $16,881 | | $16,960 |
| Deep Energy Retrofit | $118,261 | 60% | $0 | 0% | $78,945 | 100% | $78,945 | 40% | $197,206 |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $12,101 | 29% | $29,741 | 100% | $0 | 0% | $29,741 | 71% | $41,842 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | $20,310 | 12% | $145,141 | 100% | $0 | 0% | $145,141 | 88% | $165,451 |
| Residential New Construction Lighting Design statewide pilot | $12,119 | 46% | $14,017 | 100% | $0 | 0% | $14,017 | 54% | $26,136 |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 38% | $0 | 0% | $0 | 100% | $0 | 62% | $1 |
| Heat Pump Water Heater Pilot | $31 | 0% | $0 | 0% | $7,754 | 100% | $7,754 | 100% | $7,785 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $8,093 | 0% | $59,409 | 0% | $33,260 | 0% | $92,668 | 0% | $100,762 |
| Statewide Marketing & Education* | $0 | 0% | $686,573 | 0% | $2,560 | 0% | $689,133 | 0% | $689,133 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $1 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $351,597 | 0% | $351,597 | 0% | $351,597 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 0% | $60,787 | 0% | $60,787 |
| **Low Income (total)** | $260,259 | 8% | $754,589 | 27% | $2,049,119 | 73% | $2,803,708 | 92% | $3,063,967 |
| Low-Income Residential New Construction | $48,249 | 94% | $0 | 0% | $2,870 | 100% | $2,870 | 6% | $51,119 |
| Low-Income 1 to 4 Family Retrofit | $160,632 | 8% | $314,149 | 17% | $1,539,762 | 83% | $1,853,911 | 92% | $2,014,544 |
| Low-Income Multifamily Retrofit | $51,377 | 8% | $374,537 | 68% | $178,890 | 32% | $553,427 | 92% | $604,804 |
| Statewide Marketing & Education* | $0 | 0% | $65,902 | 100% | $0 | 0% | $65,903 | 100% | $65,903 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $177,621 | 100% | $177,621 | 100% | $177,622 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $149,976 | 100% | $149,976 | 100% | $149,976 |
| **Commercial & Industrial (total)** | $5,465,097 | 41% | $3,877,141 | 48% | $4,117,799 | 52% | $7,994,940 | 59% | $13,460,037 |
| C&I New Construction and Major Renovation | $2,799,831 | 56% | $1,069,546 | 49% | $1,101,313 | 51% | $2,170,859 | 44% | $4,970,689 |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | $2,463,912 | 38% | $1,982,033 | 49% | $2,103,019 | 51% | $4,085,052 | 62% | $6,548,965 |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | $201,353 | 23% | $572,360 | 86% | $90,493 | 14% | $662,853 | 77% | $864,206 |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Statewide Marketing & Education* | $0 | 0% | $253,202 | 0% | $183 | 0% | $253,385 | 0% | $253,385 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $1 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $762,004 | 0% | $762,004 | 0% | $762,004 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 0% | $60,787 | 0% | $60,787 |
| **TOTAL** | $7,167,828 | 23% | $ 15,904,299 | 67% | $7,933,076 | 33% | $23,837,374 | 77% | $31,005,203 |

**Percent Variance**

| Program | In-House Activities | | Outsourced Activities: Competitively Procured | | Outsourced Activities: Non-Competitively Procured | | Total Outsourced Activities | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | $ | % of Total | $ | % of Outsource | $ | % of Outsource | $ | % of Total | $ |
| **Residential (total)** | ($1,100,639) | -43% | ($3,958,067) | 26% | ($497,706) | 22% | ($4,455,774) | 25% | ($5,556,412) |
| Residential New Construction & Major Renovation | ($159,935) | -72% | $47,087 | 8% | $23,938 | 57% | $71,026 | 11% | ($88,909) |
| Residential Cooling & Heating Equipment | ($83,774) | -33% | ($338,857) | 42% | $17,090 | 31% | ($321,767) | 37% | ($405,542) |
| Multi-family Retrofit | ($125,518) | -40% | ($1,285,418) | 48% | $145,098 | 284% | ($1,140,320) | 42% | ($1,265,838) |
| MassSave | ($212,752) | -49% | ($2,958,244) | 40% | $317,576 | 144% | ($2,640,668) | 35% | ($2,853,420) |
| Behavior/Feedback Program | ($28,340) | -20% | $43,015 | 76% | ($65,837) | 64% | ($22,823) | 14% | ($51,162) |
| ENERGY STAR Lighting | ($40,715) | -12% | ($327,638) | 15% | $347,985 | 720% | $20,346 | 1% | ($20,369) |
| ENERGY STAR Appliances | ($47,501) | -21% | $207,966 | 17% | ($143,964) | 868% | $64,002 | 5% | $16,501 |
| Residential Education Program | $49,329 | 0% | $0 | 0% | ($1,074,728) | 98% | ($1,074,728) | 98% | ($1,025,400) |
| Workforce Development | $0 | 0% | $0 | 0% | ($134,563) | 90% | ($134,563) | 90% | ($134,563) |
| Heat Loan Program | ($90,554) | -100% | $0 | 0% | ($415,096) | 100% | ($415,096) | 100% | ($505,650) |
| R&D and Demonstration | ($95,921) | -100% | ($19,000) | 100% | $16,881 | 0% | ($2,119) | 11% | ($98,040) |
| Deep Energy Retrofit | $10,186 | 9% | ($116,006) | 100% | $35,919 | 83% | ($80,087) | 50% | ($69,901) |
| Behavior/Feedback Pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Residential New Construction & Major Renovation - Major Renovation statewide pilot | $12,101 | 0% | $29,741 | 0% | $0 | 0% | $29,741 | 0% | $41,842 |
| Residential New Construction Multi Family (4-8 story) statewide pilot | ($54,123) | -73% | ($711) | 0% | ($6,024) | 100% | ($6,736) | 4% | ($60,859) |
| Residential New Construction Lighting Design statewide pilot | ($62,314) | -84% | $14,017 | 0% | ($4,844) | 100% | $9,173 | 189% | ($53,141) |
| Residential New Construction V3 Energy Star Homes statewide pilot | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $1 |
| Heat Pump Water Heater Pilot | $31 | 0% | $0 | 0% | $7,754 | 0% | $7,754 | 0% | $7,785 |
| Residential Technical Development | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Hot Roofs | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Home Automation | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($170,839) | -95% | $59,409 | 0% | $20,165 | 154% | $79,573 | 608% | ($91,266) |
| Statewide Marketing & Education* | $0 | 0% | $686,573 | 0% | $2,560 | 0% | $689,133 | 0% | $689,133 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $1 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $351,597 | 0% | $351,597 | 0% | $351,597 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 0% | $60,787 | 0% | $60,787 |
| **Low Income (total)** | ($396,701) | -60% | ($932,112) | 55% | ($137,182) | 6% | ($1,069,295) | 28% | ($1,465,996) |
| Low-Income Residential New Construction | ($39,420) | -45% | $0 | 0% | ($55,359) | 95% | ($55,359) | 95% | ($94,779) |
| Low-Income 1 to 4 Family Retrofit | ($167,456) | -51% | ($1,175,740) | 79% | $1,427,309 | 1269% | $251,568 | 16% | $84,113 |
| Low-Income Multifamily Retrofit | ($189,826) | -79% | $177,725 | 90% | ($1,836,729) | 91% | ($1,659,004) | 75% | ($1,848,830) |
| Statewide Marketing & Education* | $0 | 0% | $65,902 | 0% | $0 | 0% | $65,903 | 0% | $65,903 |
| Low-Income Energy Affordability Network Funding* | $0 | 0% | $0 | 0% | $177,621 | 0% | $177,621 | 0% | $177,622 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $149,976 | 0% | $149,976 | 0% | $149,976 |
| **Commercial & Industrial (total)** | ($4,311,983) | -44% | ($3,304,766) | 46% | ($509,873) | 11% | ($3,814,639) | 32% | ($8,126,623) |
| C&I New Construction and Major Renovation | ($382,374) | -12% | $1,069,546 | 0% | ($2,107,151) | 66% | ($1,037,605) | 32% | ($1,419,979) |
| C&I New Construction and Major Renovation - Gvmt | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Large Retrofit | ($3,814,000) | -61% | ($4,282,048) | 68% | $920,608 | 78% | ($3,361,440) | 45% | ($7,175,441) |
| Large C&I Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| C&I Small Retrofit | ($88,110) | -30% | ($306,754) | 35% | ($144,267) | 61% | ($451,021) | 40% | ($539,131) |
| C&I Small Retrofit - Government | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $0 |
| Community Based Pilot | ($178,933) | -100% | $0 | 0% | ($13,095) | 100% | ($13,095) | 100% | ($192,028) |
| Statewide Marketing & Education* | $0 | 0% | $253,202 | 0% | $183 | 0% | $253,385 | 0% | $253,385 |
| EEAC Consultants* | $0 | 0% | $0 | 0% | $0 | 0% | $0 | 0% | $1 |
| DOER Assessment* | $0 | 0% | $0 | 0% | $762,004 | 0% | $762,004 | 0% | $762,004 |
| Sponsorships & Subscriptions* | $0 | 0% | $0 | 0% | $60,787 | 0% | $60,787 | 0% | $60,787 |
| **TOTAL** | ($5,809,323) | -45% | ($8,194,946) | 34% | ($1,144,761) | 13% | ($9,339,708) | 28% | ($15,149,031) |

