

# Advancing/Enhancing Existing Initiatives, Approaches, & Measures

## Briefing Document for October 24 EEAC Residential Planning Workshop #2

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## DOCUMENT OVERVIEW

This briefing document is for the second of three dedicated residential planning workshops for the 2019-2021 energy efficiency plan. In the first workshop on September 26, the briefing document and presentation prepared by the Consultants addressed *New Approaches in the Face of Rising Baselines and Other Trends: Challenges and Innovative Options*. The first workshop was intended to frame the discussion of residential programs at a high level, with a focus on the significant reduction of claimable lighting savings, the implications of this development on the design and delivery of the residential programs, and main areas of opportunity for program innovation, such as fuel switching, active demand management, evolution of whole home approaches, and technology platform modernization. The Consultants did not present specific recommendations for the EEAC's consideration at this first workshop.

This second residential planning workshop—*Advancing/Enhancing Existing Initiatives, Approaches, & Measures*—moves the level of conversation to an examination of more specific details. This information and details provided in this briefing document are not intended to be an exhaustive list of opportunities. Rather, the Consultants have identified initiative-, end use-, and measure-specific opportunities in five areas that were not treated fully at the last workshop:

- Heating and cooling equipment
- Serving hard to reach populations
- Lighting and consumer products
- Behavior programs
- New construction

The content for each of these five topics includes:

- An Overview section, including information about current status in Massachusetts, performance details, comparison area information, and relevant EM&V findings, and
- A Consultant Findings section, outlining barriers and opportunities and the Consultants' recommendations

Councilors are encouraged to keep the larger context of the September 26 workshop in mind as they review and process the opportunities presented herein for the October 24 workshop. The Consultants have prepared draft strategic recommendations for the five areas in this briefing document for initial discussion while the content is fresh in Councilors' minds. While the December 5 workshop agenda is still being refined, the general intention is to develop a list of recommendations encompassing the full scope of issues addressed at the prior two workshops.

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## HEATING AND COOLING EQUIPMENT

## Overview

This brief addresses energy savings opportunities for heating and cooling equipment, including heating, ventilation and air conditioning (HVAC) and water heating equipment and systems. As can be seen in Figure 1, 75% of residential energy use in Massachusetts is used for heating (59%) and hot water (16%). Cooling only comprises 1% of residential energy use, though cooling use is increasing and it has a disproportionate impact on summer peak.

**Figure 1. Massachusetts Energy Use by End Use**

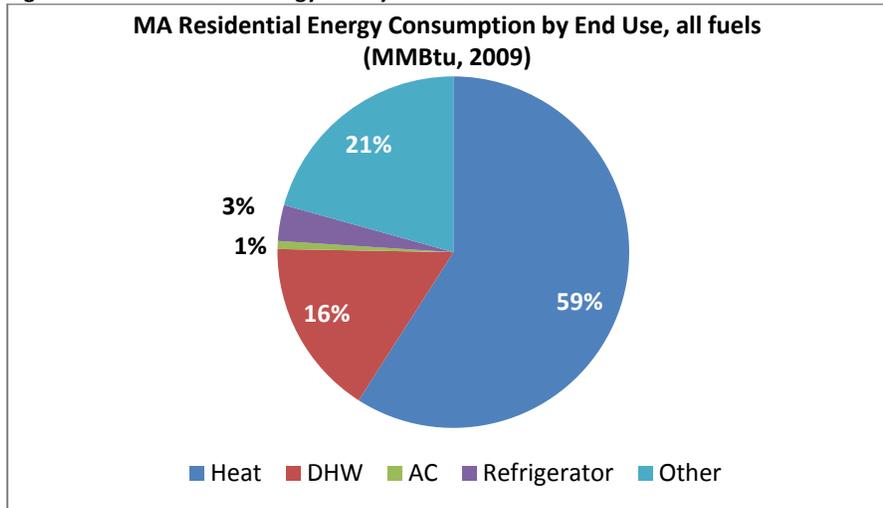
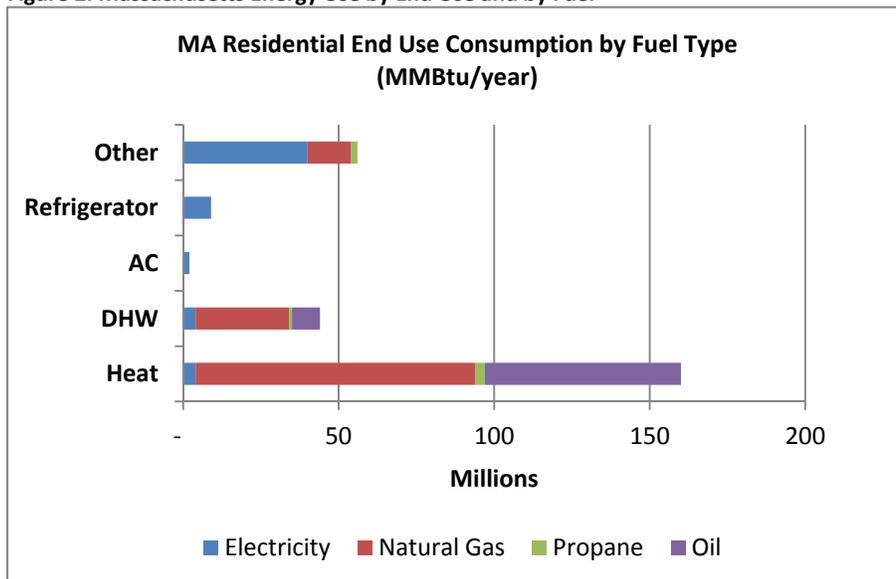


