

# Residential Products:

## Savings Opportunities and Innovative Strategies for 2015 and the 2016-2018 Plan

JANUARY 20, 2015

[www.ma-eeac.org](http://www.ma-eeac.org)

---

# Table of Contents

<b>2</b>	<b>Executive Summary</b>
<b>4</b>	<b>Introduction</b>
<b>5</b>	<b>Products Program Information</b>
<b>7</b>	<b>Product-Specific Analysis and Recommendations</b>
<b>22</b>	<b>Innovative Strategies</b>
<b>25</b>	<b>Conclusion</b>
	<b>Appendices</b>

## EXECUTIVE SUMMARY

### Purpose

This report has been prepared by the Consultant Team pursuant to its 2014 work plan. In 2013, the Massachusetts Program Administrators' (PAs') Residential Products Programs contributed 57% of annual electric savings (71% lifetime) and 24% of annual gas savings (35% percent lifetime). With the exception of lighting, residential products (which also includes heating and cooling equipment, water heating equipment, appliances, and consumer electronics) have not been a focus of recent discussion before the Massachusetts Energy Efficiency Advisory Council (Council). Given the significance of residential products to the achievement of the PAs' goals, the Consultants felt it was important to provide the Council with additional information and recommendations to support its ongoing review of achievements pursuant to the 2013-15 plan and with respect to planning for the 2016-2018 Plan.

The starting point for this report is that the PAs are producing strong results through their electric and gas Residential Products Programs. Maintaining or growing residential savings levels in this next three-year planning cycle may prove to be a challenge, however, particularly for the electric programs. Increasing baseline efficiencies and higher market saturation of efficient products will serve to erode existing saving opportunities for many key measures. This report identifies new or enhanced opportunities for additional and deeper savings that could be pursued in the 2016-2018 Plan while noting actions that may also be undertaken in 2015. It also highlights innovative strategies for WiFi thermostats and home energy management that merit consideration by the PAs.

### Methodology

The Consultants have drawn on a variety of information sources for this report, including the PAs' own reporting, evaluation studies, information supplied by organizations such as ENERGY STAR®, and interviews with knowledgeable parties. In this effort to identify additional savings opportunities, the Consultants focused particularly on gathering and presenting information on the work of non-Massachusetts PAs. Given the breadth of the topics of residential products and innovative strategies, the primary audience (the Council), and limited available resource, this report does not constitute a full potential assessment or other deep research effort. It is intended to balance high-level concepts with supporting details in order to inform ongoing discussions with the Council and PAs, and the Consultants expect this work to continue to evolve.

### Products Programs Summary

The PAs' residential products programs include three electric initiatives and one gas initiative.

Initiatives in the Residential Products Programs	Products Encompassed by Initiative	% of Annual Sector Savings (for respective fuel type)
Residential Lighting (electric)	Efficient compact fluorescent lamps (CFLs) and light emitting diode (LED) lamps and fixtures, promoted through a wide variety of retailers	50%
Residential Cooling & Heating Equipment (electric)	Efficient cooling (central air conditioning), heating (primarily heat pumps), and hot water equipment (heat pump water heaters); programmable and "WiFi" thermostats; and efficient boiler circulator pumps	3%
Residential Heating & Water Heating (gas)	Efficient gas-fired heating and hot water equipment, WiFi and programmable thermostats, and the installation of controls on older boilers	24%
Residential Consumer Products (electric)	Efficient appliances and consumer electronics (including advanced power strips and pool pumps) as well as the	4%

removal and environmentally responsible recycling of inefficient second refrigerators and freezers
--

## Product-Specific Analysis and Recommendations

This report presents analysis and recommendations in four main sections: lighting, HVAC and water heating, appliances and consumer electronics, and innovative strategies. The sections include additional information about the PAs' offerings in these areas, practices from PAs in other states, and key considerations the Consultants have identified for both 2015 and for the 2016-2018 Plan. Recommendations and supporting considerations are presented in each section. This Executive Summary presents only the recommendations; we strongly recommend that the reader review the full text of this report to gain a full understanding of the context, considerations, and nuance of each issue.

Recommendation	Applicable date(s)
<b>Lighting</b>	
Phase out support for specialty CFLs by the end of 2015	2015
Assess phasing out support for all CFLs by the end of 2016	2015 & 2016-18 Plan
Develop realistic total resource cost (TRC) and TRC incentive estimates for LEDs; adjust upstream LED costs and incentive levels to reflect changes in retail pricing	2016-18 Plan
Develop a market monitoring effort to assess the maturity of the retail lighting market and the extent of its transformation	2016-18 Plan
Address the possible uncertainty as to the need for continued retail lighting support in the latter part of the 2016-18 plan	2016-18 Plan
<b>HVAC and Water Heating</b>	
Test upstream HVAC and water heating activities with distributors and additional retailers	2015
Align heat pump incentives and promotions, for both ducted and ductless units, with the Northeast Energy Efficiency Partnerships cold climate heat pump specification and criteria supported by the Clean Energy Center and Department of Energy Resources pursuant to the Alternative Portfolio Standard.	2015 & 2016-18 Plan
Policies on fuel conversions and displacements should be aligned with the Commonwealth's longer-term greenhouse gas reduction and climate change goals as put forward in the Green Communities Act.	2015 & 2016-18 Plan
Once policies are aligned, the PAs should develop and implement a plan to fully leverage fuel conversion opportunities to promote the most efficient equipment. The PAs should report quarterly on the number and percentage of fuel conversion customers installing initiative eligible equipment	2015 & 2016-18 Plan
Quantify the impacts of heat pump water heaters on home heating and	2016-18 Plan

cooling loads and include in Technical Resource Manual	
Monitor findings from the ongoing gas heating impact evaluation, to inform development of boiler installation requirements and contractor training offerings	2016-18 Plan
The PAs and Consultants should work together through the Evaluation Management Committee's Baselines Subcommittee to develop appropriate, updated baseline estimates for the 2016-18 plan for all key heating and hot water equipment	2016-18 Plan
<b>Appliances and Consumer Electronics</b>	
Develop and offer a two-tier dryer rebate supporting ENERGY STAR® gas and electric dryers at the entry level and heat/pump models at the highest level	2015
Test Enervee customer engagement platform	2015
Develop measure savings and freeridership estimates for appliance and consumer electronics measures that most accurately reflects current baselines	2016-18 Plan
The PAs, either on their own or through NEEP, should participate in the development of the Retail Products Platform and consider implementation once it has been fully developed	2016-18 Plan
<b>Innovative Strategies</b>	
Continue to build on work on WiFi thermostats and specifically assess and address opportunities for leveraging WiFi thermostats to secure additional energy savings and enhance customer experience	2015 & 2016-18 Plan
Continue home energy management (HEM) assessment efforts, including through work in the Massachusetts Technology Assessment Committee and participation in discussions at the Consortium for Energy Efficiency and NEEP	2015 & 2016-18 Plan
Specify activities to assess future HEM opportunity in 2016-18 plan	2016-18 Plan

---

## INTRODUCTION

### Purpose of This Report

Over the course of the past year, discussions at Council meetings related to residential issues have primarily focused on the Multifamily Retrofit and Home Energy Services Initiatives and on lighting. As the Council begins its work with the PAs to continue strong success in achieving residential goals in 2015 and to develop the next three-year plan for 2016-2018, the Consultants felt it was important to round out the residential picture with information, planning considerations, and recommendations for the full Residential Products Programs, which include electric and gas initiatives for lighting; appliances and consumer electronics; heating, ventilation and air conditioning (HVAC) equipment; and domestic hot water (DHW).

Maintaining or growing residential savings levels in this next three-year planning cycle may prove to be a challenge, particularly for the electric programs. Increasing baseline efficiencies and higher efficient product

saturations will serve to erode existing saving opportunities for many key measures. This report identifies new or enhanced opportunities for additional and deeper savings that could be pursued in the 2016-18 Plan. Some of these build on current PA offerings. Others reflect new innovative strategies, particularly in the area of controls and home energy management. This report includes a preliminary assessment of these new opportunities. In most cases it does not quantify the anticipated costs and benefits for these measures, anticipating that such measure characterizations and screenings will occur in early 2015 to inform whether and to what extent these new opportunities are included in the next plan. As the three-year energy efficiency plans are not static documents, measures not initially included can still be added as technologies mature, savings become more certain, and costs decline.

## Methodology and Data Sources

The consultants used a variety of data sources to inform this report.

- Three-Year Plan for 2013-2015
- PA 2013 plan year reports and supporting documentation and other program reporting
- Mass Save® website
- U.S. Department of Energy (DOE) reports on solid state lighting (light emitting diodes or LEDs)
- Northeast Energy Efficiency Partnership's (NEEP) Residential Lighting Strategy 2014-2015 Update
- documents distributed by NEEP's Home Energy Management Working Group
- the recent (October 2014) ENERGY STAR® Partners meeting
- discussions with staff at ENERGY STAR, the Super-Efficient Dryer Initiative (SEDI), and Enervee
- review of PA program activity in other states, online retailer offerings, and other industry sources.

The Consultants have also discussed many of the issues addressed in the report with the PAs over the course of the past year. The Consultants have sought and received PA input on discrete issues in this report, on a proposed report outline, and on a draft of this report. The input was provided through individual phone calls, in written communications, and at meetings of the Residential Management Committee. The Consultants appreciate the cooperative spirit and information the PAs have provided to this effort.

## Structure of this Report

The remaining sections of this report are as follows:

- A summary of the current products program
- Product-specific analysis and recommendations, organized into four major product categories; within each, a discussion of several relevant issues and a table of recommendations for PA consideration
- A short discussion of innovative strategies in the area of residential energy controls
- Several appendices providing detailed information in support of the main text

---

## PRODUCTS PROGRAM INFORMATION

### Current Products Program Offerings

The Products Program is one of two Residential Sector Programs, with the other one being the Whole House Program. In 2013, 57% of annual Residential Sector electricity savings and 71% of lifetime sector electricity savings came from the Products Program. In the gas portfolio, the Products Program contributed 24% of annual and 35% of lifetime 2013 Residential Sector savings (Table 1).