* National Grid did not plan for outsourced or competitively procured activities and therefore, cannot provide this data.

VII. Appendix

B.1. Master Summary

| Electric PA's Master Summary of Energy Efficiency Activities | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Benefits ($) | | | | | | TRC Costs ($) | | | | |
| **Customer Sector** | **Capacity** | **Energy** | **DRIPE (Capacity & Energy)** | **Non-Elec. Resource** | **Non-Resource** | **Total Benefits** | **PA** | **Customer** | **TOTAL** | **TRC B/C Ratio** | **Net Benefits** |
| **Planned** | | | | | | | | | | | |
| Residential | 28,925,775 | 80,756,925 | 22,239,570 | 72,215,173 | 3,312,897 | 185,210,771 | 60,354,500 | 6,754,217 | 67,108,718 | 2.76 | 118,102,053 |
| Low Income | 3,652,849 | 19,767,066 | 3,826,907 | 10,289,738 | 23,335,305 | 57,044,958 | 21,146,323 | 156,435 | 21,302,758 | 2.68 | 35,742,201 |
| C&I | 125,625,107 | 388,971,937 | 94,073,190 | 1,586,963 | 12,579,541 | 528,763,548 | 114,784,098 | 52,365,786 | 167,149,884 | 3.16 | 361,613,664 |
| TOTAL | 158,203,731 | 489,495,928 | 120,139,667 | 84,091,875 | 39,227,743 | 771,019,277 | 196,284,921 | 59,276,438 | 255,561,359 | 9 | 515,457,918 |
| **Evaluated** | | | | | | | | | | | |
| Residential | 14,117,364 | 62,868,278 | 23,622,492 | 42,466,826 | 57,501,493 | 200,576,453 | 50,854,686 | 11,951,363 | 62,851,291 | 3.19 | 137,725,163 |
| Low Income | 1,851,520 | 8,752,113 | 2,147,282 | 13,849,143 | 16,589,233 | 43,189,291 | 14,218,480 | 1,910 | 14,220,390 | 3.04 | 28,968,902 |
| C&I | 82,376,150 | 256,892,617 | 70,851,528 | (36,867,837) | 25,139,411 | 398,391,870 | 60,401,350 | 14,151,718 | 74,553,069 | 5.34 | 323,838,801 |
| TOTAL | 98,345,034 | 328,513,007 | 96,621,303 | 19,448,133 | 99,230,137 | 642,157,614 | 125,474,515 | 26,104,991 | 151,624,749 | 4.24 | 490,532,865 |
| **Percent Variance** | | | | | | | | | | | |
| Residential | -51% | -22% | 6% | -41% | 1636% | 8% | -16% | 77% | -6% | 16% | 17% |
| Low Income | -49% | -56% | -44% | 35% | -29% | -24% | -33% | -99% | -33% | 13% | -19% |
| C&I | -34% | -34% | -25% | -2423% | 100% | -25% | -47% | -73% | -55% | 69% | -10% |
| TOTAL | -38% | -33% | -20% | -77% | 153% | -17% | -36% | -56% | -41% | -51% | -5% |

**Notes:**

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

VII. Appendix

B.1. Master Summary

**Electric PA's Master Summary of Energy Efficiency Activities**

| Customer Sector | Savings: Capacity (kW) Annualized | Savings: Capacity (kW) Lifetime | Savings: Electric Energy (MWh) Annualized | Savings: Electric Energy (MWh) Lifetime | Savings: Non-Electric Resources (MMBTU) Annualized | Savings: Non-Electric Resources (MMBTU) Lifetime | Avg Measure Life (yrs.) | TR Summer Demand Cost ($/kW) | TR Energy Cost ($/Lifetime-MWh saved) | Emissions Reductions ( Short Tons) (1): NOx | SO2 | GHG (MA Based) | GHG (Regional) | Participants |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | | | | | | | | | | | | | | |
| Residential | 14,774 | 158,841 | 124,878 | 760,284 | 164,423 | 1,001,046 | 6 | 422 | 88 | 236 | 649 | 407,392 | 357,116 | 227,098 |
| Low Income | 1,429 | 20,494 | 14,240 | 200,630 | 20,577 | 289,903 | 14 | 1,039 | 106 | 62 | 171 | 107,506 | 94,238 | 11,687 |
| C&I | 55,943 | 710,288 | 283,796 | 3,603,971 | 10,421 | 132,333 | 13 | 235 | 46 | 1,117 | 3,074 | 1,931,160 | 1,692,833 | 2,528 |
| TOTAL | 72,146 | 889,623 | 422,914 | 4,564,884 | 195,420 | 1,423,281 | 33 | 1,697 | 241 | 1,415 | 3,894 | 2,446,058 | 2,144,187 | 241,313 |
| **Evaluated** | | | | | | | | | | | | | | |
| Residential | 11,545 | 86,299 | 122,268 | 753,648 | 1,284,501 | 7,917,563 | 6 | 728 | 83 | 234 | 643 | 403,837 | 353,999 | 1,076,337 |
| Low Income | 884 | 11,603 | 7,515 | 105,258 | 282,982 | 3,963,789 | 14 | 1,226 | 135 | 33 | 90 | 56,402 | 49,441 | 8,746 |
| C&I | 36,002 | 525,107 | 213,214 | 3,144,310 | (265,240) | (3,911,549) | 15 | 142 | 24 | 975 | 2,682 | 1,684,854 | 1,476,924 | 3,513 |
| TOTAL | 48,431 | 623,009 | 342,996 | 4,003,217 | 1,302,244 | 15,198,905 | 12 | 243 | 38 | 1,241 | 3,415 | 2,145,093 | 1,880,364 | 1,088,596 |
| **Percent Variance** | | | | | | | | | | | | | | |
| Residential | -22% | -46% | -2% | -1% | 681% | 691% | 1% | 72% | -6% | -1% | -1% | -1% | -1% | 374% |
| Low Income | -38% | -43% | -47% | -48% | 1275% | 1267% | -1% | 18% | 27% | -48% | -48% | -48% | -48% | -25% |
| C&I | -36% | -26% | -25% | -13% | -2645% | -3056% | 16% | -40% | -49% | -13% | -13% | -13% | -13% | 39% |
| TOTAL | -33% | -30% | -19% | -12% | 566% | 968% | -64% | -86% | -84% | -12% | -12% | -12% | -12% | 351% |

**Notes:**

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

# Massachusetts
# Technical Reference Manual

for Estimating Savings from Energy Efficiency Measures

2011 Program Year – Report Version

August 2012

# Table of Contents

# 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.

# 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:<br>▪ Assure collaboration and consensus by the PAs regarding TRM updates<br>▪ Assure updates are compiled from the PAs and incorporated into the TRM<br>▪ 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.<br>▪ Identify needed updates to the TRM<br>▪ Coordinate with other PAs on all TRM updates<br>▪ File TRM updates with the DPU |

| Stakeholder | Responsibilities |
|---|---|
| Department of Energy Resources | ▪ Provide one representative to the TRM Coordinating Committee<br>▪ 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.