Figure 2 below shows how gas and fuel oil dominate both of these end uses. The percentage of heating and hot water consumption that is provided by gas for these 2009 data has likely increased due to fuel conversions, mostly at the expense of fuel oil.

**Figure 2. Massachusetts Energy Use by End Use and by Fuel**



Source: 2009 Residential Energy Consumption Survey, U.S. Energy Information Administration

More detailed data from the PAs' last residential appliance saturation survey in 2008 is provided in Appendix A.

As discussed more fully below, electric, gas, oil, and propane heating HVAC and water heating equipment are

measures offered in several PA initiatives. The PAs’ approach, particularly the gas PAs, to HVAC and hot water savings opportunities has been primarily at the equipment level, rather than at the broader HVAC system or whole house level. Addressing HVAC and water heating efficiency at a system level entails consideration of controls, the distribution system design and condition, and proper equipment installations. Addressing HVAC and water heating efficiency at the whole house level would also consider ways to manage building heat loss and cooling loads to more fully optimize the overall comfort and energy performance of the high efficiency equipment. The various HVAC offers and participation paths could potentially be simplified and have increased integration.

While the gas and electric Heating and Cooling Initiatives are offered statewide, they are not implemented as a single, unified HVAC and water heating offering and initiative offerings are inconsistent. As discussed below, the PAs’ Electric Heating and Cooling Initiative provides a variety of services related to quality installation practices; the Gas Heating and Cooling Initiative does not. Delivered fuel HVAC and water equipment and control efficiency opportunities are primarily pursued through HES where significant equipment replacements do occur. However, as with gas space and water heating equipment, no quality installation services are offered. Further, under current program and policy frameworks, customers installing delivered fuel heating and hot water heating equipment are not informed of potential fuel switching options.

As with most of the PAs’ efficiency efforts, the principal focus has been on energy savings. Increasingly, PA HVAC and water heating efforts will require greater consideration of demand impacts. The PAs will have the ability to co-promote active demand management through their efficient equipment and control offerings, primarily by supporting the sale and installation of connected equipment and Wifi thermostats.

## Status in Massachusetts

### PROGRAM AND PERFORMANCE OVERVIEW

To date, the PAs’ support of HVAC and water heating end uses has primarily focused on providing financial incentives (rebates) for the installation of efficient equipment. This includes not only central heating and cooling equipment—boilers, furnaces, ducted heat pumps, and central air conditioning (CAC)—and efficient water heating units, but also ductless (minisplit) heat pumps, programmable and Wifi thermostats, boiler reset controls, and efficient circulator pumps and furnace fans.