**Table 1 | 2013 Plan Year Report Savings by Program and Initiative<sup>1</sup>**

Residential Products Programs and Initiatives	2013 Annual Savings (kWh or Therms)	% of Annual Sector Savings (for respective fuel type)	2013 Lifetime Savings (kWh or Therms)	% of Lifetime Sector Savings (for respective fuel type)
<b>Electric Residential Products Program</b>	235,461	57%	1,978,648	71%
Residential Cooling & Heating Equipment	12,175	3%	160,588	6%
Residential Lighting	207,161	50%	1,698,937	61%
Residential Consumer Products	16,125	4%	119,123	4%
<b>Gas Residential Heating &amp; Water Heating</b>	3,288,486	24%	57,133,343	35%

This table also displays the relative contribution of the various products initiatives to 2013 savings achievements. In the PAs’ electric portfolio the Products Program consists of the following initiatives:<sup>2</sup>

**Lighting** – Promotes, primarily through upstream incentives, efficient compact fluorescent lamps (CFLs) and light emitting diode (LED) lamps and fixtures through a wide variety of retailers. This initiative also has an online product catalog. Note that in addition to the PAs’ efforts to promote lighting at retail, a substantial number of lamps and fixtures are installed through the PAs’ Home Energy Services, Multifamily Retrofit, and New Construction Initiatives within the Whole House Program. In 2013 the over 1.5 million lamps and fixtures installed through these initiatives contributed from 72% to 93% of the total annual electric savings for each initiative.<sup>3</sup> Final 2013 plan year report data showed that the PAs’ Lighting Initiative achieved 133% of its annual savings goal compared to total Residential Sector annual savings of 126% of goal.

**Cooling & Heating Equipment** – Promotes efficient cooling (central air conditioning), heating (primarily heat pumps), and hot water equipment (heat pump water heaters), programmable and “WiFi” thermostats, and efficient boiler circulator pumps. The initiative provides contractor training and incentives to support quality installation practices, equipment tune-ups, and duct sealing. Also, through a joint offering with the gas PAs, the initiative promotes ENERGY STAR furnaces that have efficient distribution fans.

**Consumer Products** – Promotes the sale of efficient appliances and consumer electronics as well as the removal and environmentally responsible recycling of inefficient second refrigerators and freezers. The initiative leverages the ENERGY STAR brand whenever possible. It initiative also supports advanced power strips. Of the 2013 Consumer Products initiative savings, 40% came from freezer and refrigerator recycling and 41% came from televisions.

In the PAs’ gas portfolio there is a single initiative in the Products Program:

**Heating and Water Heating** – Promotes efficient gas-fired heating and hot water equipment, WiFi and programmable thermostats, and the installation of controls on older boilers.

While this report presents information on the Residential Sector and focuses on Residential Sector opportunities, many of the measures and strategies identified will also be appropriate for consideration in the Low Income Sector.

<sup>1</sup> For reasons of efficiency in compiling this information, the values in this table are for National Grid, NSTAR and WMECo. Combined, these three PAs represented 96% of 2013 evaluated Residential Sector annual savings.

<sup>2</sup> The PAs’ 2013-2015 Plan contains more detailed information about these initiatives.

<sup>3</sup> More detailed information on the contribution of lighting to the electric Whole House Program’s savings may be found in Appendix 1.

## Program-Specific Market Barriers

As the PAs move forward with enhanced and new program offerings they will continue to face many of the same market barriers that they have historically faced in this area. The PAs have largely been successfully in addressing these barriers and similar outcomes are expected in the next three-year plan. These barriers, and current and potential responses to them, include:

**Price** – First cost remains the principal barrier for many efficient residential technologies and practices. The PAs have worked diligently and creatively to overcome this barrier through customer rebates, upstream incentives to retailers and manufacturers, and bulk product procurements to lower the cost for measures installed as part of direct install activities in Whole House and Low Income Programs.

**Information** – Keeping abreast of technology innovations and making right choices is an increasing challenge for consumers and contractors as efficient alternatives proliferate. The PAs undertake marketing and consumer outreach efforts through in-store displays and point-of purchase materials, in-store demonstrations, social media, radio, print, and other media. The PAs also conduct significant contractor outreach and training for their HVAC initiatives and often work through distributors to reach these contractors.

**Product Availability** – New, efficient technologies are often not readily available when first introduced to the market. The PAs' upstream efforts with retailers and manufacturers increase the stocking of program supported efficient products.

---

## PRODUCT-SPECIFIC ANALYSIS AND RECOMMENDATIONS

This section includes discussion of four product categories, including specific analysis of issues relevant to both near-term implementation and to the development of the next Three-Year Plan. For each category, we also provide a summary of recommendations for PA consideration.

### Lighting

As noted above, lighting is the largest contributor to the PAs' residential electricity savings. These savings have historically come from CFLs, but LED lamps have recently contributed an increasing portion. This transition to LEDs reflects increased retail product availability, better performance relative to CFLs (for at least some attributes), and rapidly declining prices, which have combined to also increase consumer demand. While still more expensive compared to CFLs, PA program activities in Massachusetts and in other jurisdictions are accelerating the pace of their transition to LEDs. The key lighting questions relevant to developing the 2016-2018 plan are:

- The pace of this transition. Should CFL support cease at some point during the next plan? For certain lamp categories first?
- Does the rapid transition to LEDs create some uncertainty as to the continued role for lighting toward the end of the 2016-18 plan? Will there be less of a need for PA support for lighting, particularly at retail, if LED price and performance continue to evolve at current rates?

The following sections describe several factors that the Consultants believe are relevant to planning for 2015 program activities and the development of the 2016-18 plan. Generally, near-term issues are presented first, followed by those more relevant to the 2016-2018 planning period.

#### CHANGES IN LIGHTING INITIATIVE PRODUCT MIX

The most noteworthy change over the last two years in the PA support of residential lighting has been the growth of LEDs as a key product category. In 2013 LEDs contributed more savings to the PAs' residential portfolio than any other measure category except for CFLs. This growth is expected to continue as PA support for CFLs correspondingly decreases. The pace of this transition, and its impact on PA cost and savings, is one of the critical set of planning assumptions for the 2016-2018 Plan.

Since beginning their support of LEDs at retail in 2012, the PAs have achieved significant growth in the percentage of Lighting Initiative lamps and fixtures that are LEDs. For 2013, the PAs' planning assumption was for a 5% LED product share based on units, but they achieved a 15% LED product share in their Lighting Initiative at year's end. For 2014 the PAs assumed an 11% LED product but have achieved a 22% product share through the end of November. As a result of their higher per-unit net savings and longer measure lives as compared to CFLs, LEDs contribute a greater share of the Lighting Initiative's lifetime savings goals versus annual goals; through the end of November 2014 LEDs contributed 37% of the Lighting Initiative's annual savings and 58% of its lifetime savings.

**EISA, LEDS, AND THE CHANGING LIGHTING LANDSCAPE**

The Energy Independence and Security Act (EISA) established efficiency standards for a number of lamp categories, most notably for the common A-lamp. The EISA standards are to be implemented in two phases. The first, now-completed set of standards was phased in over the three years of 2012-2014. This set of standards effectively banned the continued manufacture of inefficient incandescent lamps, though retailers have been able to sell through their stock of these lamps. The standards, however, are based on performance (lumens per watt) and are technology neutral. The second tier of EISA is to go into effect in 2020 and will likely require lamp efficiencies equivalent to a moderately efficient CFL.

Concurrent with—though not necessarily as a result of—the first tier of EISA standards, LED products have become increasingly available at retail. Initially, LEDs were available in a limited number of lamp shapes and only in lower lighting outputs (lumens) equivalent to 40 and 60 watt incandescent lamps. However, over the past year the number of LED models available at retail has grown substantially. Table 2 shows the wide availability of ENERGY STAR LEDs nationwide with LEDs comprising over 70% of the 3,837 listed ENERGY STAR lamps as of early December 2014. The table also shows that ENERGY STAR LEDs are readily available in shapes beyond the typical A-lamp.<sup>4</sup> Note that the number of types of LEDs available on retailers' shelves may vary from this larger list of qualified ENERGY STAR LEDs.

**Table 2 | Distribution of ENERGY STAR Lamps as of December 5, 2014**

	# of Lamps	% of All Lamps	# of All LEDs
All ENERGY STAR Qualified Bulbs	3,837		
CFLs	1,097	29%	
LEDs	2,740	71%	
Omnidirectional LEDs	549	14%	20%
Decorative LEDs	246	6%	9%
Directional LEDs	1,945	51%	71%

**PRODUCT PRICING, INCENTIVES, AND THE PACE OF TRANSITION TO LEDS**

Currently, there are no statistically valid up-to-date pricing data for LEDs in Massachusetts. In general LED prices appear to have fallen substantially over the past couple years, particularly in key retail channels like home improvement and wholesale clubs. While the Environmental Protection Agency (EPA) has been tracking national LED and CFL pricing on a quarterly basis since the end of 2012, these data do not appear useful for forward-looking planning purposes in Massachusetts.<sup>5</sup> To meet this need for better cost data, the PAs will be attempting to develop better LED cost estimates as described below.

NEEP's recently released Residential Lighting Strategy (RLS) 2014-2015 Update includes price modeling for a

<sup>4</sup> Note that a new ENERGY STAR Lamp specification became effective on September 30, 2014. As a result, the mix and number of qualified products is likely to change over the coming months.

<sup>5</sup> An earlier Q1 2014 version of these ENERGY STAR pricing data were presented by the PAs at the November 12 Council meeting.

number of key LED lighting product categories.<sup>6</sup> The price data presented in the report are not meant to be fully representative of all retailers in the Northeast. The report instead examines and models pricing at retailers with lower product pricing, which also constitute some of the most active retail channels in the PAs' Retail Lighting Initiative. In August 2014 the average retail prices for 40 and 60 watt equivalent A-lamp LEDs in the region were \$8.89 and \$9.12, respectively. These prices reflect undiscounted manufacturer recommended retail prices.<sup>7</sup> By the end of 2015 these prices are projected to further decrease to \$6.11 and \$6.81, respectively.

In support of the NEEP RLS price data an informal review of both on-line pricing and in-store pricing at southern New England Home Depot and Lowe's stores indicates that the average undiscounted price for ENERGY STAR 40 and 60 W equivalent A-lamp LEDs is less than \$10, and around \$15-\$18 for 75 or 100 W equivalents.

Finally, according to a May 2014 DOE report, a typical 60 watt equivalent A-lamp is expected to begin to become cost competitive with CFLs starting in 2015 on a first-cost basis, particularly relative to higher-cost dimmable CFLs.<sup>8</sup> An illustration of this may be found in Appendix 3. Note that from a lifetime cost consumer perspective, residential LEDs are already the lowest cost lighting option in many, if not most, residential applications.

In comparison the EPA LED prices appear too high for a number of key lamp categories. The reasons for this are not entirely clear. The higher reported prices may be due to the retailers surveyed or to the methodology used to develop average lamp type pricing. At the lamp category level the data are weighted in a manner that neither reflects current product sales at retail nor the PAs' Lighting Initiative incentive activity. For example, EPA estimated the average cost for an omnidirectional LED as \$31.28 in the third quarter of 2014. For the more prevalent 60 watt equivalent omnidirectional lamp the average price was \$28.14; about three times higher than the NEEP RLS data for August 2014. While the NEEP and ENERGY STAR LED pricing may not be fully comparable, they strongly highlight the need to develop better LED cost data for the next plan.