# 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 | |

### 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:

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

Below the savings algorithms, a table contains the definitions (and, in some cases, default values) of each input in the equation(s). The inputs for a particular measure may vary and will be reflected as such in this table (see example below).

| | | |
|---|---|---|
| ΔkWh | = | gross annual kWh savings from the measure |
| ΔkW | = | gross connected kW savings from the measure |
| Hours | = | average hours of use per year |
| $Watts_{BASE}$ | = | baseline connected kW |
| $Watts_{EE}$ | = | energy efficient connected kW |

### Baseline Efficiency

This section will include a statement of the assumed equipment/operation efficiency in the absence of program intervention. Multiple baselines will be provided as needed, e.g., for different markets. Baselines may refer to reference tables or may be presented as a table for more complex measures.

### High Efficiency

This section will describe the high efficiency case from which the energy and demand savings are determined. The high efficiency case may be based on specific details of the measure installation, minimum requirements for inclusion in the program, or an energy efficiency case based on historical participation. It may refer to tables within the measure characterization or in the appendices or efficiency standards set by organizations such as ENERGY STAR® and the Consortium for Energy Efficiency.

### Hours

This section will note operating hours for equipment that is either on or off, or equivalent full load hours for technologies that operate at partial loads, or reduced hours for controls. Reference tables will be used as needed to avoid repetitive entries.

### Measure Life

Measure Life includes equipment life and the effects of measure persistence. Equipment life is the number of years that a measure is installed and will operate until failure. Measure persistence takes into account business turnover, early retirement of installed equipment, and other reasons measures might be removed or discontinued.

### Secondary Energy Impacts

This section described any secondary energy impacts associated with the energy efficiency measure, including all assumptions and the method of calculation.

### 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.

| | 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 |

# 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 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**:
- <u>Summer On-Peak</u>: average demand reduction from 1:00-5:00 PM on non-holiday weekdays in June July, and August
- <u>Winter On-Peak</u>: average demand reduction from 5:00-7:00 PM on non-holiday weekdays in December and January

**Seasonal Peak Definition**:
- <u>Summer Seasonal Peak</u>: 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
- <u>Winter Seasonal Peak</u>: 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** ($SO_{NP}$).

The **net savings** value is the final value of savings that is attributable to a measure or program. Net savings differs from gross savings because it includes the effects of the free-ridership and/or spillover rates.

The **net-to-gross** ratio is the ratio of net savings to the gross savings adjusted by any impact factors (i.e., the "adjusted" gross savings). Depending on the evaluation study, the NTG ratio may be determined from the free-ridership and spillover rates, if available, or it may be a distinct value with no separate specification of FR and SO values.

# Standard Net–to–Gross Formulas

The TRM measure entries provide algorithms for calculating the gross savings for those efficiency measures. The following standard formulas show how the impact factors are applied to calculate the adjusted gross savings, which in turn are used to calculate the net savings. These are the calculations used by the PAs to track and report gross and net savings. The gross savings reported by the PAs are the unadjusted gross savings without the application of any impact factors.

### Calculation of Net Annual Electric Energy Savings

$$adj\_gross\_kWh = gross\_kWh \times RR_E \times SPF \times ISR$$
$$net\_kWh = adj\_gross\_kWh \times NTG$$

### Calculation of Net Summer Electric Peak Demand Coincident kW Savings

$$adj\_gross\_kW_{SP} = gross\_kW \times RR_{SP} \times SPF \times ISR \times CF_{SP}$$
$$net\_kW_{SP} = adj\_gross\_kW_{SP} \times NTG$$

### Calculation of Net Winter Electric Peak Demand Coincident kW Savings

$$adj\_gross\_kW_{WP} = gross\_kW \times RR_{WP} \times SPF \times ISR \times CF_{WP}$$
$$net\_kW_{WP} = adj\_gross\_kW_{WP} \times NTG$$

### Calculation of Net Annual Natural Gas Energy Savings

$$adj\_gross\_MMBtu = gross\_MMBtu \times RR_E \times SPF \times ISR$$
$$net\_MMbtu = adj\_gross\_MMBtu \times NTG$$

Depending on the evaluation study methodology:

- NTG is equal to $(1 – FR + SO_P + SO_{NP})$, or
- NTG is a single value with no distinction of FR, $SO_P$, $SO_{NP}$, and/or other factors that cannot be reliably isolated.

Where:

| | | |
|---|---|---|
| Gross_kWh | = | Gross Annual kWh Savings |
| adj_gross_kWh | = | Adjusted Gross Annual kWh Savings |
| net_kWh | = | Net Annual kWh Savings |
| $Gross\_kW_{SP}$ | = | Gross Connected kW Savings (summer peak) |
| $adj\_gross\_kW_{SP}$ | = | Adjusted Gross Connected kW Savings (summer peak) |
| $Gross\_kW_{WP}$ | = | Gross Connected kW Savings (winter peak) |

| | | |
|---|---|---|
| $adj\_gross\_kW_{WP}$ | = | Adjusted Gross Connected kW Savings (summer peak) |
| $net\_kW_{SP}$ | = | 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 |

# Residential Electric Efficiency Measures

# 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.

## 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.

# 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.

*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.

## 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.

# 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.

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.

### 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.

# 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

## 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.

# 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.

$\Delta$kW = 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
$\Delta$kWh = Average annual kWh reduction: 106 kWh
$\Delta$kW = 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.

| 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.

# 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:

$$\Delta kWh = (kW_{BASE} - kW_{LED}) \times Hours$$
$$\Delta kW = \Delta kW$$

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.

### 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.

# 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]

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[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.

### 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 |

**<u>In-Service Rates</u>**
The In-Service rate is from the 2011 Residential Retrofit Multifamily Impact Analysis[60]

**<u>Savings Persistence Factor</u>**
The Savings Persistence Factor is from the 2011 Residential Retrofit Multifamily Impact Analysis[61]

**<u>Realization Rates</u>**
Realization rates are based on Massachusetts Common Assumptions.

**<u>Coincidence Factors</u>**
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.

# 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.*

## 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.

# 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.

## 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.

# 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]

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[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

### 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]
.

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

# 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.

## 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 |

**<u>In-Service Rates</u>**
In-service rates are set to 100% based on the assumption that all purchased units are installed.

**<u>Savings Persistence Factor</u>**
All PAs use 100% savings persistence factors.

**<u>Realization Rates</u>**
Realization rates are based on Massachusetts Common Assumptions.

**<u>Coincidence Factors</u>**
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.

# 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.

## 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.

# 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.

| | | |
|---|---|---|
| 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.

# 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.

### 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.

# 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 |
| $\Delta kWh_{RETIRE}$ | = | Annual energy savings over remaining life of existing equipment: 884 kWh[91] |
| $\Delta kWh_{ES}$ | = | Annual energy savings over full life of new ES refrigerator: 80 kWh[92,93] |
| $\Delta kW_{RETIRE}$ | = | Average demand reduction over remaining life of existing equipment: 0.106 kW[94] |
| $\Delta kW_{ES}$ | = | 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.

Where:

| | | |
|---|---|---|
| Unit | = | Replacement of existing refrigerator with new ENERGY STAR® Refrigerator |
| $\Delta kWh_{RETIRE}$ | = | Annual energy savings over remaining life of existing equipment: 884 kWh[96] |
| $\Delta kWh_{ES}$ | = | Annual energy savings over full life of new ES refrigerator: 80 kWh[97,98] |
| $\Delta kW_{RETIRE}$ | = | Average demand reduction over remaining life of existing equipment: 0.112 kW[99] |
| $\Delta kW_{ES}$ | = | 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 |
| $\Delta kWh$ | = | Average annual kWh savings per unit: 762 kWh[102] |
| $\Delta kW$ | = | 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.

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[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.

## 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..

# 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.

## 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.

# 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.

### 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.

# 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).

| Measure | $\Delta$kW[116] | $\Delta$kWh[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.