The electric PAs’ Heating and Cooling equipment Initiative also provides incentives for a suite of specification and installation services. These include training and incentives for ducted heat pump and CAC quality installation and verification through their AC Check program (air flow and charge check) and duct sealing services. In 2016, the electric PAs tested offering quality installation and verification services for ductless heat pumps, and the PAs plan to offer this measure in 2018. In comparison, the PAs’ gas Heating and Cooling Initiative does not currently provide incentives to address proper equipment specification and installation. In 2015, the PAs began work on duct sealing through HES for gas, oil, and propane heated homes, and this measure was rolled out statewide in 2017.

Table 1 summarizes and maps the different HVAC and water heating offerings by initiative. It demonstrates that there are multiple points of program entry depending on the event timing (replacement on failure (ROF) vs. early retirement (ER)) and fuel. We have not included new construction or multi-family HVAC and water heating measures.

**Table 1. HVAC and Water Heating Offerings**

2016 HVAC and Water Heating Measures	Home Energy Services Initiative	Electric Heating and Cooling Initiative	Gas Heating and Cooling Initiative
Gas Boilers and Furnaces – ROF			x
Gas Boilers and Furnaces – ER	x		
Gas water heaters			x
Central AC and Heat Pumps - ROF		x	

Central AC and Heat Pumps - ER		x	
Heat pump water heaters		x	
Oil and Propane Boilers and Furnaces - ROF	x		
Oil and Propane Boilers and Furnaces - ER	x		
Oil and Propane water heaters	x		
Wifi thermostats - gas and gas + electric	x		x
Wifi thermostats - electric only	x		
Wifi thermostats - oil/propane	x		
AC Check and Rightsizing		x	
Duct sealing	x	x	
Circulator Pumps (Upstream)		x	
Efficient Furnace Fans <sup>1</sup>		x	

The electric Heating and Cooling Initiative contributed 1% and 3%, respectively, of 2016 evaluated annual and lifetime Residential sector savings (Table 2).

**Table 2. Massachusetts Electric Heating and Cooling Initiative Summary Statistics**

Initiative Metric	2016 Evaluated Value
% of Residential Sector Annual MWh Savings	2%
% of Residential Sector Lifetime MWh Savings	3%
% of Residential Sector Benefits	2%
Lifetime Cost to Achieve (\$/kWh)	\$0.08

Table 3 shows the breakout of the electric Heating and Cooling Initiative's savings for 2016, as well as unit numbers. In 2016, three measures (circulator pumps, ductless heat pumps, and heat pump water heaters) accounted for nearly 75% of the Initiative's savings, and incentives for all measures totaled \$8.6M. These savings and incentives do not include any thermostat or direct install<sup>2</sup> measures offered through HES or the multi-family initiatives, nor any multi-family custom electric heating, cooling, or hot water equipment or control measure installations.

**Table 3. 2016 Massachusetts Electric Heating and Cooling Initiative Measure Savings Breakout**

Measures	Units	Annual MWh	Lifetime MWh
Circulator Pumps	20,526	31%	32%
Ductless Heat Pumps	8,341	19%	24%
Heat Pump Water Heaters	1,473	26%	18%
Ducted Heat Pumps	615	6%	7%
Efficient Furnace Fans	3,894	6%	7%
Central Air Conditioners	2,600	5%	6%
Early Retirement CAC and HPs	1,736	6%	5%

<sup>1</sup> Promoted through gas HVAC, paid for by electric HVAC

<sup>2</sup> Primarily low flow showerheads, faucet aerators and pipe insulation

Installation Practices/Duct Sealing	2,302	1%	1%
<b>TOTAL</b>	<b>41,487</b>	<b>100%</b>	<b>100%</b>

As indicated in Table 4, gas Heating and Cooling Initiative savings represented a significantly larger percentage of 2016 evaluated gas Residential Sector savings at 17% of annual savings and 25% of lifetime savings. 2016 Gas Heating and Cooling Initiative incentives totaled \$17.1M. These savings and incentives do not include thermostat, duct sealing, or direct install measures offered through the HES or multi-family initiatives nor any multifamily custom gas heating or hot water equipment or control measure installations.