To meet this need the PAs are in the process of developing a scope of work for an LED incremental cost study. However, results from this study will not be available until the second quarter of 2015 at the earliest. This study may have an ongoing data collection component that will provide for regular updates of LED pricing.

#### **THE POTENTIAL END OF PROGRAM SUPPORT FOR CFLS**

With the increased availability of LEDs, their declining prices, and their general superior performance, it is important to consider the transition from CFLs to LEDs in the context of the 2016-2018 Plan. The Plan should address to what extent the PAs should promote and guide this transition. It should also address whether there are particular CFL lamp types that should be phased out sooner than others, and the extent that there remains a continued, albeit diminished, role for CFLs through the end of the Plan.

Given the fall in LED pricing, the decision as to when and how quickly to shift program activity completely away from CFLs to LEDs depends on the relative importance of three key parameters driving this decision:

- Promotion of the superior lighting product
- Incentive efficiency as measured by cost per lifetime kWh saved
- Incentive efficiency as measured by cost per annual (first-year) kWh saved

With the exception of cost, LEDs are generally viewed as the superior lighting product based on nearly all key

---

<sup>6</sup> Northeast Residential Lighting Strategy: 2014-2015 Update. Northeast Energy Efficiency Partnerships. December 2014. <http://www.neep.org/sites/default/files/resources/2014-2015%20RLS%20Update.pdf>

<sup>7</sup> "Undiscounted" applies to product pricing before any PA incentive.

<sup>8</sup> Solid State Lighting Research and Development Multi-Year Program Plan, p. 21. U.S. Department of Energy. April 2014 (Updated May 2014).

lighting product criteria as shown in Table 3.<sup>9</sup>

**Table 3 | Lighting Product Criteria**

Criterion	Discussion
Efficacy (lumens/watt)	LEDs are, on average, more efficient than comparable CFLs and will therefore yield higher savings in the same application. As shown in Appendices 2a and 2b, even at the lowest wattage equivalence, LED efficacies are comparable to or better than CFLs with similar lumen outputs. LED efficacies are expected to continue to increase and to do so at faster rate than CFL efficacies
Measure life	ENERGY STAR LEDs have a minimum rated lifetime of 25,000 hours vs. 10,000 hours for CFLs
Startup time	LEDs reach full brightness immediately at start up. CFLs may take one to two minutes to reach full brightness
Cold temperature performance	Many CFLs do not perform well in cold temperature applications. LEDs do not have this problem
Directional lighting application	LEDs perform better than CFLs in most directional lamp applications, e.g., reflector lamps, particularly where a narrow beam focus is required
Dimmability	Most ENERGY STAR LEDs are dimmable; only a small number of ENERGY STAR CFLs are. While LEDs generally dim better than dimmable CFLs there are still dimmer compatibility issues with LEDs that may limit their ability to dim well in all situations
Lack of mercury	While both CFLs and LEDs must be disposed of properly, LEDs do not contain mercury, which is a neurotoxin
Durability	LEDs have no glass tubing to shatter

LED performance should only continue to improve as industry continues its investment in the technology. Conversely, CFL performance will likely show little, if any, improvement as both manufacturers and retailers view the product category largely as a dead-end technology. At least one major CFL manufacturer has stated that it will not re-qualify its specialty CFLs under the new ENERGY STAR lamp specification.<sup>10</sup> Similarly, we are aware of plans at several retail chains to cease carrying specialty CFLs at some point in 2015.

Superior LED product performance, increased consumer interest in LEDs, and a successful bulk procurement effort (for both LEDs and CFLs) resulted in significant changes in the PAs' direct install lighting efforts in 2014. The PAs no longer provide direct installation of 40 and 60 watt equivalent standard CFLs nor do they install reflector or candelabra CFLs in their Whole House and Low Income programs. While there may be different factors in play in determining product support between the Whole House and Products Programs, the PAs' changes in their direct install efforts do represent an important step in transitioning to an LED-only future.

The cost per unit of saved energy is also an important consideration in any decision to transition to a more LED-centric product mix for the Lighting Initiative. Appendix 4 shows that on an incentive \$/annual kWh basis, LEDs were two to three times as expensive as CFLs. However, on an incentive \$/lifetime kWh basis, LEDs and CFLs had similar program costs for comparable product categories. In 2015 and in the 2016-2018 Plan these costs should further converge. On an incentive cost per lifetime kWh basis, LEDs should attain a lower cost in 2015 as a result of two factors.

<sup>9</sup> See, for example: p 2. NEEP RLS Update, op. cit.

<sup>10</sup> Personal communication from Lisa Mcleer, General Electric. ENERGY STAR Partners Meeting. Scottsdale AZ. October 28, 2014.

- As the program year gets closer to the 2020 EISA “backstop” standard, lifetime savings for standard CFLs will fall dramatically. In 2017 the lifetime savings for a standard CFL will be about half that for a CFL installed in 2013.
- Tracking the sharp reductions in LED pricing, LED incentives levels should decline significantly relative to 2013.

One additional consideration in planning the phase-out of CFLs is PA efforts to reach underserved hard-to-reach (HTR) markets. The PAs have targeted retailers serving these markets and typically provide higher incentives to attain lower product pricing. In 2013, 18% of lamps and fixtures promoted through the Lighting Initiative were HTR CFLs. Currently the PAs do not have a defined LED HTR lamp category. Nonetheless, the cost to promote LEDs in HTR retailers may be higher than in non-HTR retailers. These considerations prompt the question of whether the PAs should delay transitioning these stores fully to LEDs and continue to mainly promote CFLs. Note that the PAs’ Low Income initiatives have almost entirely transitioned to LEDs. Further, continued promotion of CFLs by HTR retailers while LEDs are being promoted elsewhere may raise questions of equity.

#### **HOW LIGHTING CONTRIBUTES TO UNCERTAINTY IN THE NEXT THREE-YEAR PLAN**

The pace of LED technology progression, price declines, and retail sales has been faster than nearly anyone had forecasted. Yet LEDs still represent a very small portion of the installed residential lighting base. The question of whether the LED market could evolve over the next three to four years such that continued PA market intervention would no longer be necessary (or at least could be significantly reduced) cannot be answered at this time, but it should be considered as the Council establishes goals for the next three-year plan given the large role that lighting plays in meeting the PAs’ Residential (and Low Income) goals.

Similarly, the 2016-2018 planning process will need to develop appropriate estimates of LED free ridership, spillover, and the resulting net-to-gross (NTG) ratios. Current LED NTG ratios are set at 100% as a default value, absent any empirical data. Evaluation results to inform LED NTG will be available in Q1 2015. Ongoing efforts to measure additional LED market effects will not be available until 2016.

#### **THE ROLE OF LEDS IN EFFICIENCY PROGRAMS IN OTHER STATES**

As LEDs become increasingly available at continuing falling prices, the Massachusetts PAs and other efficiency programs are increasing the shares of program resources dedicated to LEDs. The Massachusetts PAs’ increased their LED program product share from 6% in 2012 to 15% in 2013 to 22% through the end of November 2014. However, a number of other retail lighting programs in the region have achieved even higher proportions of LED product share compared to the Massachusetts PAs.

Table 4 provides current retail lighting program market share for several leading retail lighting programs in the Northeast and Mid-Atlantic regions and shows that the Connecticut PAs have achieved a 39% LED program market share and Efficiency Vermont has attained a 30% LED product share.

**Table 4 | Lighting Initiative 2014 LED Program Market Shares**

	2013	2014 YTD
Connecticut	15%	39%
District of Columbia	2%	21%
Massachusetts	15%	22%
Rhode Island	9%	20%
Vermont	20%	30%

Moving forward into 2015 the Consultants note two trends observed from other programs. First, there has been an overall increase in LED program market share for retail-based programs. In 2015 the Connecticut PAs

project their LED market share to be approximately 48%.<sup>11</sup> The District of Columbia Sustainable Efficiency Utility (SEU) projects its LED market share will be 50%. Some of these LED market share differences may be explainable, in part, by differences in retail market channels and levels of support for HTR retailers. Nonetheless, the much higher LED market shares in other jurisdictions are notable.

The second trend is a cessation of all support for specialty CFLs in 2015. Both Connecticut and the SEU plan to halt CFL specialty lamp support at retail once current upstream promotions run out for these products. These decisions reflect the notably better performance of LEDs in this product category. Further, the price differential (on a percentage basis) is smaller between specialty LEDs and CFLs than it is currently between standard (spiral) CFLs and A-lamp LEDs. Note that many current LED products, including A-lamp LEDs, have inherent “specialty” features, such as dimming performance.

The NEEP RLS 2014-2015 Update also adopts a similar position. The one new recommendation in the Update is “Consider rapid transition of program support towards specialty LEDs and away from specialty CFLs as LED technology is better suited for the specialty applications and the prices of specialty LEDs continue to fall.”<sup>12</sup>

**RECOMMENDED PRACTICES FOR LIGHTING IMPLEMENTATION EFFORTS**

Table 5 below presents the Consultants’ proposed recommendations for lighting in 2015 and for the 2016-2018 Plan. These must be viewed in the context that the PAs’ current and historic lighting program activities, particularly those at retail, have been hugely successful. Further, the PAs are able to deliver lighting savings efficiently at a cost per annual kWh bettered only by their Behavior Initiative within the Whole House Program. That said, LEDs have progressed to the point where they are typically the better lighting technology and their performance and pricing will only continue to improve. CFLs are a dead-end technology and little, if anything, can be expected in the way of improved product performance.

Moving to higher proportions of LEDs as this report recommends will have cost and cost efficiency implications and this should be considered in assessing the recommendations below. Even with higher LED incentives, lighting savings will continue to be one of the least expensive efficiency resources in the PAs’ Residential portfolio.

**Table 5 | Recommended Practices for Lighting Implementation Efforts**

Recommendation	Supporting Information	Applicable to...
Phase out support for specialty CFLs by the end of 2015	Specialty lamps are the product category where LED performance most clearly exceeds that of CFLs and where LEDs and CFLs are closest to cost parity. At the end of November the 491,537 specialty LEDs invoiced to date were only slightly less than the combined 609,421 specialty and EISA exempt CFL lamps invoiced. Little will be required to implement this effort other than to allow existing upstream MOUs to expire and to increase LED specialty lamp goals in subsequent PAs’ upstream lighting solicitations.	2015
Assess phasing out support for all CFLs by the end of 2016	This will require cessation of support for CFL A-lamps including bare spirals. The cost implications for this may be significantly greater than the above recommendation on specialty CFLs, and this recommendation should be revisited in late 2015. Any final phase-out decision should be informed by the price trajectory for LED A-lamps. As noted above there is currently a significant price premium for	2015 & 2016-2018 Plan

<sup>11</sup> While the CT PAs 2014 LED performance was driven in part by a shareholder performance metric, through November 2014 their achieved unit market share exceeded not only their 2014 metric goal, but also their 2015 goal.