# 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.

## 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.

# 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
.

### 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.

# 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.

| | | |
|---|---|---|
| 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.

# 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.

## 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.

# 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 |
| $\Delta kWh_{HP}$ | = | Reduction in annual kWh consumption of HP equipment |
| $\Delta kW_{HP}$ | = | Reduction in electric demand of HP equipment |
| $\Delta kWh_{SEAL}$ | = | Annual energy savings from duct sealing: See *HVAC – Duct Sealing* |
| $\Delta kW_{SEAL}$ | = | 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.

$Hours_H$ = 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.

# 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 |
| $\Delta kWh_{SEAL}$ | = | Annual energy savings from duct sealing: See *HVAC – Duct Sealing* |
| $\Delta kW_{SEAL}$ | = | 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.

## 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.

# 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.

## 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.

# 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.

### 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.

# 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.

## 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.

# 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.

### 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.

# 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.

## 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.

# 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.

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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.

## 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.

# 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.

## 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.

# 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:

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

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

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

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

Where:

| | | |
|---|---|---|
| Unit | = | 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.

### 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.

# 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.

## 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.

# 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.

## 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.

# 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.*

| 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.

# 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.

| 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.

# 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.

## 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.

# 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]

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[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.

## 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.

# 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 |
| $\Delta kWh_{ES}$ | = | 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 |
| $\Delta kW_{ES}$ | = | 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

### 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.

## 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.

# 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.

## 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.

# 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.

| | | |
|---|---|---|
| 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.

# 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..

### 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.

# 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.

## 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]

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[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.

# 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.

## 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]

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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.

# 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.

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[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.

## 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.

# 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.

$\Delta kW$ = 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]

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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.

# 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.

## 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.

# 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.

### 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.

# 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.

## 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].

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[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.

# 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).

## 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.

# 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.

### 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.

| 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

# 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.

## 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.

| 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.

# 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.

## 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.

# 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%.

### 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.

# 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.

## 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.

# 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

## 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.

# 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.

### 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.

# 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.

### 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.

# 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:

$$\Delta kWh = Stories \times SQFT \times (CFM / SQFT_{PRE} - CFM / SQFT_{POST}) \times \Delta kWh / CFM$$
$$\Delta kW = \Delta kWh \times kW / kWh$$

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.

### 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.

# 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.

### 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.

# 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:

$$\Delta kWh = [(QTY_{PRE} \times Watts_{PRE} \times Hours_{PRE}) - (QTY_{EE} \times Watts_{EE} \times Hours_{EE})]/1000 \times 52$$
$$\Delta kW = [(QTY_{PRE} \times Watts_{PRE}) - (QTY_{EE} \times Watts_{EE})]/1000$$

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.

### 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.

# 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.

### 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.

# 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.

## 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.

# Commercial and Industrial Electric Efficiency Measures

# 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 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.

| 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

# 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

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

## 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.

- 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.

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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.

# 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.

### 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.

**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.

# 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:

| | | |
|---|---|---|
| $\Delta kWh_{LED}$ | = | Reduction in lighting energy |
| $\Delta kWh_{Heat}$ | = | 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.

### 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.

**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

# 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. |

$EER_{EE}$ = 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.

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.

# 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:*

$$\Delta kWh = \Delta kWh_{Cool} + \Delta kWh_{Heat}$$

$$\Delta kWh_{Cool} = (kBtu/h_{COOL})\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)(EFLH_{COOL})$$

$$\Delta kWh_{Heat} = \frac{(kBtu/h_{HEAT})}{3.412}\left(\frac{1}{COP_{BASE}} - \frac{1}{COP_{EE}}\right)(EFLH_{HEAT})$$

$$\Delta kW = (kBtu/h)\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right)$$

Where:

| | | |
|---|---|---|
| $\Delta kWh_{COOL}$ | = | Gross annual cooling mode kWh savings from the measure. |
| $\Delta kWh_{HEAT}$ | = | 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.

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.

### 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]

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[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.

# 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.

## 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.

# 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.

### 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]

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[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.

# 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.

### 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.

# 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.

| 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.

# 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.

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.

## 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.

# 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.

### 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 |

**<u>In-Service Rates</u>**
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

**<u>Savings Persistence Factor</u>**
All PAs use 100% savings persistence factors.

**<u>Realization Rates</u>**
- 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]

**<u>Coincidence Factors</u>**
- 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.

# 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.

### 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.

# 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.

## 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.

# 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.

## 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.

# 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:

| | | |
|---|---|---|
| $\Delta kWh_{Fan}$ | = | Energy savings due to increased efficiency of evaporator fan motor |
| $\Delta kWh_{Heat}$ | = | 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.

## 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.

# 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:

| | | |
|---|---|---|
| $\Delta kWh_{Motor}$ | = | Energy savings due to increased efficiency of case motor |
| $\Delta kWh_{Heat}$ | = | 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.

### 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.

# 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.*

### 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.

# 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. |
| $\Delta kWh_{Heat}$ | = | 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.

### 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.

# 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:

| | | |
|---|---|---|
| $\Delta kWh_{Fan}$ | = | Energy savings due to evaporator being shut off |
| $\Delta kWh_{Heat}$ | = | 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.

### 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.

- 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.

# 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.

## 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.

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[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.

- 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.

# 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.

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.

# 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.

### 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*

# Compressed Air – Low Pressure Drop Filters

## Version Date and Revision History

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

## Measure Overview

**Description:** Filters remove solids and aerosols from compressed air systems. Low pressure drop filters have longer lives and lower pressure drops than traditional coalescing filters resulting in higher efficiencies.
**Primary Energy Impact:** Electric
**Secondary Energy Impact:** None
**Non-Energy Impact:** None
**Sector:** Commercial & Industrial
**Market:** Lost Opportunity & Retrofit
**End Use:** Compressed Air
**Program:** C&I New Construction, C&I Large Retrofit

## Algorithms for Calculating Primary Energy Impacts

$$\Delta kWh = (Quantity)(HP_{COMP})(0.7457)(\%Savings)(Hours)$$
$$\Delta kW = (Quantity)(HP_{COMP})(0.7457)(\%Savings)$$

Where:

| | | |
|---|---|---|
| ΔkWh | = | Energy savings |
| ΔkW | = | Demand savings |
| Quantity | = | Number of filters installed |
| $HP_{COMP}$ | = | Average compressor load |
| 0.7457 | = | Conversion from HP to kW |
| % Savings | = | Percent change in pressure drop. Site specific. |
| Hours | = | Annual operating hours of the lower pressure drop filter. |

## Baseline Efficiency

The baseline efficiency case is a standard coalescing filter with initial drop of between 1 and 2 pounds per sq inch (psi) with an end of life drop of 10 psi.

## High Efficiency

The high efficiency case is a low pressure drop filter with initial drop not exceeding 1 psi over life and 3 psi at element change. Filters must be deep-bed, “mist eliminator” style and installed on a single operating compressor rated 15 – 75 HP.

## Hours

The annual hours of operation are site specific and will be determined on a case by case basis.

## Measure Life

For lost-opportunity installations, the lifetime for this measure is 5 years. For retrofit projects, the lifetime is 3 years.[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.

# 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.

### 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.

# 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 |
| $\eta_{base}$ | = | Baseline motor efficiency. See Table 33. |
| $\eta_{ee}$ | = | 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.

### 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.

- 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.

# 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:

$\eta_{motor}$ = 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**.

$kW/HP_{WP}$ = Electric winter demand reduction based on building and equipment type. See **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.

| | 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.

### 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.

# 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.

## 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.

| 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

- 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]

<u>*C&I Small Retrofit:*</u>

- 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]

**<u>Coincidence Factors</u>**

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.

# Residential Natural Gas Efficiency Measures

# 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.

## 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.

# 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.

## 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.

# 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.

### 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.

# 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.

## 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.

# 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.

### 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.

# 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.

## 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.

# 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.

### 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 |

**<u>In-Service Rates</u>**
All installations have 100% in service rate since programs include verification of equipment installations.