**Table 4. Massachusetts Gas Heating and Cooling Initiative Summary Statistics**

Initiative Metric	2016 Evaluated Value
<b>% of Residential Sector Annual Therm Savings</b>	17%
<b>% of Residential Sector Lifetime Therm Savings</b>	25%
<b>% of Residential Sector Benefits</b>	20%
<b>Lifetime Cost to Achieve (\$/therm)</b>	\$0.48

In addition to the electric and natural gas heating, cooling, and water heating measures, in 2016 there were 2,358 oil and propane hot water equipment measures, 4,696 oil and propane boilers and furnaces, and 372 oil and propane boiler reset controls, and 26 heating equipment tune ups provided through the HES Initiative. The incentives for these measures totaled \$5.2 million.

Incentives for HVAC and water heating measures are mostly directed downstream to customers or contractors. The two notable exceptions are efficient circulator pumps and heat pump water heaters. The former is supported with upstream incentives at the distributor/supply house level. Heat pump water heaters (HPWHs) have been supported midstream with specific retailer/manufacturer promotions (but not midstream incentives), though most HPWHs are supported with downstream customer/contractor incentives.

**SAVINGS POTENTIAL**

The PAs' 2016 heat pump water heater units represent an estimated 4% of the annual turnover of existing electric water heaters, providing an example of potential unrealized participation and savings opportunities.<sup>3</sup> While there are some installation restrictions for heat pump water heaters, this annual program market share estimate does not account for a potentially larger market size driven by fuel switching installations.

Also of note is that both heat pump water heaters and ductless heat pumps are currently only being promoted as electric efficiency measures. Neither technology is promoted as a cost savings opportunity for homeowners or renters that may benefit from fuel switching. This is expected to change in the 2019-2021 Plan as PA programs move to a more fuel neutral environment that includes support of cost effective fuel switching recommendations.

Estimates of Gas Heating and Cooling Initiative annual measure penetrations similarly point to further opportunities to expand program participation and savings. The Consultants estimate that the 2016 Gas Heating and Cooling Initiative captured about 23% of the replacement on failure boiler market and 18% of the replacement on failure furnace market.<sup>4</sup> While considerably higher than that for heat pump water heaters, it still highlights significant lost savings opportunities. Further, these program market share estimates may be over stated, as they

<sup>3</sup> This estimate assumes 2.2 million MA 1-4 family housing units (2016 Census estimate), a 16% electric water saturation (2008 Massachusetts Residential Appliance Saturation Survey), and a 10-year electric water heater lifetime.

<sup>4</sup> These estimates assume 2.2 million MA 1-4 family housing units (2015 Census estimate), a 24% gas boiler and a 20% gas furnace saturation (MA RASS), and 20 year boiler and 18 year furnace lifetimes. Early retirement gas boiler and furnace measures through HES were not included in the calculations.

do not account for fuel conversions to gas heating.

#### IN-FIELD PERFORMANCE

Evaluation findings have shed additional light on recent PA ductless heat pump activity and results. As noted in the Relevant Evaluation Findings and Activities discussion below, measured ductless heat pump performance was considerably lower than expected for the average participant. However, the top 25% of metered ductless heat pump participants performed in line with expected savings estimates. The PAs are working with contractors and directly with consumers to provide education and training to optimize ductless heat pump usage patterns and savings. However, preliminary research conducted in Maine<sup>5</sup> to determine potential remedies for low realization rates associated with ductless heat pump installations suggests that the beneficial impact of education alone is small when compared to integrated control strategies designed to optimize energy savings from cold climate heat pump installations. Presently, not all major ductless heat pump manufacturers provide an integrated control solution.