<sup>12</sup> p. 7. NEEP RLS Update. Op. cit.

	75 and 100 We LED A-lamps. If pricing for these products does not converge with those for 40 and 60 We LEDs then limited CFL support may be required beyond 2016. As with the above recommendation few active program changes will be required to make this transition as it can be easily operationalized through the PAs' upstream lighting efforts.	
Develop realistic total resource cost (TRC) and TRC incentive estimates for LEDs; adjust upstream LED incentive levels to reflect changes in retail pricing	The LED costs and incentives in the current three-year plan show little if any decline over the three years. For the next plan these costs and incentives should be informed in the near-term by the planned LED incremental cost study and should be revised each year. From a program implementation perspective the PAs may want to consider shorter cycles for their upstream lighting promotions to allow them greater flexibility in adjusting incentive levels as LED prices fall.	2016-2018 Plan
Develop a market monitoring effort to assess the maturity of the retail lighting market and the extent of its transformation	The PAs and the consultants should work together to develop indicators to assess retail lighting market development. Development of these indicators should include means by which to measure them in a timely basis. Indications of sufficient market transformation may necessitate reduced PA engagement in this market or complete cessation of PA support for retail lighting.	2016-2018 Plan
Address the possible uncertainty as to the need for continued retail lighting support in the latter part of the 2016-18 plan	Even if not fully resolved this issue should be addressed during the 2016-18 Plan development efforts in 2015 and should be acknowledged in the plan text. Ideally a process would be put in place that could address this uncertainty, and adjust PA savings goals and performance metrics accordingly.	2016-18 Plan

## HVAC and Water Heating

In the PAs' portfolio, HVAC and water heating/DHW are supported through separate initiatives for electric measures (Residential Cooling and Heating Initiative, branded in the market as Cool Smart), and gas measures (Residential Heating & Water Heating Initiative, promoted in the market by GasNetworks®). Both electric and gas opportunities are reviewed in this section.

The largest savings opportunities from the PAs' electric HVAC initiative over the next four years are likely to occur in:

- Cold climate heat pumps (CCHPs)
- Heat pump water heaters (HPWHs)
- Gas heating and hot water
- WiFi thermostats
- Equipment connectivity and demand response

The first three of these are discussed in this section, while the latter two are addressed below in the "Innovative Strategies" section. Because this category of measures and opportunities includes a variety of equipment types and end-uses (unlike the lighting market discussed above), we present information and findings for each of these opportunities separately.

### **COLD CLIMATE HEAT PUMPS (ELECTRIC)**

Efficient heat pumps, most notably ductless heat pumps, are being promoted actively by PAs and others in Massachusetts and in other states. In Massachusetts, in addition to long-standing PA rebates for efficient heat pumps, the Clean Energy Center (CEC) provides additional financial incentives for efficient heat pumps as part

of its larger thermal renewable program that also includes ground source heat pumps and pellet stoves.

Further, beginning in 2015 thermal HVAC systems that are classified as renewable will qualify for alternative energy credits under Massachusetts' Alternative Portfolio Standard (APS). In addition to heat pumps that have a minimum efficiency rating biomass boilers and solar domestic hot water systems will also qualify for these credits. The details of these credits are still being worked out, as are project metering requirements. For smaller residential-scale systems the credits will mostly be in the form of an upfront lump sum payment. While the APS credit details are still being made final, any eligible system installed in 2015 will be eligible for these credits. The PAs will need to work closely with DOER and the CEC to ensure that as many eligible heat pumps as possible meet the APS standards to qualify for the APS credits. The PAs should also consider the expected impact that these additional credits will have in driving higher participation in 2015 and in the 2016-2018 Plan.

Efficient heat pumps provide an option to homeowners and small businesses that are seeking alternatives to heating with electric resistance and with fossil fuels, particularly more expensive delivered fuels like oil and propane. The relationship between electric and delivered fuel prices will affect consumer decision making regarding displacing delivered fuel heating with heat pumps.

While heat pump technology has been available for several decades, it has only been in the last few years that models engineered for cold temperature operation have become more widely available in the U.S. Typically, conventional heat pump performance – both efficiency and output – declines significantly as the outdoor temperature falls. This then requires the use of more costly back-up electric resistance heating. Unfortunately, current equipment ratings do not adequately address cold climate performance, leaving contractors and consumers with insufficient information to make an informed decision.

In recognition of this need, NEEP has worked with PAs, manufacturers, and others to characterize the CCHP opportunity and to develop common performance specifications. NEEP's recently finalized (December 2014) CCHP draft specification has the following key elements:<sup>13</sup>

- 10.0 HSPF<sup>14</sup> for single zone systems (higher than ENERGY STAR)
- 9.0 HSPF for multi-zone systems
- 1.75 coefficient of performance (COP) at 5° F (at maximum capacity operation)
- Compressor must be variable capacity

Besides the higher HSPF criteria, the NEEP specification is noteworthy for including a low-temperature rating at 5° F. Currently, manufacturers only readily provide specific COP ratings at 47 and 17 degrees. Getting manufacturers to routinely provide the 5 degree COP rating point is both one of the NEEP specification's greatest values and one of its greatest challenges.

While only recently made final, several programs have already embraced all or major components of the NEEP specification:

**Efficiency Vermont (EVT)** began offering a revised CCHP incentive that mirrors all of the key NEEP metrics. As of mid-December, sixteen ductless heat pump models from three manufacturers meet EVT's program requirements. Note that EVT's \$300 incentive is an upstream distributor incentive. Currently there are nine participating distributors.

---

<sup>13</sup> Cold Climate Air-Source Heat Pump Specification. Northeast Energy Efficiency Partnerships. December 2014. <http://www.neep.org/sites/default/files/resources/Cold%20Climate%20Air-source%20Heat%20Pump%20Specification.pdf>

<sup>14</sup> HSPF – heating seasonal performance factor – is a federally mandated rating requirement for residential scale (65,000 Btuh and smaller) heat pumps. In comparison, the current federal minimum HSPF is 7.8, increasing to 8.2 on January 1, 2015. ENERGY STAR's current HSPF requirement is 8.2, proposed to increase to 8.5 in September 2015.

The **Connecticut** PAs' 2015 heat pump criteria will include 9.0 and 10.0 HSPF tiers that will correspond to the NEEP multi- and single-head criteria. The Connecticut PAs do not intend to adopt the low temperature COP specification.

**Efficiency Maine** offers a \$500 rebate through its Home Energy Savings Program. Criteria are more stringent than NEEP's with a minimum HSPH of 10.0 for multi-head units and 12.0 for single-head units. As of mid-November, there were 16 qualified single-head systems from 4 manufacturers and 25 multi-head systems from 12 manufacturers.

The Massachusetts PAs recently revised their heat pump eligibility criteria and incentive levels for 2015 (Appendix 5). For ductless heat pumps the PAs have adopted components of the NEEP specification. There are two HSPF tiers, one at 9.0 and one at 11.0. The higher tier exceeds the NEEP specification while the lower tier allows for multi-head ductless heat pumps to qualify for PA rebates. Units that just meet the new ENERGY STAR heat pump criteria will not qualify for PA ductless heat pump rebates in 2015. The PAs, like those in Connecticut, did not adopt NEEP's low temperature COP requirement. For ducted heat pumps the 2015 qualifying HSPFs for the two rebate tiers fall below the NEEP specification of 10.0 for single head systems. The 2015 rebate criteria are 8.5 and 9.6 HSPF.

It is important to note that current PA heat pump savings claims assume only incremental savings and costs from a less-efficient federal minimum standard compliant unit. No savings are assumed from either a resistance or fossil fuel heated baseline. This differs significantly from the approach and objective of the CEC's thermal renewable heat pump promotion efforts. The CEC explicitly seeks to replace less efficient heating systems with high performance heat pumps. The PAs' current heat pump objectives also differ from the goals of the EVT and Efficiency Maine heat pump programs.

The PAs have screened ductless heat pumps against resistance heating in the past and the benefit/cost ratios were both slightly above and below 1.0 depending on the size of the unit screened. Currently, the PAs would need clearer policy guidance to allow them to promote efficient heat pumps to displace other heating fuels and to claim these savings (though the CEC's thermal renewable efforts allow for the displacement of fossil fuels). Further, the revised RCS regulations, once final, are also expected to provide a more fuel neutral environment that will allow the PAs to make fuel conversion and displacement recommendations. Note that Massachusetts has fairly low electric heat saturation, just 8% compared to 53% for gas and 36% for oil.<sup>15</sup> In single-family homes, the saturation of electric heat is even lower at 4%, but oil heating increases to 44% of all homes.

#### **HEAT PUMP WATER HEATERS (ELECTRIC)**

Although heat pump water heating (HPWH) technology has been through several attempts at commercialization over the past two decades, it has only been in the last four to five years that efficient and reliable HPWHs became widely available with the support of major water heater manufacturers. HPWHs have the distinction of having the highest net savings of any measure in the PAs' residential portfolio: 1,775 kWh/year for a 50-gallon unit and 2,672 kWh/year for an 80-gallon unit. These savings arise from the doubling of efficiency of a HPWH compared to a conventional electric storage hot water heater.

Because HPWHs extract heating from the indoor space there is some interaction with the home's heating and cooling load, though currently this interaction has not been well characterized for HPWHs installed in New England. The extent of any such interaction is also dependent on the location of the HPWH within the home. A unit installed in the living space will have more impact on heating and cooling loads than on one installed in a basement.

As with heat pumps used for space heating, HPWHs are only promoted and eligible for electric hot water replacement. Nonetheless, HPWHs may provide a cost-effective alternative to homeowners heating hot water with fossil fuels, particularly oil and propane. Further, HPWHs may be a more climate friendly alternative to heating water with fossil fuels. Prior PA screenings of HPWHs showed them not to be cost-effective

---

<sup>15</sup> Massachusetts Residential Appliance Saturation Survey (RASS). Volume 1: Summary Results and Analysis. Final. Opinion Dynamics Corporation. April 2009.

replacements for oil or gas water heating, but there were some questions as to the screening assumptions used, particularly the summer peak demand impacts of adding HPWHs. If current policy constraints on PA support of fuel conversions are resolved, these screening assumptions should be revisited and the screenings re-done.