**<u>Savings Persistence Factor</u>**
All PAs use 100% savings persistence factor.

**<u>Realization Rates</u>**
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.

**<u>Coincidence Factors</u>**
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.

# 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.

## 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 |

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## Impact Factors for Calculating Adjusted Gross Savings

| Measure Name | Program | PA | ISR | SPF | $RR_E$ | $RR_{SP}$ | $RR_{WP}$ | $CF_{SP}$ | $CF_{WP}$ |
|---|---|---|---|---|---|---|---|---|---|
| Combo Water Heater/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.

# 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.

| 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.

# 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].

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[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.

## 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.

# 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.

## 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.

# 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
$\Delta$MMbtu = 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 | $\Delta$MMBtu/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.

### 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.

# 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.

## 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.

# 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

$$\Delta MMBtu = BldgVolume \times (ACH_{PRE} - ACH_{POST}) \times HDD \times 24 \times 0.018 \times \frac{CorrectionFactor}{SeasonalEff} \times \frac{1}{1{,}000{,}000}$$

Where:

| | | |
|---|---|---|
| $CFM50_{PRE}$ | = | CFM50 measurement before air sealing ($ft^3$/min) |
| $CFM50_{POST}$ | = | CFM50 measurement after air sealing ($ft^3$/min) |
| LBL | = | LBL Factor[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.

### 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.

# 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.

## 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 |

**<u>In-Service Rates</u>**
All installations have 100% in service rate since all PA programs include verification of equipment installations.

**<u>Savings Persistence Factor</u>**
All PAs use 100% savings persistence factor.

**<u>Realization Rates</u>**
The energy realization rate is 100% based on no evaluations.

**<u>Coincidence Factors</u>**
There are no electric savings for this measure.

# 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.

## 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.

# 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.

## 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.

# 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

### 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*.

# 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.

## 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 |

**<u>In-Service Rates</u>**
All installations have 100% in service rate since all PA programs include verification of equipment installations.

**<u>Savings Persistence Factor</u>**
All PAs use 100% savings persistence factor.

**<u>Realization Rates</u>**
The energy realization rates are 100% based on no evaluations.

**<u>Coincidence Factors</u>**
There are no electric savings for this measure.

# 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.

## 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.

# 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.

## 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.

# 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]

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[574] Savings assumptions from National Grid program vendor.
[575] Environmental Protection Agency (2010). *Life-Cycle Assessment for Thermostats*.

## 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.

# 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.

## 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.

# Commercial and Industrial Natural Gas Efficiency Measures

# 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.

## 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.

# 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."

## 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.

# 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]

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[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.

## 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.

# 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.

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[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.

## 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.

# 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.

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.

**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.

# 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.

**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).

**Coincidence Factors**
Not applicable for this measure since no electric savings are claimed.

# 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.

## 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.

# 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."

### 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.

# 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.

## 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.

# 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.

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[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.

## 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.

# 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.

## 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.

# 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.

## 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.

# 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.

## 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.

# 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.

## 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.

# 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.

## 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.

# 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.

### 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.

# 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.

## 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.

# 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. |
| $\eta_{BASE}$ | = | 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. |
| $\eta_{EE}$ | = | 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.

### 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.

# 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 =

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[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.

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.

# 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.

## 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.

# APPENDICES

# 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.

| 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 | |

| 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 |

| **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 |

**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.

**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

**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 |

| 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

**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

# 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.

# 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<br>Outdoor Fixture<br>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<br>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<br>Cooling System<br>Heating and Cooling System | $48.63<br>$3.92<br>$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<br>Heating and Cooling System | $2.83<br>$1.42 | Annual | |
| | Home Durability | Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials | Heating System<br>Cooling System<br>Heating and Cooling System | $17.42<br>$1.54<br>$1.98 | Annual | |
| | Equipment Maintenance | Reduced maintenance costs of owning newer and/or more efficient appliance equipment | Heating System<br>Cooling System<br>Heating and Cooling System | $102.40<br>$7.54<br>$9.42 | Annual | |
| | Health Benefits | Fewer colds and viruses, improved indoor air | Heating System<br>Cooling System | $1.56<br>$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 | $678.52 | One Time | |
| | | | Cooling System | $62.65 | | |
| | | | Heating and Cooling System | $80.69 | | |
| MassSave | Thermal Comfort | Greater participant-perceived comfort in home | N/A | $125.00 | Annual | |
| | Noise Reduction | Less participant-perceived noise in the home | | $31.00 | Annual | |
| | Home Durability | Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials | | $149.00 | Annual | |
| | Equipment Maintenance | Reduced maintenance costs of owning newer and/or more efficient appliance equipment | | $124.00 | Annual | |
| | Health Benefits | Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home | | $4.00 | Annual | |

| 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.*
3. Source of Price Hedging NEI is Lawrence Berkeley National Laboratory (2002). *Quantifying the Value That Wind Power Provides as a Hedge Against Volatile Natural Gas Prices.*

## 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 | $48.63 | Annual | Values are applied per participant. Since program participants = rebates, measure category values are counted for every unit except for Thermostats which are counted for every 1.15 units. The average number of thermostats installed per participant is 1.15. The "heating and hot water system" values are applied to integrated water heater/condensing boilers. |
| | | | Heating and Hot Water System | $1.83 | | |
| | | | Thermostats | $3.99 | | |
| | Home Durability | Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials | Heating System | $17.42 | Annual | |
| | | | Hot Water System | $2.13 | | |
| | | | Heating and Hot Water System | $0.72 | | |
| | | | Thermostats | $1.33 | | |
| | Equipment Maintenance | Reduced maintenance costs of owning newer and/or more efficient appliance equipment | Heating System | $102.40 | Annual | |
| | | | Heating and Hot Water System | $3.41 | | |
| | Health Benefits | Fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity as a result of weatherization in home | Heating System | $1.56 | Annual | |
| | | | Heating and Hot Water System | $0.06 | | |
| | | | Thermostats | $0.13 | | |
| | Property Value Increase | Increased value of property and expected ease of selling home | Heating System | $678.52 | One Time | |
| | | | Hot Water System | $82.56 | | |
| | | | Heating and Hot Water System | $29.17 | | |
| | | | Thermostats | $51.49 | | |
| Weatherization | Thermal Comfort | Greater participant-perceived comfort in home | N/A | $25.00 | Annual | As an approximation of program weatherization participants, values |

| 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 | $25.15 | 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 |
| | | | Air Sealing | $10.13 | | |
| | Noise Reduction | Less participant-perceived noise in the home | Insulation | $11.54 | Annual | |
| | | | Air Sealing | $4.88 | | |
| | 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 | $0.80 | Annual | |
| | | | Air Sealing | $0.32 | | |
| | Property Value Increase | Increased value of property and expected ease of selling home | Insulation | $378.05 | One Time | |
| | | | Air Sealing | $135.83 | | |
| Residential New Construction | Thermal Comfort | Greater participant-perceived comfort in home | N/A | $77.00 | Annual | Values are applied to the "Heating" measure quantity in this program as an approximation of program participants. |
| | Noise Reduction | Less participant-perceived noise in the home | | $40.00 | Annual | |
| | Property Value Increase | Increased value of property and expected ease of selling home | | $72.00 | Annual | |
| Low Income Single Family<br><br>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<br>Heating System | $30.23<br>$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<br>Air Sealing | $13.56<br>$16.39 | Annual | |
| | Home Durability | Increased home durability in terms of maintenance requirements because of better quality heating, cooling and structural materials | Insulation<br>Air Sealing<br>Heating System | $8.76<br>$10.61<br>$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<br>Air Sealing<br>Heating System | $4.77<br>$5.69<br>$5.27 | Annual | |
| | Property Value Increase | Increased value of property and expected ease of selling home | Insulation<br>Air Sealing<br>Heating System | $223.63<br>$144.93<br>$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.