Similarly, a late 2015 gas space and water heating impact study found that many condensing boilers were failing to consistently condense due to high return water temperatures. The PAs and their evaluation contractor pursued follow-up field research to investigate this issue, but the implemented solutions do not address the entire problem. Remedies have focused primarily on outdoor reset control strategies that limit the boiler water temperature based on outdoor temperature. However, this is not a one size fits all solution and control only solutions failed to recover the very large majority of “lost” savings.<sup>6</sup> Additionally, more complex controls are needed when the boiler provides both space heating and domestic hot water. For some homes, distribution system upgrades or building envelope improvements might be required to overcome this problem. As a result, it is important that the program creates opportunities for customers to pursue the most appropriate and effective course of action to achieve both savings and comfort. Better integration of HVAC and whole house participation paths could help address those issues.

#### Comparison Area Information

Several jurisdictions in the region have been moving incentives upstream to retailers, distributors and supply houses. In the Northeast, PAs in both Connecticut and in Vermont have moved nearly all of their HVAC and water heating incentives upstream. In the case of Connecticut, upstream incentives have increased their unit numbers substantially compared to their prior downstream incentive program design. Most recently, Connecticut moved its ductless heat pump incentives upstream in 2017. While ductless heat pumps have been a technology that the Connecticut utilities had actively supported for years, they nonetheless saw large increases in participation when they moved from a mail-in rebate in 2016 to an upstream (distributor) model in 2017. Through the end of September 2017, the Connecticut utilities saw a 115% increase in units compared to all of 2016 and expect a 187% increase by year’s end.<sup>7</sup> For 2018, Rhode Island will be moving more of its heat pump water heater support upstream. In Massachusetts, the PAs have moved their gas hot water engagement from the C&I Retrofit Initiative upstream and have seen an approximate five-fold increase in measure quantities. Further, PA incentives are available in several jurisdictions that allow fuel switching from fossil fuels to efficient electric heating and hot water technologies. Such incentives are currently available in Vermont, Maine and New York on either a program or pilot basis.

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<sup>5</sup> Fischer, Dana; “Efficiency Maine: Integrated 2-Stage Thermostat Mini-Split Mini-Test Preliminary Control Update”, presentation at NEEP 2017 Regional Cold Climate Air Source Heat Pump Market Transformation Workshop; <http://www.neep.org/sites/default/files/DanaFischerIntegratedControls.pdf>. Seven homes receiving homeowner education alone increased energy savings in “gallons of oil equivalent” from 70 to 108, or 54% improvement. Seven homes receiving integrated controls increased energy savings in “gallons of oil equivalent” from 317 to 607, or 91% improvement. These results do not attempt to measure reduction in other heat sources. These data are preliminary and final results could vary, but initial indicators are that integrated controls are needed to maximize HP performance when used on part-load situations to displace other fuels in the home.

<sup>6</sup> HEHE Condensing Equipment Barriers. Draft Final Report. Navigant Consulting, Inc. March 31, 2017

<sup>7</sup> Pernia, Jesus. Connecticut Residential HVAC & Water Heating Rebate Program. Gain Steam, Go Midstream! Distributor-Focused Residential HVAC and Water Heating Incentives. October 27, 2017 (forthcoming). ENERGY STAR Partners Meeting. Chicago, IL.

## Relevant Evaluation Findings and Activities

Heating, cooling, and hot water efficiency efforts have received significant amounts of evaluation and market research resources over the past several years, and this trend continues through 2017 and into 2018 to inform 2019-2021 planning. Recently completed, ongoing, or planned studies focus on boiler and ductless heat pump performance, heat pump water heater deemed savings estimates, gas heating and hot water incremental costs, and Wifi thermostats (Table 5). Findings and recommendations from all of these studies will inform the 2019-2021 Plan.