Efficiency Vermont allows HPWHs to replace oil or propane units, but not natural gas-fired water heaters. Efficiency Maine has no restrictions on HPWH installations. Note that Massachusetts has fairly low electric hot water saturation at about 16% compared to 58% for gas and 24% for oil.<sup>16</sup>

### **GAS HEATING AND HOT WATER**

Efficient gas heating and hot water technologies are well established. Generally, the PAs have been more successful in promoting very high efficiency heating equipment than they have been with promoting the most efficient hot water models, the exception to this being add-on indirect-fired hot water units. Table 6 illustrates this with National Grid’s gas Heating and Water Heating Initiative rebates by equipment type.

**Table 6 | 2013 National Grid Gas Heating and Water Heating Initiative Activity**

<b>Grid 2013 Plan Year Report</b>	<b>Units</b>	<b>% of all Units</b>
Furnaces	3,602	13%
Boilers	4,183	15%
Combo Condensing Boiler	1,305	5%
Boiler Early Retirement	90	0%
Standalone DHW	2,198	8%
Indirect DHW	3,181	12%
Programmable Thermostats	6,575	24%
Wifi Thermostats	6,043	22%
Boiler Reset Controls	130	0%
Heat Recovery Ventilation	52	0%
<b>Total</b>	<b>27,359</b>	<b>100%</b>

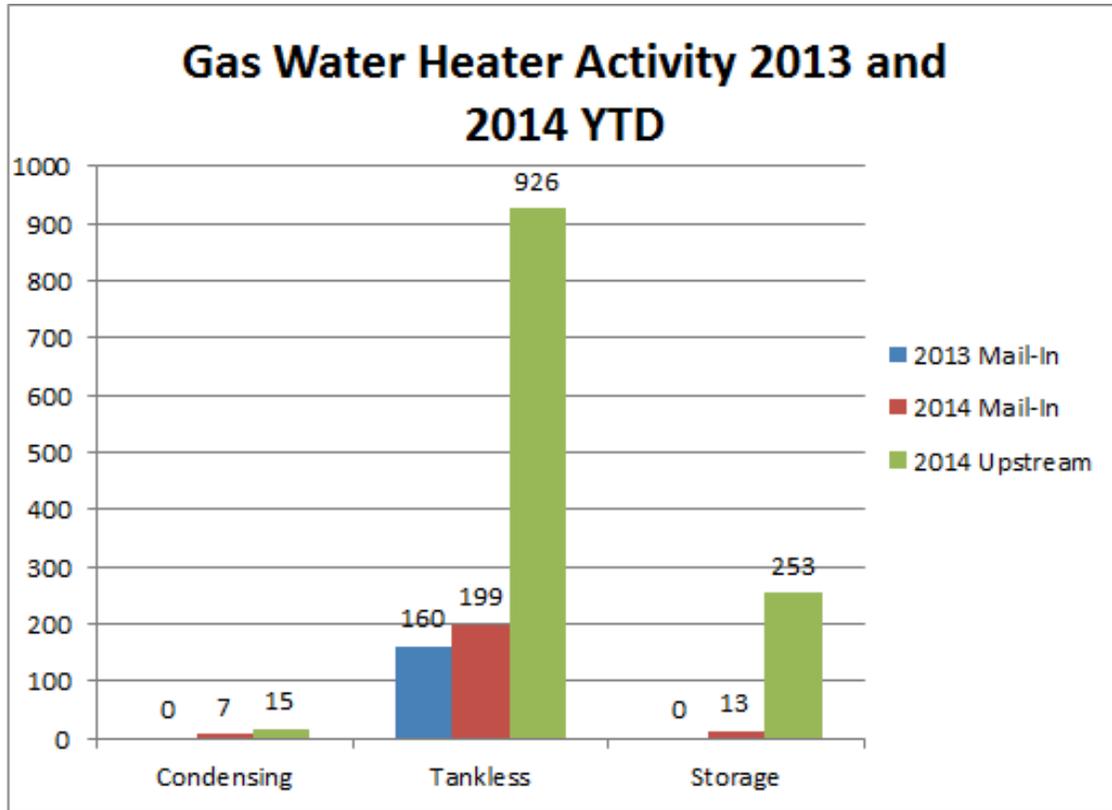
To date all PA gas HVAC rebates have been paid to homeowners or to contractors. Increasingly, efficiency programs are exploring the use of upstream incentives, typically to distributors, to increase their gas (and electric) HVAC program activity. As noted above, Efficiency Vermont is doing this with their ductless heat pump incentives. Of greater relevance is the success of the Connecticut PAs in moving their gas heating and hot water incentives upstream. This began as a pilot activity in the latter half of 2013. Over the past year the PAs have actively recruited distributors throughout the state and have now achieved full, statewide coverage.

For 2015, all gas heating and hot water incentives will be upstream in Connecticut. The PAs’ upstream success there is evidenced by their significantly increased participation numbers for several key measures, most notably electronically commutated motor (ECM) circulator pumps, and gas hot water and space heating equipment. For example, the Connecticut PAs have been supporting efficient gas hot water heating equipment for several years, but their numbers increased over ten-fold when they moved the main focus of their gas water heater efforts upstream (Figure 1). To date, efforts to assess how NTG would change through this upstream effort have not yet been undertaken.

In contrast to the apparent success of Connecticut’s residential HVAC upstream efforts have been those of the Massachusetts PAs’ upstream engagement in the commercial sector. To date, these efforts have not realized the hoped for increased program participation. These results have tempered the expansion of these upstream HVAC efforts into the residential sector.

<sup>16</sup> Massachusetts Residential Appliance Saturation Survey (RASS). Volume 1: Summary Results and Analysis. Final. Opinion Dynamics Corporation. April 2009.

Figure 1



Presentation at Connecticut Energy Efficiency Board Residential Committee Meeting. New Britain, CT. December 10, 2014.

An impact evaluation of the PAs' gas heating initiative (still in draft form) uncovered some potentially serious issues related to boiler installation practices. It appears that the large majority of condensing boilers are not fully condensing, as the return water temperature is too high. As a result, a significant amount of the expected efficiency improvement from installing these units is not being realized. This issue is being examined more closely by the study's evaluation team.

The PAs have been actively promoting condensing heating technologies for over two decades and the technology is widely available. The PAs have responded to the increasing penetration of condensing heating equipment by steadily increasing their minimum efficiency criteria for ratepayer supported furnaces and boilers. A planning and evaluation challenge has been to determine what efficiency baseline to use to determine gross savings. Historically, federal standards have been viewed as the baseline for the PAs' TRM gross savings calculations. However, there is substantial evidence that the baseline for many measures is above the relevant federal standard. This issue is being addressed by the newly formed Baseline Subcommittee under the auspices of Evaluation Management Committee (EMC). Recently, there has been agreement to raise the baseline for furnaces to 84% for 2014-15 compared to the federal minimum of 80%. For the 2016-2018 Plan, estimating baselines will be an important activity given the impact on gross savings.

**CROSSCUTTING ISSUE: FUEL DISPLACEMENT AND FUEL NEUTRALITY**

There should be clear guidance as to the PAs' ability to support fuel displacement and conversion efforts. A 2013 gas HVAC evaluation found that approximately half of gas heating equipment initiative activity was being driven by oil to gas conversions. What is not known is what percentage of all conversions was prompted by installing efficient equipment. In the past year the Department of Energy Resources (DOER) has been examining a fuel neutral approach to providing customers with options for heating system replacements through its proposed revision of the Residential Conservation Services (RCS) statute implementing regulations and guidelines. Though not yet complete (the process is expected to continue in early 2015), the revisions could well provide increased clarity on fuel conversion and support an increased emphasis on efficient cCHP

and HPWH technologies as part of a truly fuel-neutral approach to achieving the Commonwealth's energy savings and climate goals.

**RECOMMENDED PRACTICES FOR HVAC AND WATER HEATING**

Table 7 below presents the Consultants' proposed recommendations for HVAC and water heating in 2015 and for the 2016-2018 Plan.

**Table 7 | Recommended Practices for HVAC and Water Heating**

Recommendation	Supporting Information	Applicable to...
Policies on fuel conversions and displacements should be aligned with the Commonwealth's longer-term greenhouse gas reduction and climate change goals as put forward in the Green Communities Act.	There should be clear guidance in the revised RCS guidelines for the Residential and Multi-family sectors as to the PAs' ability to support such fuel conversion and displacement efforts. DOER's revision of the RCS regulations and guidelines could assist with this	2015 & 2016-2018 Plan
Once policies are aligned, the PAs should develop and implement a plan to fully leverage fuel conversion opportunities to promote the most efficient equipment. The PAs should report quarterly on the number and percentage of fuel conversion customers installing initiative eligible equipment	It will be important to track and characterize the type of fuel switching occurring that is supported by efficiency funds. Information to be collected might include current fuel, equipment type, efficiency and age, new fuel, equipment type and efficiency.	2015 & 2016-18 Plan
Quantify the impacts of HPWHs on home heating and cooling loads and include in TRM	These impacts could be informed through secondary research or possibly through building modeling or a more formal impact evaluation. As there may be possible regional interest in these findings NEEP might play a role	2016-2018 Plan
Test upstream HVAC and DHW activities with distributors and additional retailers	The PAs have only advanced limited residential upstream HVAC and DHW efforts while monitoring trial C&I upstream HVAC efforts. The success of upstream efforts in Connecticut and Vermont argues for a near-term test initiative to investigate this opportunity in Massachusetts. An RFP or possibly non-competitive solicitation should be developed through the RMC in time for the 2015-2016 heating season.	2015
Align heat pump incentives and promotions, for both ducted and ductless units, with the Northeast Energy Efficiency Partnerships cold climate heat pump specification and criteria supported by the Clean Energy Center and Department of Energy Resources pursuant to the Alternative Portfolio Standard.	The PAs should consider adopting the proposed HSPF criteria and examine the value of also including the 5° COP requirement. Rebate levels should be aligned to drive customers and contractors to the most efficient models and to provide clear market differentiation between cold climate and non-cold climate heat pumps, both for smaller systems available now, and for larger systems expected to be increasingly available over the next couple of years.	2015 & 2016-18 Plan
Monitor findings from the ongoing gas heating impact	The high incidence of boilers not attaining full condensing is a potential serious concern. Once the issue has been fully	2016-2018 Plan

evaluation, to inform development of boiler installation requirements and contractor training offerings	characterized, the PAs should respond accordingly	
The Consultants should work with the EMC's Baseline Subcommittee to develop appropriate, updated baseline estimates for the Three-Year Plan for all key heating and hot water equipment	The efforts to address and revise the furnace baseline are a good first step, but revised baseline estimates will be needed for other equipment such as boilers; consideration will need to be given as to whether these baselines will remain static over the Three-Year Plan timeframe	2016-18 Plan

**Appliances and Consumer Electronics**

For both 2015 and for the 2016-2018 Plan, the ability to grow or to even retain current appliance and consumer electronics savings levels will be challenged by rising baseline efficiencies. There are, however, some enhanced and possibly some new savings opportunities to pursue including efficient dryers, new online customer engagement strategies, and working with retailers at the national level.