# Appendix E: Table of Referenced Documents

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| ACEEE (2006). Emerging Technologies Report: Advanced Boiler Controls. Prepared for ACEEE. | ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls |
| ADM Associates, Inc. (2009). Residential Central AC Regional Evaluation. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating. | ADM_2009_Residential_Central_AC_Regional_Evaluation |
| Appliance Standards Awareness Project (2007). Dehumidifiers. | ASAP_2007_Dehumidifiers_2011 08 05 |
| Cadmus Group (2012). Non-Controls Lighting Evaluation for the Massachusetts Small Commercial Direct Install Program: Multi-Season Study. Prepared for Massachusetts Utilities. | CADMUS_2012_SBDI_Non-Controls_Lighting_Multi-Season_Study.pdf |
| Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR. Prepared for NSTAR. | Chan_2010_Formulation_of_Prescriptive_VFD_Impact_Tables_NSTAR |
| Consortium for Energy Efficiency (2008). Consumer Electronics Program Guide: Information on Voluntary Approaches for the Promotion of Energy Efficient Consumer Electronics - Products and Practices. | CEE_2008_Consumer_Electronics_Program_Guide |
| Consortium for Energy Efficiency (2008). Technology Opportunity Assessment: Convection Ovens. | CEE_2008_Technology_Opportunity_Assessment_Convection_Ovens.doc |
| Consortium for Energy Efficiency (2010). Program Design Guidance: Steamers. | CEE_2010_Program_Design_Guidance_Steamers.pdf |
| Davis Energy Group (2008). Proposal Information Template for Residential Pool Pump Measure Revisions. Prepared for Pacific Gas and Electric Company. | Davis_2008_Residential_Pool_Pump_Measure_Revisions |
| DOE (2008). ENERGY STAR® Residential Water Heaters: Final Criteria Analysis. Prepared for the DOE. | DOE_2008_ENERGY_STAR_Residential_Water_Heaters_Final_Criteria_Analysis |
| Ecotrope, Inc. (2003). Natural Gas Efficiency and Conservation Measure Resource Assessment for the Residential and Commercial Sectors. Prepared for the Energy Trust of Oregon. | Ecotrope_2003_Natural_Gas_Efficiency_and_Conservation_Measure_Resource_Assessment |
| Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities. | ERS_2005_Measure_Life_Study |
| ENERGY STAR Set-Top Boxes Qualified Product List. Accessed on 10/12/2011. | ENERGY STAR_Set_Top_Boxes_Product_List_2011 10 12.xls |
| ENERGY STAR Website. Dishwashers Key Product Criteria. Accessed 10/12/2011. | ENERGY_STAR_Website_Dishwashers_Key_Product_Criteria_2011 10 12 |
| ENERGY STAR Website. Refrigerators & Freezers Key Product Criteria. Accessed 10/12/2011. | ENERGY_STAR_Website_Refrigerators_and_Freezers_Key_Product_Criteria_2011 10 12 |
| ENERGY STAR Website: Learn About LEDs. Accessed 10/12/2011. | ENERGY_STAR_Website_Learn_About_LEDs_2011 10 12 |
| ENERGY STAR Website: Light Bulbs for Consumers. Accessed on 10/12/2011. | ENERGY_STAR_Website_Light_Bulbs_for_Consumers_2011 10 12 |
| ENERGY STAR Website: Televisions for Consumers. Accessed on 10/12/2011. | ENERGY_STAR_Website_Televisions_for_Consumers_2011 10 12 |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| Environment Northeast (2009). Energy Efficiency: Engine of Economic Growth: A Macroeconomic Modeling Assessment | ENE_2009_Energy_Efficiency_Engine_of_Economic_Growth_NEng.pdf |
| Environmental Protection Agency (2002). Life Cycle Cost Estimate for ENERGY STAR Dehumidifier. | EPA_2002_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Dehumidifier.xls |
| Environmental Protection Agency (2008). Life Cycle Cost Estimate for ENERGY STAR Television. | EPA_2008_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Television.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for an ENERGY STAR Qualified Boiler. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Qualified_Boiler.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for an ENERGY STAR Residential Refrigerator. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Residential_Refrigerator.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Furnace. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Furnace.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Gas Fryer. | EPA_2011_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Commercial_Kitchen_Equipment.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Qualified Lighting Fixtures. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Qualified_Lighting_Fixtures.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Room Air Cleaner. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Room_Air_Cleaner.xls |
| Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Room_Air_Conditioner.xls |
| Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Office Equipment. | EPA_2010_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Office_Equipment.xls |
| Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat. | EPA_2010_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Programmable_Thermostat.xls |
| Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Residential Dishwasher. | EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Residential_Dishwasher.xls |
| Federal Energy Management Program (2011). Energy Cost Calculator for Faucets and Showerheads. Accessed on 10/12/2011. | FEMP_2011_Energy_Cost_Calculator_for_Faucets_2011 10 12 |
| Food Service Technology Center (2010). Gas Combination Oven Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/gcombicalc.php. Accessed 6/10/10. | Food_Service_Technology_Center_2010_Gas_Combination_Oven_LifeCycle_Cost_Calculator_Website_Screenshot.pdf |
| Food Service Technology Center (2010). Gas Griddle Life-Cycle Cost Calculator. http://www.fishnick.com/saveenergy/tools/calculators/ggridcalc.php. Accessed on 10/22/10. | Food_Service_Technology_Center_2010_Gas_Griddle_LifeCycle_Cost_Calculator_Website_Screenshot.pdf |
| Food Service Technology Center (2011). Gas Fryer Life-Cycle Cost Calculation. Accessed on 10/12/2011. | FSTC_2011_Gas_Fryer_LifeCycle_Cost_Calculation_2011 10 12 |
| GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group. | GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Prepared for GasNetworks. | GDS_SummitBlue_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA |
| HEC, Inc. (1995). Analysis of Door Master Walk-In Cooler Anti-Sweat Door Heater Controls Installed at Ten Sites in Massachusetts. Prepared for New England Power Service Company. | HEC_1995_Analysis_of_Door_Master_Walk-In_Cooler_Anti-Sweat_Door_Heater_Controls |
| HEC, Inc. (1996). Analysis of Savings from Walk-In Cooler Air Economizers and Evaporator Fan Controls. Prepared for New England Power Service Company. | HEC_1996_Analysis_of_Savings_from_Walk-In_Cooler_Air_Economizers_and_Evap_Fan_Controls |
| Hewitt, D. Pratt, J. & Smith, G. (2005). Tankless Gas Water Heaters: Oregon Market Status. Prepared for the Energy Trust of Oregon. | Hewitt_Pratt_Smith_2005_Tankless_Gas_Water_Heaters_Oregon_Market_Status |
| ICF International (2008). Energy/Demand Savings Calculation and Reporting Methodology for the Massachusetts ENERGY STAR ® Homes Program. Prepared for Joint Management Committee. | ICF_2008_Energy_Demand_Savings_Calculation_Reporting_Methodology_MA_ESH_Program |
| KEMA (2009). 2007 Business & Construction Solutions (BS/CS) Programs - Measurement and Verification of 2007 Lighting Measures. Prepared for NSTAR. | KEMA_2009_NSTAR_BS_CS_Programs_Measurement_and_Verification_2007_Lighting_Measures |
| KEMA (2009). Design 2000plus Lighting Hours of Use and Load Shapes Measurement Study. Prepared for National Grid. | KEMA_2009_NGRID_D2_Lighting_HOU_Load_Shapes_Measurement_Study |
| KEMA (2009). National Grid USA 2008 Custom Lighting Impact Evaluation, Final Report. Prepared for National Grid. | KEMA_2009_NGRID_2008_Custom_Lighting_Impact_Evaluation |
| KEMA (2009). Sample Design and Impact Evaluation Analysis of the the 2008 Custom Program. Prepared for National Grid. | KEMA_2009_NGRID_Sample_Design_and_Impact_Evaluation_Analysis_2008_Custom_Program |
| KEMA (2010). Sample Design and Impact Evaluation Analysis of the 2009 Custom Program. Prepared for National Grid. | KEMA_2010_NGRID_Sample_Design_and_Impact_Evaluation_Analysis_2009_Custom_Program |
| KEMA (2011). 2007/2008 Large C&I Programs Final Report. Prepared for Western Massachusetts Electric Company. | KEMA_2011_WMECO_2007-2008_Large_CI_Programs_Final_Report |
| KEMA (2011). C&I Lighting Loadshape Project – Final Report. Prepared for the Regional Evaluation, Measurement and Verification Forum. | KEMA_2011_NEEP_EMV_CI_Lighting_Load_Shape_Project |
| KEMA (2011). C&I Unitary HVAC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum. | KEMA_2011_NEEP_EMV_CI_Unitary_HVAC_Load_Shape_Project |
| KEMA (2012). Impact Evaluation of 2010 Custom Process and Compressed Air Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council. | KEMA_2012_Custom_Process_and_CAIR_Report.pdf |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| KEMA (2012). Impact Evaluation of the 2010 Custom Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council. | KEMA_2012_Custom_Lighting_Final_Report.pdf |
| KEMA (2012). Prescriptive Gas Program Final Evaluation Report. Prepared for Massachusetts Energy Efficiency Program Administrators | KEMA_2012_Prescriptive_Gas_Report.pdf |
| KEMA (2012). 2010 Combined Heat and Power Impact Evaluation Methodology and Analysis Memo. Prepared for National Grid and NSTAR; Table 1-1 | KEMA_2012_CHP_Impact_Eval_Memo.pdf |
| KEMA and DMI (2011). Impact Evaluation of 2009 Custom HVAC Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council. | KEMA_DMI_2011_LCIEC_Impact_Evaluation_2009_Custom_HVAC_Installations |
| KEMA and SBW (2011). Impact Evaluation of 2008 and 2009 Custom CDA Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council. | KEMA_SBW_2011_LCIEC_Impact_Evaluation_2008-2009_Custom_CDA_Installations |
| KEMA ERS (2012). Impact Evaluation of 2010 Custom Gas Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council; Page 8. | KEMA_2012_Custom_Gas_Impact_Eval.pdf |