**Table 5. Massachusetts Residential HVAC and Water Heating Evaluation and Market Research Activities**

Study	Summary Description	Report Date or Scheduled Completion
<b>Ductless Mini-Split Heat Pump Impact Evaluation</b>	Metering study found a large variation in ductless heat pump heating operation as evidenced by the wide range in heating equivalent full load hours. Variation was driven by several factors including customer purpose (some were installed for cooling only), usage patterns, control integration with the primary heating system, and unit installation.	December 30, 2016
<b>High Efficiency Heating Equipment (HEHE) Impact Evaluation</b>	Field metering revealed that furnace efficiency performance was consistent with nameplate rating. However, a large percentage of boilers were not fully condensing. As a result, the assumed increased field efficiency for program supported boilers was reduced significantly.	March 2015
<b>HEHE Condensing Equipment Barriers</b>	Attempts to address the lost efficiency from condensing issues identified in the 2015 HEHE impact evaluation were largely unsuccessful.	March 31, 2017 (posted Draft Final Report)
<b>HEHE Condensing Boiler Loss &amp; Savings Potential</b>	To determine whether any of the areas for further research identified in the HEHE Condensing Equipment Barriers study have sufficient savings potential to warrant in-depth research.	November 2017
<b>HEHE Incremental Cost Study</b>	Develop total and incremental costs associated with high efficiency water heater, boiler, and furnace equipment, compared to a retrofit/early retirement baseline and to a replace on burnout baseline.	November 2017
<b>HEHE Wi-Fi Thermostat Technology &amp; Literature Review (RES 17)</b>	To understand the current and future state of thermostat technology and impact on energy use.	October 2017
<b>Heat Pump Water Heaters Impact Study</b>	Assessment of HPWH deemed savings based on customer surveys. Surveys found that many customers were displacing fossil fuel-fired hot water units, not just electric resistance storage units.	March 23, 2017

## Consultant Findings

The historic and current focus of the PAs' HVAC and water heating activities has been on downstream engagements to achieve energy savings with an emphasis on equipment change outs. Moving forward, the PAs will need to pursue more system-level and whole building approaches in order to increase per participant savings. These efforts can also consider active demand management opportunities, particularly for electric cooling and hot water technologies. Finally, revised program designs that move PA engagement upstream have the potential to significantly increase HVAC and water heating participation levels, but may have to be balanced with some degree of continued downstream engagement if the PAs seek to focus on the more system-level and whole building approaches stated above.

The Consultants have identified the following barriers and opportunities in Table 6 for further progress moving into

**Table 6. Massachusetts HVAC and Water Heating Barriers and Opportunities**

Barriers	Opportunities
<p><b>In field performance of boilers and ductless heat pumps leaves savings on the table.</b> Impact evaluations and follow up discussions and investigations indicate a variety of reasons for lower than expected savings from these two key technologies.</p>	<ul style="list-style-type: none"> <li>• PA activities are underway to increase ductless heat pump equivalent full-load hours and resulting savings. Based on these efforts, additional activities may be required, including consideration of control requirements.</li> <li>• Improved boiler performance may require a whole building assessment to ensure proper condensing. Not all homes may be candidates for condensing boilers.</li> </ul>
<p><b>Equipment-only focus fails to fully leverage program cost and saving opportunities by moving from equipment to system to whole building approaches.</b> While the Electric Heating and Cooling Initiative actively promotes quality installation practices for HVAC equipment, most other HVAC measures are installed with less consideration to system and whole building interactions</p>	<ul style="list-style-type: none"> <li>• PA efforts to promote efficient HVAC and water heating measures should be done at a systems and/or whole house level whenever possible.</li> <li>• Consideration should be given to distribution systems, controls and control integration, and to reducing overall building heating and cooling loads. This may require a staged approach to building retrofit efforts (equipment level, system level (equipment+distribution+controls), whole house level (system+envelope)), which will work best in early retirement scenarios.</li> </ul>
<p><b>The ability of HES energy advisors and HVAC technicians to accurately identify and recommend HVAC improvement opportunities to homeowners varies with individual experience and each company’s primary business area.</b></p>	<ul style="list-style-type: none"> <li>• Improved integration and alignment of HVAC and whole house program offers to enable better cross-promotion and appropriate delivery channel referrals.</li> <li>• Delivery via a standardized, technology-enabled platform could further support a system whereby consumers and contractors can work together to identify and plan for HVAC improvements that will effectively meet their comfort and energy savings goals.</li> </ul>
<p><b>The current downstream program design for most HVAC and water heating measures may limit program participation</b></p>	<ul style="list-style-type: none"> <li>• Pursue upstream engagement of one or more additional technologies, possibly starting with hot water, potentially in coordination with National Grid RI.</li> <li>• Leverage success with circulator pumps and the apparent success of the C&amp;I Retrofit Initiative with upstream gas hot water equipment.</li> </ul>
<p><b>The current initiative’s efficiency focus doesn’t address other opportunities including active demand management and fuel switching</b></p>	<ul style="list-style-type: none"> <li>• Co-promotion of Wifi thermostats for both their energy and demand savings capabilities. Consider bundling equipment upgrades with Wifi thermostats.</li> <li>• Assessing the benefits and cost-effectiveness of promoting connected HVAC and hot water equipment, particularly HPWHs.</li> <li>• Assessing and pursuing fuel switching opportunities within evolving regulatory and policy objectives and constraints. Continue work with Mass CEC to leverage their thermal renewable incentives and other, related program activities like HeatSmart.</li> </ul>