Average appliance energy use has decreased dramatically over the past two decades and continues to fall, largely driven by continued upgrades in minimum federal efficiency standards. As these standards have taken effect and lowered baseline consumption, the savings from promoting more efficient appliances, including ENERGY STAR qualified products, has dropped considerably for key appliance product categories. Nonetheless, there remain a number of opportunities to promote efficient appliances, including some new ones (clothes dryers) as well as consideration of how appliances may be used for demand response.

There has been and will be significant activity for new minimum federal standards and updated ENERGY STAR product specifications in 2014 and 2015. ENERGY STAR typically reviews product specifications every three years and considers technology advancement, the need to differentiate truly efficient products for consumers, and the timing of new federal minimum standards in deciding whether a specification should be updated. The ENERGY STAR manufacturer shipment market share for many program-supported products had grown to very high levels as of 2013. ENERGY STAR has responded by updating (or beginning the process to update) many of these ENERGY STAR product specifications. Table 8 below illustrates how the shipment market share of ENERGY STAR qualified products has increased over time.

These high ENERGY STAR market shares also indicate that much of the sales for these products exceed federal standards minimums. This needs to be considered in developing the measure characterizations for these products to estimate baselines, gross savings and the extent of measure free-ridership.

**Table 8 | ENERGY STAR Appliance Market Share**

	2008	2009	2010	2010	2012	2013	Status of Recent/Next Spec
Refrigerators	31%	35%	50%	56%	76%	74%	V5.0 Effective 9/2014
Room ACs	43%	36%	33%	62%	58%	72%	V4.0 in development
Clothes Washers	24%	48%	64%	60%	66%	66%	V7.0 Effective 4/2014
Dishwashers	67%	68%	100%	96%	89%	90%	V6.0 in development
Freezers			25%	21%	44%	29%	V5.0 Effective 9/2014

Source: EPA

Appendix 6 details the revised federal standards and ENERGY STAR specifications that became effective in 2014, that are scheduled to become effective in 2015, or that are in revision with a pending effective date determination. Even with these updated ENERGY STAR standards, the PAs are typically not supporting efficient products at the ENERGY STAR level given the reduced savings increments caused by more efficient federal standards baselines. The PAs will mostly be supporting many consumer products in 2015 at the higher

ENERGY STAR “Most Efficient” efficiency criteria, including several key consumer electronics categories. In 2015 ENERGY STAR will have Most Efficient criteria for refrigerators, clothes washers, dishwashers, televisions, and computer monitors. ENERGY STAR dropped freezers from qualifying under their Most Efficient designation in 2015, largely due to the very small incremental savings remaining after the September 2014 federal standards upgrade. Of the appliances listed in Table 7, the PAs will only be offering incentives for refrigerators at the Most Efficient level.

Previously, the PAs were also supporting several product categories through the TopTen USA program. This program supported the very highest efficiency models in key product categories ranging from appliances to water heaters. However, TopTen USA will largely come to an end in 2014.

Consumer electronics pose an interesting planning challenge to the PAs. As noted above in the HVAC discussion, federal minimums have historically been used to define measure baselines and gross savings calculations. Even if there is evidence of significant non-program sales at higher efficiencies, the federal standard serves to help ground any discussion of measure baseline. However, for consumer electronics there are no federal standards. This lack of a baseline “floor,” combined with rapidly improving technology efficiencies in key product categories such as TVs and computers, has made it extremely difficult to determine and keep updated accurate measure baselines and gross savings estimates for most consumer electronics measures.

#### **NEW MEASURE OPPORTUNITY: CLOTHES DRYERS**

At the recent ENERGY STAR Partners meeting EPA strongly encouraged PAs to develop a two-tiered approach to promoting the emerging and growing number of efficient clothes dryers that are now available. EPA recommended support at the new ENERGY STAR specification level, which will yield savings of approximately 20% over the new federal standard. There are both electric and gas dryers that meet this new specification. For a higher tier, EPA continues to promote its Emerging Technology Award (ETA) winners. These models use some version of heat pump dryer technology, which has been long available in Europe and Asia, to achieve electric savings in the 40-45% range. The PAs have been supporting the limited number of ETA qualified clothes dryers in 2014 and are screening ENERGY STAR clothes dryers to assess their support for this measure.

There are six manufacturers/brands with ENERGY STAR dryers, including two with qualifying gas dryers and two with models that meet the ETA advanced dryer criteria. The recommended two-tier incentive approach is being pursued, or will be in 2015, by the DC Sustainable Efficiency Utility, Efficiency Vermont, the Connecticut PAs, and by PSE&G Long Island.

Once possible concern raised at the Partner Meeting was whether ENERGY STAR would continue to qualify new ETA winners after 2014. If not, then PAs will need to develop their own qualifying criteria for these most efficient dryers. Potentially qualifying criteria for these heat pump or hybrid dryers could be developed through an organization like CEE, NEEP, or SEDI. National Grid has been assessing heat pump dryers, and if the assessment is favorable could be in a position to include them in the 2016-2018 Plan.

#### **NEW CUSTOMER ENGAGEMENT OPPORTUNITY: ENERVEE**

Another opportunity highlighted at the Partner Meeting was the emergence of the Enervee online consumer platform. This tool is meant to fill and expand on the void created when TopTen ceases to operate as a standalone activity at the end of 2014. Enervee provides consumers with a means to sort appliances and consumer electronics by several attributes including efficiency, energy savings, and price. It also provides information on lifecycle ownership and operating costs. This “TRUECOST” can be customized to reflect utility rates specific to a given PA. The platform has a store locator function and can provide store pricing for specific models.

For efficiency, Enervee ranks all products within a given product category and assigns each model an Efficiency Score from 1-100. The higher the score, the more efficient the model. A PA can then establish a minimum score as the criterion for a rebate. Qualification to either ENERGY STAR or Most Efficient can also be used in conjunction with the score as a rebate criterion.

The Connecticut PAs are currently piloting Enervee through the end of 2014 and plan to roll it out as an ongoing program support activity at the start of 2015. The Connecticut Enervee program features a closed loop marketing platform, whereby visitors to the Enervee CT website can be followed through the entire purchase cycle of research, shopping, email communications, point of sale, incentive fulfillment (online redemption), and post-purchase communication. The Connecticut PAs are supporting refrigerators, freezers, and clothes washers with rebates of \$50, \$25, and \$50, respectively. For their pilot they are using a score of 75 to qualify products for rebate eligibility. Rebates can be applied for online through the Enervee site. The Enervee CT Enervee site can be viewed at <http://energizect.enervee.com/>.

The PAs decision to pursue Enervee should be based, in part, on the costs to implement the platform and whether quantifiable initiative savings can be directly attributed to it. Monitoring the progress of Connecticut’s Enervee roll out will help inform such a decision.

**NEW RETAILER ENGAGEMENT OPPORTUNITY: ENERGY STAR RETAIL PRODUCTS PLATFORM**

ENERGY STAR is developing a Retail Products Platform (RPP) that PAs across the US could adopt and modify to meet their program needs. The RPP is a national midstream implementation retail products program developed through common interests among the Retail Action Council (RAC), consisting of Sears, Best Buy, Home Depot and Lowes; the large California investor owned utilities represented by Pacific Gas and Electric Co. and Southern California Edison; and the Northwest Energy Efficiency Alliance (NEEA). Incentives will be paid to the retailer, who will use the incentives to increase product sales. The retailers have significant flexibility as to how they accomplish this increase.

The California utilities and NEEA have implemented midstream program pilots and have plans to expand these pilot programs in 2015, adding additional program sponsors from other jurisdictions.

At the request of the RAC, a suite of products and eligibility criteria will be determined by the program developers and will be consistently implemented by any PAs that choose to adopt and implement the ENERGY STAR RPP. PAs will be able to determine what level of incentives that they provide to the retailers for these products. Four product categories have been selected for the 2015 ENERGY STAR RPP pilot program, although the eligibility criteria is still in discussion to balance sufficient program savings with product availability. The 2015 product categories are:

- Sound Bars and “Home Theater in a Box“
- Freezers
- Clothes Dryers
- Room Air Cleaners

Note that the PAs currently support room air cleaners and ETA qualified clothes dryers at retail.

To date, the SEU, EVT, and PEPCO Maryland have committed to participate in the 2015 RPP pilot. The Massachusetts PAs are investigating this opportunity and have had some initial discussions with EVT. There may be some implementation barriers that might prevent the PAs from participating in the RPP. These include the type and quantity of data provided by participating retailers and the possible need for the PAs to sign onto a single, national retailer Memorandum of Understanding.

**RECOMMENDED PRACTICES FOR APPLIANCES AND CONSUMER PRODUCTS**

The table below presents the Consultants’ proposed recommendations for appliances and consumer products in 2015 and for the 2016-2018 Plan.

**Table 9 | Recommended Practices for Appliances and Consumer Products**

Recommendation	Supporting Information	Applicable to...
Develop and offer a two-tier dryer rebate supporting	Such a product offering will be easily implemented through current retailer-based activities. Note that NEEP is currently	2015

ENERGY STAR gas and electric dryers at the entry level and heat/pump models at the highest level	completing a baseline study of electric dryer usage. While these results will help the PAs refine any savings measure estimates, the PAs should proceed with implementing a two-tier dryer rebate informed by their own savings or estimates from ENERGY STAR or others.	
Test Enervee customer engagement platform	Consider a mid-2015 test initiative of the Enervee online customer engagement tool. Begin discussions with Enervee and work with the Connecticut PAs to assess their pilot and early 2015 results	2015
Develop measure savings and freeridership estimates for appliance and consumer electronics measures that most accurately reflects current baselines	The PAs and consultants should work through the EMC Baseline Committee starting in early 2015 to address this challenge for the 2016-2018 Plan	2016-2018 Plan
The PAs, either on their own or through NEEP, should participate in the development of the Retail Products Platform and consider implementation once it has been fully developed	The PAs should participate in ongoing discussions on the RPP and monitor the initial results of the California utilities and NEEA. Although the PAs' recent experience with the lighting market lift pilot may engender some skepticism, this may be an excellent opportunity to work directly with some of the Initiative's most active retailers at the national level	2016-2018 Plan

## INNOVATIVE STRATEGIES: WIFI THERMOSTATS AND HOME ENERGY MANAGEMENT

Massachusetts is a nation-leading innovator in energy efficiency. In order to meet the Commonwealth's ambitious energy efficiency and climate goals, continuous innovation in deploying energy savings technologies and program approaches will be required. Because the full scope of innovations that could be studied and presented here is extremely large, the Consultants felt it would be most productive to focus on a more discrete area. The Consultants selected residential controls for this effort for several reasons that will be more fully described below:

- The PAs are supporting these products in their current offerings
- The market and technology are rapidly evolving
- Controls are well positioned to support and leverage other energy efficiency efforts.