| KEMA, Inc (2008). The Opportunity for Energy Efficiency that is Cheaper than Supply in Rhode Island – Phase I Report. Prepared for Rhode Island Energy Efficiency and Resource Management Council | KEMA_2008_The_Opportunity_for_Energy_Efficiency_that_is_Cheaper_than_Supply_in_RI_Phase_I_Report.pdf |
| KEMA, Inc. (2010). 2007/2008 Large C&I Programs, Phase 1 Report Memo for Lighting and Process Measures. Prepared for Western Massachusetts Electric Company. | KEMA_2010_2007_2008_Large_C_I_Programs_Report_Memo_for_Lighting_and_Process_Measures.pdf |
| Lawrence Berkeley National Laboratory (2002). Quantifying the Value That Wind Power Provides as a Hedge Against Volatile Natural Gas Prices | LBL_2002_Hedge_Value.pdf |
| MassSave (2010). C&I New Construction Lighting Baseline Wattage Tables. | MassSave_2010_C_and_I_New_Construction_Lighting_Baseline_Wattage_Tables.pdf |
| MassSave (2010). C&I New Construction Lighting Wattage Tables. | MassSave_2010_CI_New_Construction_Lighting_Wattage_Tables.pdf |
| Michael Blasnik & Associates (2004). Measurement & Verification of Residential Refrigerator Energy Use, 2003 - 2004 Metering Study. Prepared for NSTAR, National Grid and WMECO. | Blasnik_2004_Measurement_and_Verification_of_Residential_Refrigerator_Energy_Use |
| National Grid (2008). National Grid 2008 Steam Trap Savings Calculation. | National Grid 2008 steam trap loss chart.xls |
| National Grid and NSTAR (2010). Energy Analysis: Hotel Guest Occupancy Sensors. Prepared for National Grid and NSTAR. | NGRID_NSTAR_Energy_Analysis_Hotel_Guest_Occupancy_Sensors |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| Nexus Market Research (2011). Estimated Net-To-Gross (NTG) Factors for the Massachusetts Program Administrators (PAs) 2010 Residential New Construction Programs, Residential HEHE and Multi-Family Gas Programs, and Commercial and Industrial Gas Programs. | TetraTech_2011_Estimated_NTG_2010_Gas_Programs.pdf |
| Nexus Market Research and Dorothy Conant (2006). Massachusetts ENERGY STAR® Homes: 2005 Baseline Study: Part I: Inspection Data Analysis Final Report. Prepared for the Massachusetts Joint Management Committee. | NMR_Conant_2006_MA_ESH_2005_Baseline_Study_Part_I_Inspection_Data_and_Analysis |
| Nexus Market Research and 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. | NMR_Conant_2006_MA_ESH_2005_Baseline_Study_Part_II_Homeowner_Survey_Analysis_Incorporating_Inspection_Data |
| Nexus Market Research and RLW Analytics (2004). Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs. Submitted to The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, N | NMR_RLW_2004_Impact_Evaluation_MA_RI_VT_2003_Residential_Lighting_Programs |
| Nexus Market Research and RLW Analytics (2008). Residential Lighting Measure Life Study. Prepared for New England Residential Lighting Program Sponsors. | NMR_RLW_2008_Residential_Lighting_Measure_Life_Study |
| Nexus Market Research and The Cadmus Group (2010). HEHE Process and Impact Evaluation - Volume 1 Integrated Report of Findings. Prepared for GasNetworks. | NMR_Cadmus_2010_HEHE_Proces_Impact_Evaluation_Vol1_Integrated_Report_Findings |
| Nexus Market Research, RLW Analytics and GDS Associates (2009). Residential Lighting Markdown Impact Evaluation. Prepared for Markdown and Buydown Program Sponsors in CT, MA, RI, and VT. | NMR_RLW_GDS_2009_Residential_Lighting_Markdown_Impact_Evaluation |
| NMR Group (2011). Massachusetts Appliance Turn-In Program Evaluation Integrated Report Findings. Prepared for National Grid, NSTAR Electric, Cape Light Compact, and Western Massachusetts Electric Company. | NMR_2011_MA_Appliance_Turn-In_Program_Evaluation |
| NMR Group, Inc (2011). Massachusetts ENERGY STAR® Lighting Program: 2010 Annual Report. Prepared for the Electric Program Administrators of Massachusetts; June 13, 2011. | NMR_2011_ES_Lighting_Annual_Report.pdf |
| NMR Group, Inc., KEMA Inc., Dorothy Conant (2012). Massachusetts Mini-Baseline Study of Homes Built at the end of the 2006 IECC Cycle; June 15, 2012 | NMR_2012_MA_Mini_Baseline_Rpt.pdf |
| NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for Massachusetts Program Administrators | Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation.pdf |
| Northeast Energy Efficiency Partnerships (2006). Strategies to Increase Residential HVAC Efficiency in the Northeast. Prepared for National Association of State Energy Offices. | NEEP_2006_Strategies_Increase_Residential_HVAC_Efficiency_Northeast |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| Opinion Dynamics Corporation (2007). Evaluation Study of KeySpan's Commercial and Industrial High Efficiency Heating Equipment Program. Prepared for KeySpan Energy Delivery. | ODC_2007_Evaluation_Study_KeySpan_CI_HEHE_Program |
| Opinion Dynamics Corporation (2009). Massachusetts Residential Saturation Survey (RASS) - Volume 1: Summary Results and Analysis. Prepared for Cape Light Compact, National Grid, NSTAR Electric, Unitil and Western Massachusetts Electric Company. | ODC_2009_MA_Residential_Appliance_Saturation_Survey_Vol1_Summary_Results_Analysis |
| Opinion Dynamics Corporation (2012). Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report. Prepared for the Massachusetts Program Administrators. | ODC_2012_Behavior_Eval_Integrated_Report.pdf |
| Optimal Energy, Inc. (2008). MEMO: Non-Electric Benefits Analysis Update. Prepared for NSTAR. | Optimal_2008_NonElectric_Benefits_Analysis_Update |
| Patel, Dinesh (2001). Energy Analysis: Dual Enthalpy Control. Prepared for NSTAR. | Patel_2001_Energy_Analysis_Dual_Enthalpy_Controls |
| RLW Analytics (2002). Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating. | RLW_2002_Market_Research_RI_MA_CT_Residential_HVAC_Market |
| RLW Analytics (2003). Small Business Solutions Program Year 2002 Impact Evaluation - Final Report. Prepared for NSTAR. | RLW_2003_NSTAR_Small_Business_Solutions_PY2002_Impact_Evaluation |
| RLW Analytics (2004). 2003 Energy Initiative "EI" Program Lighting Impact Evaluation - Final Report. Prepared for National Grid. | RLW_2004_NGRID_2003_EI_Lighting_Impact_Evaluation |
| RLW Analytics (2006). Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Intiative and Design 2000 Programs. Prepared for National Grid. | RLW_2006_NGRID_Sample_Design_and_Impact_Evaluation_Analysis_Prescriptive_Compressed_Air_Measures |
| RLW Analytics (2006). Custom Services Impact Evaluation - Final Report: 2004 Measure Installations. Prepared for Northeast Utilities. | RLW_2006_Custom_Service_Impact_Evaluation_Final_Report_2004_Measure_Installations.pdf |
| RLW Analytics (2007). Coincidence Factor Study: Residential and Commercial Industrial Lighting Measures. Prepared for the New England State Program Working Group. | RLW_2007_Coincidence_Factor_Study_Residential_and_Commercial_Industrial_Lighting_Measures |
| RLW Analytics (2007). Impact Evaluation Analysis of the 2005 Custom SBS Program. Prepared for National Grid. | RLW_2007_NGRID_Impact_Evaluation_Analysis_2005_Custom_SBS_Program |
| RLW Analytics (2007). Lighting Controls Impact Evaluation - Final Report, 2005 Energy Initiative, Design 2000plus and Small Business Services Programs. Prepared for National Grid. | RLW_2007_NGRID_Lighting_Controls_Impact_Evaluation |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| RLW Analytics (2007). Small Business Services Custom Measure Impact Evaluation. Prepared for National Grid. | RLW_2007_NGRID_SBS_Custom_Measure_Impact_Evaluation |
| RLW Analytics (2007). Validating the Impact of Programmable Thermostats. Prepared for GasNetworks. | RLW_2007_Validating_Impacts_of_Programmable_Thermostats |
| RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas. | RLW_2008_NSTAR_BS_CS_Programs_Measurement_and_Verification_2006_Final_Report |
| RLW Analytics (2008). Coincidence Factor Study: Residential Room Air Conditioners. Prepared for Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group. | RLW_2008_Coincidence_Factor_Study_Residential_Room_Air_Conditioners |
| Sachs, Harvey (2003). Energy Savings from Efficient Furnace Air Handlers in Massachusetts. | Sachs_2003_Energy_Savings_Efficient_Furnace_Air_Handlers_MA |
| SAIC (1995). Motor Run-Time and Persistence Study - Final Report. Prepared for New England Power Service Company. | SAIC_1995_Motor_Run_Time_and_Persistence_Study.pdf |
| SAIC (1998). 1998 Impact Evaluation of the Design 2000 Unitary HVAC Program. Prepared for New England Power Service Company. | SAIC_1998_Impact_Eval_of_the_Design_200plus_Unitary_HVAC_Program.pdf |
| SBW Consulting, Inc. (2004). Evaluation, Measurement & Verification Report for the CUWCC Pre-Rinse Spray Head Distribution Program. Prepared for the California Urban Water Conservation Council | SBW_2004_CUWCC_EMV_Report_Pre-Rinse_Spray_Head_Distribution_Program |
| Select Energy Services (2004). Analysis of Cooler Control Energy Conservation Measures. Prepared for NSTAR. | SelectEnergy_2004_NSTAR_Analysis_Cooler_Control_Energy_Conservation_Measures |
| Summit Blue Consulting, LLC (2006). Impact Evaluation of 2005 EnergyWise Program – Final Report. Prepared for National Grid. | SummitBlue_2006_NGRID_Impact_Evaluation_2005_EnergyWise_Program |
| Summit Blue Consulting, LLC (2008). Large Commercial and Industrial Retrofit Program Impact Evaluation 2007 – Final Report. Prepared for National Grid. | SummitBlue_2008_NGRID_LCI_Retrofit_Program_Impact_Evaluation_2007 |
| Summit Blue Consulting, LLC (2008). Multiple Small Business Services Programs Impact Evaluation 2007 – Final Report Update. Prepared for Cape Light Compact, National Grid, NSTAR, Unitil and Western Massachusetts Electric Company. | SummitBlue_2008_Multiple_Small_Business_Service_Programs_Impact_Evaluation_2007 |
| Tetra Tech and NMR Group (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for Massachusetts Program Administrators. | TetraTech_NMR_2011_MACC_Res_LI_NEI_Evaluation |
| TetraTech (2011). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study. June 23, 2011 | TetraTech_2011_MACC_2010_CI_FRSO_Study.pdf |
| TetraTech (2012). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact 2011 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study. June 2012 | TetraTech_2012_CI_Gas_FR_SO_Report.docx |