Controls work with many products made for the residential market, including HVAC equipment (e.g. boiler reset controls, thermostats), lighting, appliances, and consumer electronics (e.g., advanced power strips). A common element for these devices is that through the use of programming and other advanced features they provide the user with the ability to customize the operation of the device to optimize energy efficiency savings and meet other user goals. In some cases, PAs have the ability to control these devices as well, which has important implications for demand response efforts. Programmable communicating thermostats (also known as smart thermostats and usually called "WiFi" thermostats in Massachusetts discussions) have been the largest focus to date in the controls area in Massachusetts for reasons that are noted below. They will therefore be the primary focus here. WiFi thermostats are programmable and additionally are able to receive and transmit data. Among other things, this can allow customers to remotely control their thermostat's setting.

### Current Massachusetts Practice

WiFi thermostats were introduced to Massachusetts' energy efficiency programs through a 2011 National Grid pilot in which 86 households received free WiFi thermostats that could be programmed and remotely controlled. The goal of the pilot was to assess gas and electric savings and the feasibility of a full-scale program. The 2012 impact and process evaluation of this pilot found gas savings of between 63 and 100 therms per year per thermostat (a 10 percent savings over average pre-installation gas usage) and average

electric savings per thermostat of 104 kWh per year (a 16 percent savings on estimated cooling season energy usage).

On the basis of the evaluation findings, the PAs included WiFi thermostats in two residential initiatives in the text of the 2013-2015 plan: the gas residential heating and hot water initiative and gas and electric multifamily retrofit, each with a \$100 rebate. In the two years since, they have been made more widely available, including to customers with electric and oil heat (also \$100 rebate) and recently free of charge through the HES initiative with a home energy assessment. The latter effort is supported by a bulk procurement of units.

## Other PA Practices

WiFi thermostats play a variety of roles in the research and program offering of PAs from across the country. Several PAs have been assessing an approach that pairs a WiFi thermostat with behavioral messaging using Opower. Pacific Gas and Electric Company conducted a field assessment of this approach in 2012. This combination enabled customers to control their HVAC system using a smartphone “app” provided by Opower. The app included behavioral messages to the customer designed to prompt efficient HVAC choices. The evaluation of the field assessment conducted for PG&E found no significant electric or gas savings, though Opower believes the savings calculation and design used in the evaluation were flawed. Customers complained about the usability of the wall unit/thermostat and had connection problems requiring troubleshooting for remotely controlling the thermostat. Nonetheless, the customers noted that the app was a highly valued function and rated the behavioral messaging mildly positive for likeability and helpfulness.<sup>17</sup> Opower has implemented program improvements since that time and is expecting that results of a second independent evaluation of the PG&E field assessment will show annual savings of 1.5 percent.<sup>18</sup> A National Grid pilot of the same behavioral approach in Rhode Island yielded cooling season savings of 2.4 percent and heating season savings of 2.3 percent for dual fuel customers.<sup>19</sup> United Illuminating Company in Connecticut is currently piloting a similar approach for gas heating customers.

WiFi thermostats are a prominent feature of smart grid projects across the country. For example, DTE Electric (Michigan) recently evaluated the effects of several approaches on residential customer consumption, including the use of pricing, technology, and customer education. Looking just at consumers with moderate electric consumption, the study found that customers using WiFi thermostats had the greatest reduction in both peak period and total energy consumption on event days, more than customers using either in-home displays (IHDs) only or IHDs paired with WiFi thermostats. Its conclusion was that simply providing WiFi thermostats could be considered the most effective way to reduce consumption.<sup>20</sup>

In the spring of 2014, ComEd announced that it was partnering with Nest® Labs, Inc. to offer up to \$140 in rebates for customers who purchased a Nest Learning Thermostat™ and participate in its AC cycling demand response program in 2014. For customers that participated in the pilot, Nest sent a wireless signal to adjust the controls on a customer’s air conditioning unit, automatically helping them reduce electric demand during peak periods. Nest calls this offering Rush Hour Rewards, and it is being deployed by several other PAs as well. According to one news account, Nest announced that the AC load was cut an average of 55 percent for each demand response event.<sup>21</sup> DOER is working with Nest on a related offering—Seasonal Savings—for Massachusetts customers this winter in an effort to mitigate the effects of higher electricity rates. During the initial thermostat set up the Nest user is given the option of implementing a thermostat schedule that will achieve higher savings. If they respond affirmatively the thermostat will implement a more aggressive setback

---

<sup>17</sup> Findings from the Opower/Honeywell Smart Thermostat Field Assessment. Pacific Gas and Electric Company. ET Project Number ET11PGE3074. (July 2014).

<sup>18</sup> Personal e-mail communication from Irene Scher, Opower, December 27, 2014.

<sup>19</sup> Rhode Island Behavioral Program and Pilots Impact and Process Evaluation. Illume and Navigant Consulting.

<sup>20</sup> SmartCurrents™ Dynamic Peak Pricing Pilot: Final Evaluation Report, p. 91. DTE Energy. SGIG Project No. 10OE000146 (August 2014)

<sup>21</sup> Tweed, Katherine. “How Much Did Nest Save Utilities Last Summer?” greentechgrid: <http://www.greentechmedia.com/articles/read/how-much-did-nest-labs-save-utilities-last-summer> (May 2014)

schedule, though the customer retains the ability to revert to a less aggressive schedule.

## 2016-2018 Planning Considerations

### WIFI THERMOSTATS

WiFi thermostats interoperate with a variety of technologies and energy strategies, while providing benefits beyond behavior modification. This creates several areas for consideration in pursuing them as a supported technology.

- Pairing the device with **behavioral approaches** merits consideration as an evolution of the home energy report-based behavior program several Massachusetts PAs are offering. The PG&E results certainly indicate that caution is required.
- The electric distribution companies in Massachusetts have conducted **smart grid pilots** pursuant to a requirement in the Green Communities Act. As noted from DTE Electric's experience, WiFi thermostats can play an important role in reducing energy consumption in addition to demand. This is certainly only one piece of the energy consumption picture. It is unclear whether the Massachusetts smart grid pilots have fully integrated energy efficiency efforts and offerings into their operation. As smart grid efforts advance, ensuring the full integration of energy efficiency will be important.
- This winter provides a good illustration of the linkage between energy efficiency and **demand response**. Using WiFi thermostats as a means to secure reduction in both peak demand and overall consumption merits further assessment.
- WiFi thermostats can be a **rich source of information**, providing potentially great value to PAs. With access to information such as set points and run time, a PA could identify homes with opportunities for HVAC system or thermal envelope improvements. Opportunities to pair information from thermostats with information collected through the Energy Savvy online audit tool should also be assessed. It will be important to address data ownership and privacy issues.

### HOME ENERGY MANAGEMENT

It is useful to view WiFi thermostats as a gateway to the broader issue of home energy management (HEM). HEM describes a class of technologies including sensors and controls, smart/WiFi thermostats, and feedback devices seeking to manage residential energy consumption to reduce peak energy demand and customers' energy bills. While WiFi thermostats have generally controlled HVAC energy use,<sup>22</sup> advancing to consideration of a larger HEM approach brings control over other uses like lighting, appliances, and consumer electronics into play. HEM product and service offerings are being marketed by companies ranging from start-ups founded by small technology entrepreneurs to major companies like General Electric (with a connected/smart home strategy including Brillion™ appliances and Link LED light bulbs) and Comcast's Xfinity® Home service (offering lighting and HVAC controls).

While a full examination of the HEM opportunity is beyond the scope of this report, it is important to note that this is a field that is still evolving, with significant uncertainties still to be addressed including:

- Whether HEM devices are truly ready for market
- The verified savings for various devices and approaches
- Consistency in communication protocols, to enable and justify PA support
- Whether or not smart meters are a prerequisite for significant investment in this area

---

<sup>22</sup> Some equipment is more flexible, such as Nest thermostats' ability to control Whirlpool appliances. <http://www.whirlpool.com/works-with-nest/>

→ The program design and delivery method(s) that are best suited for this technology

### Recommended Practices for MA Implementation

The PAs are on a strong track with WiFi thermostats and are to be commended for their methodical approach, including the bulk procurement effort. As they begin work on the 2016-2018 plan, the Consultants recommend a few practices and efforts, based on the considerations and information provided above.

**Table 10 | Recommended Practices for MA Implementation**

Recommendation	Supporting Information	Applicable to...
Continue to build on work in this area and specifically assess and address opportunities for leveraging WiFi thermostats to secure additional energy savings and enhance customer experience	Areas where additional savings may be realized include behavioral changes, smart grid, demand response, and data collection for application to program design and delivery	2015 & 2016-18 Plan
Continue HEM assessment efforts, including through work in the Massachusetts Technology Assessment Committee and participation in discussions at the Consortium for Energy Efficiency and NEEP	Given the still fairly nascent state of HEM technology, it will be especially important for the Massachusetts PAs to continue their information collection efforts and participate in relevant discussions with their peers and industry representatives.	2015 & 2016-18 Plan
Specify activities to assess future HEM opportunity in 2016-18 plan	The complex nature of this issue and breadth of potential deployment opportunities will best be served by careful consideration and strategy. In addition to traditional matters like energy savings, HEM could serve as an anchor for a larger customer engagement strategy. In the 2016-18 plan the Council, DPU, and other stakeholders should understand how the PAs are seeking to position themselves.	2016-18 Plan

## CONCLUSION

The Massachusetts PAs have achieved tremendous results in securing energy savings from efficient residential products. In the current plan, these savings—especially from lighting—have been particularly important for making up a shortfall in savings from commercial and industrial programs. Maintaining this high level of savings into the future will be challenging. The Consultants feel that the information, considerations, and recommendations presented in this report will help position the PAs for that continued success and look forward to continuing to work with the PAs to achieve it.