| FULL CITATION | DIGITAL DOCUMENT FILENAME |
|---|---|
| The Cadmus Cadmus (2011). 2010 Net-to-Gross Findings: Home Energy Assessment. The Electric and Gas Program Administrators of Massachusetts. | Cadmus_2011_2010_NTG_HES.pdf |
| The Cadmus Group (2009). Impact Evaluation of the 2007 Appliance Management Program and Low Income Weatherization Program. Prepared for National Grid. | Cadmus_2009_Impact_Evalulation_2007_AMP_and_LI_Weatherization_Program |
| The Cadmus Group (2010). EnergyWise 2008 Program Evaluation. Prepared for National Grid. | Cadmus_2010_EnergyWise_2008_Program_Evaluation |
| The Cadmus Group (2010). Western Massachusetts Small Business Energy Advantage Impact Evaluation Report Program Year 2008. Prepared for Western Massachusetts Electric Company. | Cadmus_2010_WMECO_SBEA_Impact_Evalulation_Report_PY2008 |
| The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit and Low Income Net-to-Gross Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts | CADMUS_2012_ HES Net-to-Gross Impact Evaluation.pdf |
| The Cadmus Group, Inc. (2012) Massachusetts Residential Retrofit and Low Income Program Area: Brushless Fan Motors Impact Evaluation. Prepared for: The Electric and Gas Program Administrators of Massachusetts | CADMUS_2012_BFM_Impact_Evaluation_Report.pdf |
| The Cadmus Group, Inc. (2012). Demand Impact Model. Prepared for the Massachusetts Program Administrators | Cadmus_2012_Demand_Impact_Model_User_Guide.pdf |
| The Cadmus Group, Inc. (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Analysis. Prepared for the Massachusetts Program Administrators | Cadmus_2012_Multifamily_Impacts_Analysis_Report.pdf |
| The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts. | CADMUS_2012_Single_Family_Low_Income_Impact_Eval.docx |
| The Fleming Group (1994). Persistence of Commercial/Industrial Non-Lighting Measures, Volume 3, Energy Management Control Systems. Prepared for New England Power Service Company. | Fleming_Group_1994_Persistence_of_Commercial_Industrial_Non_Lighting_Measures_Volume_3_Energy_Management_Control_Systems.pdf |
| United Illuminating Company and Connecticut Light & Power Company (2010). UI and CL&P Program Savings Documentation for 2011 Program Year. | 2011_CT_PSD |
| USA Technologies Energy Management Product Sheets (2006). | USATech_2006_Energy_Management_Product_Sheets |
| Veritec Consulting (2005). Region of Waterloo Pre-Rinse Spray Valve Pilot Study, Final Report. | Veritec_2005_Pre-Rinse_Spray_Valve_Pilot_Study |
| Waste Reduction Partners (2004). Occupancy Sensors - Utility Savings Initiative - Fact Sheet. | WRP_2004_Occupancy_Sensors_Utility_Savings_Initiative_Fact_Sheet |

# 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:<br>ALght Lighting<br>HVAC HVAC<br>CMoDr Motors & Drives<br>DRefr Refrigeration<br>EHoWa Hot Water<br>FComA Compressed Air<br>GProc Process*<br>HEUBe Behavior<br>Ienvl Insulation & Air Sealing<br>JGchp Combined Heat & Power<br>KSdhw Solar Hot Water<br>LDmdR Demand Response<br>MPvEl Photovoltaic Panels<br>*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:<br>• **Summer Peak**: 6am–10pm, Monday–Friday (except ISO holidays), June–September<br>• **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<br>• **Winter Peak:** 6am–10pm, Monday–Friday (except ISO holidays), January–May and October–December<br>• **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. |