## APPENDICES

### Appendix 1 | 2013 Residential Initiative Savings and Contribution of Lighting to Savings

2013 MA Evaluated Plan Year Report Residential Savings (MWh)	2013 Evaluated Annual Savings	Annual Savings from Lighting	Percent of 2013 Annual Savings from Lighting	Percent of 2013 Non-Behavioral Annual Savings from Lighting	2013 Evaluated Lifetime Savings	Lifetime Savings from Lighting	Percent of 2013 Lifetime Savings from Lighting	Number of Units
Residential New Construction	7,524	5,391	72%		85,689	35,897	42%	140,861
HVAC	10,987	0	0%		142,457	-	0%	
Single Family Retrofit	53,612	45,635	85%		394,477	279,646	71%	1,168,756
Multifamily	20,779	19,275	93%		195,385	179,818	92%	215,098
Behavioral	90,662	0	0%		90,662	-	0%	
Lighting	200,806	200,806	100%		1,651,691	1,651,691	100%	6,658,656
Appliances	15,083	0	0%		111,124	-	0%	
<b>Total</b>	<b>399,452</b>	<b>271,107</b>	<b>68%</b>	<b>88%</b>	<b>2,671,483</b>	<b>2,147,052</b>	<b>80%</b>	<b>8,183,371</b>

Source: Calculated from National Grid, NSTAR and WMECo Plan Year Report Benefit Cost Ratio (BCR) Screening Models.

**Appendix 2a: Distribution of ENERGY STAR Omnidirectional LEDs Wattage Equivalency as of December 5, 2014**

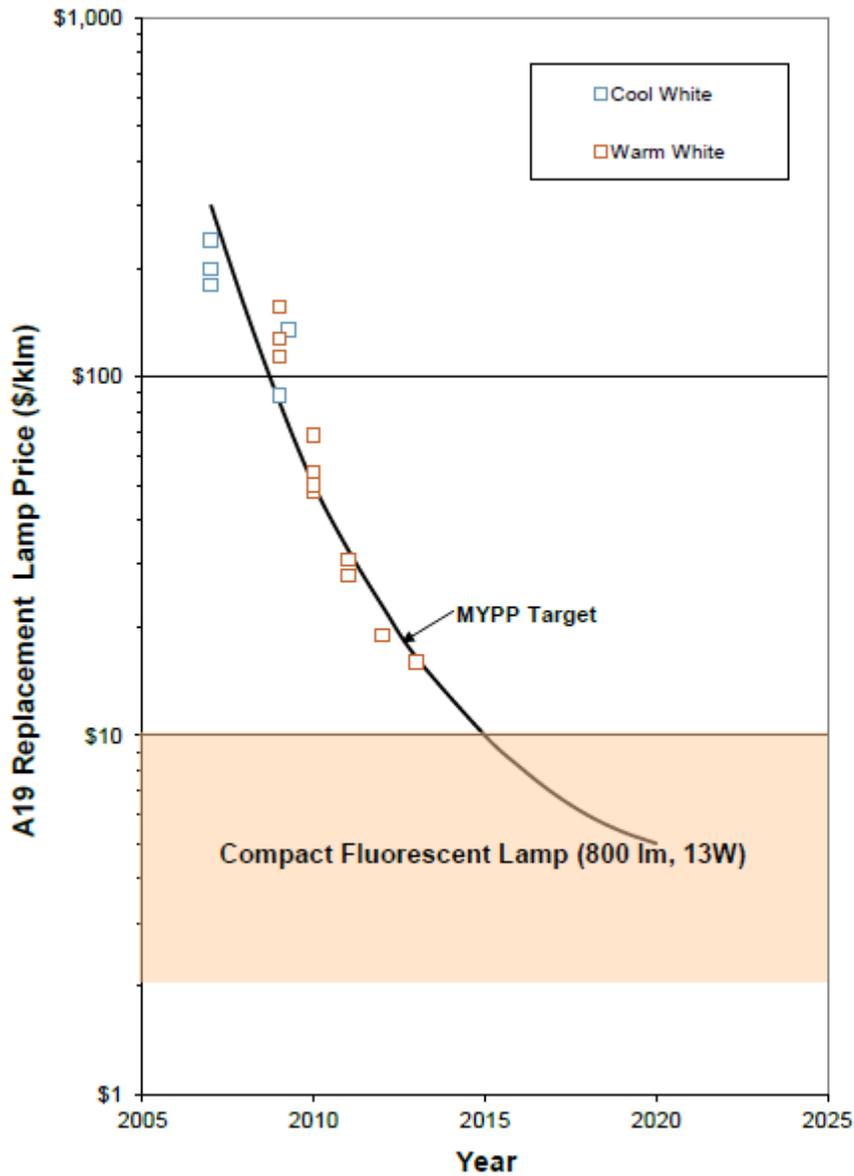
Wattage Equivalency	# of LED Bulbs	% of All LED Bulbs	Average Rated LED Wattage	Average LED Lumen Output	Average LED Lumens/Watt
25 watts	3	1%	4.5 watts	278	61.8
40 watts	148	27%	6.9 watts	467	67.7
60 watts	279	51%	10.5 watts	805	76.7
75 watts	41	7%	12.9 watts	1,122	87.0
100 watts	50	9%	17.3 watts	1,614	93.3
Not listed	28	5%			
Total	549	100%			

**Appendix 2b: Distribution of ENERGY STAR CFLs Wattage Equivalency as of December 5, 2014**

Wattage Equivalency	# of CFL Bulbs	% of All CFL Bulbs	Average Rated CFL Wattage	Average CFL Lumen Output	Average CFL Lumens/Watt
25 watts	0	0%	N/A	N/A	N/A
40 watts	90	10%	9.5 watts	558	58.7
60 watts	311	34%	13.3 watts	864	65.0
75 watts	161	18%	19.1 watts	1,268	66.4
90 watts	2	0%	23.0 watts	1,600	69.6
100 watts	257	28%	23.6 watts	1,630	69.1
125 watts	37	4%	31.2 watts	2,103	67.4
150 watts	22	2%	41.1 watts	2,746	66.8
Other/Not listed	31	3%			
Total	911	100%			

Source: <http://www.energystar.gov/productfinder/product/certified-light-bulbs/results>

### Appendix 3: A19 Replacement Lamp Price Projection (60W Equivalent; Dimmable)



Note: The shaded region illustrates the price range for a typical equivalent performance CFL (13W, self-ballasted CFL, non-dimmable at bottom, and dimmable at top).

Source: Solid State Lighting Research and Development Multi-Year Program Plan, p. 21. U.S. Department of Energy. April 2014 (Updated May 2014).

#### Appendix 4: 2013 Lighting Initiative Average Incentives and Yield Rates

Measure	PA Average 2013 Incentive	2013 Lighting Incentive \$/Annual kWh	2013 Lighting Incentive \$/Lifetime kWh
CFL Bulb	\$1.47	\$0.04	\$0.007
CFL Bulb (Specialty)	\$3.31	\$0.06	\$0.010
CFL Bulb (EISA Exempt)	\$2.93	\$0.06	\$0.007
CFL Bulb (Hard to Reach)	\$1.35	\$0.02	\$0.003
Indoor Fixture	\$13.52	\$0.10	\$0.009
LED Fixture	\$13.52	\$0.11	\$0.010
LED Bulb	\$10.57	\$0.12	\$0.011
LED Bulb (EISA Exempt)	\$11.15	\$0.12	\$0.006

Source: Calculated from 2013 PA Lighting Initiative data provided to Glenn Reed by Matt Nelson, NSTAR.

## Appendix 5: 2015 Massachusetts Heat Pump Criteria and Rebate Levels

2014 MA Cool Smart Measure	2014 Incentive	New Federal Standard Effective January 1, 2015	ENERGY STAR Split System Specification Effective September 15, 2015
Heat Pumps (SEER 16/EER 13/HSPF 8.5)	\$250	SEER 14/HSPF 8.2	15 SEER/12.5 EER/8.5 HSPF
Heat Pumps (SEER 18/EER 13/HSPF 9.6)	\$500	SEER 14/HSPF 8.2	15 SEER/12.5 EER/8.5 HSPF
Mini Split HP (SEER 18/ HSPF 9)	\$250	SEER 14/HSPF 8.2	15 SEER/12.5 EER/8.5 HSPF
Mini Split HP (SEER 20/HSPF 11)	\$500	SEER 14/HSPF 8.2	15 SEER/12.5 EER/8.5 HSPF

## Appendix 6: Summary of Appliance Federal Standard and ENERGY STAR Specification Changes

Measure	Gross Savings	Free Ridership	Net Savings	New Federal Standard Effective	New ES Spec and Savings	Impact of Federal Standard	Additional Comments
Refrigerator (ENERGY STAR)	104	35%	67.6	9/15/2014	Version 5 effective 9/15/2014. Savings are 10% off of new federal std.	Will reduce savings by more than half as previously ES refrigerators achieved 20% savings off of a less stringent standard	2015 most efficient spec will be unchanged from 2014. Currently (9/25), only nine units qualified, but more should be as models are requalified under new ES spec. If models meet ES DR capability criteria can get 5% allowance to meet ES specification.
Freezers (ENERGY STAR)	49	35%	31.9	9/15/2014	V5.0 effective 9/15/2014. Savings are 10% off of new federal std.	Will reduce savings as previously ES freezers achieved 10% savings off of a less stringent standard	Unit numbers have been small (<1,000). No most efficient freezer. If models meet ES DR capability criteria can get 5% allowance to meet specification.
Room Air Conditioners (EER 10.8)	43	36%	27.5	6/1/2014. New stds use combined Energy Efficiency Ratio (CEER) not EER.	ES has updated current spec to allow for qualification under either EER or CEER. CEER includes stand-by/inactive use. Not clear when new ES spec will be drafted	New federal standard is approximately equivalent to current ES. No or little savings to be had, even from most efficient units.	Have inquired as to timeframe for new ES spec.
Clothes Washers	405	81%	77	3/17/15 with a second set on 1/1/18	Version 7.0 effective on 3/17/15 and will yield savings of about 25% for energy and 40% for water vs. the federal standard. As of 9/1/14 models could no longer be certified to the 6.1 spec.	Significant improvement in efficiency over prior standard and will reduce ES savings increment.	Use of new performance metrics: integrated MEF (IMEF) and water factor (IWF). Different standards for front and top loading models and for standard and compact units. ES working on finalizing demand response criteria. Will be incorporated into Version 7.1 and will provide a 5% DR allowance.
Dryers	Not currently in Three-Year or 2013 AR BCR Model	Not currently in Three-Year or 2013 AR BCR Model	Not currently in Three-Year or 2013 AR BCR Model	1/1/2015	Effective 1/1/2015. Savings are about 20% off of federal standard level.	Previously, dryers have never been covered by fed std. (except for pilot light prohibition) nor by ES.	Current \$200 incentive is for EPA Emerging Technology Award winners. In addition to ES dryers (35 gas and electric models listed as of 9/25) there will be small number of ES HP dryers with 40-45% savings. If models meet ES DR capability criteria can get 5% allowance to meet specification.

Source: U.S. Environmental Protection Agency and Department of Energy