### Summary of Consultant Recommendations

Significant opportunities remain for increased savings from efficient HVAC and water heating equipment and systems. Some of these savings will come from more holistic treatment of savings opportunities at the system and

whole house levels, while others may come from enhanced program designs which may use alternative incentive structures, better integration with the whole house initiatives, and trade ally engagement, e.g., upstream incentives, to increase overall participation.

Moving into the 2019-2021 Plan period, the Consultants recommend the PAs focus their residential HVAC and water heating efforts to:

- Emphasize an integrated, systems-based approach to HVAC equipment promotion and installation, particularly for heat pumps and condensing boilers
- Expand HVAC efforts by providing new active demand management and fuel switching measures
- Expand water heating and HVAC upstream offerings, leveraging best practices and lessons learned from the C&I sector
- Enhance connections between HVAC and whole house offerings, enabling customers to engage in more holistic improvements in a single transaction or over time

## SERVING HARD TO REACH POPULATIONS

## Overview

The EEAC has long prioritized equitable participation in and equal access to the Massachusetts energy efficiency programs. The EEAC's most recent annual priorities for 2017 include the following priority related to serving hard to reach populations through the residential programs:

The Council recognizes that some customers are harder to reach than others, and that the PAs have developed effective strategies over the years for bringing the benefits of energy efficiency to many of these customers. The Council will work with the PAs to ensure that programs continue to prioritize equitable access among customers, including but not limited to:<sup>8</sup>

- Initiatives targeting renters and moderate income homeowners
- Potential new strategies for reaching and incentivizing the hard-to-reach segments

This brief provides Councilors with additional information on recent PA efforts to increase services for hard to reach populations, identifies barriers and additional opportunities, and supplies the EEAC with additional information and context to support assessment of the Consultants' recommended strategies for the 2019-2021 Plan.

## Status in Massachusetts

In its October 26, 2015 resolution supporting the 2016-2018 statewide energy efficiency plan, two (of six) plan elements for which the EEAC expressed specific support addressed hard to reach populations in the residential sector, specifically renters and moderate income customers. These two population groups have been the primary focus of the PAs in 2016 and 2017.

### RENTER INITIATIVE

The renter initiative was launched by the PAs at the end of the first quarter in 2016<sup>9</sup> as a discrete effort within the larger HES Initiative, which serves 1-4 unit buildings.<sup>10</sup> The initiative screens and directs renters to a specially designed home visit by a lead vendor Energy Specialist or Home Performance Contractor that is tailored to renter opportunities and constraints. The renter visit focuses on installation of instant savings measures such as LED bulbs, advanced power strips, and water saving devices and also informs the customer of other appropriate opportunities for renters. In addition, the renter visit collects information to help PAs follow up with landlords to pursue deeper savings measures for the whole building including an enhanced insulation incentive if all units in the building are insulated.

Table 7 provides results from the first 18 months of the renter initiative. Full results by individual PA will be provided by the PAs in the 2017 Third Quarter report.

### Renter Visit Elements

- **No cost savings measures**
  - LED lighting
  - Water saving devices
  - Advanced power strips
  - Programmable thermostats
- **Other offers**
  - Enhanced incentives for refrigerators and clothes washers
  - Wireless thermostats
  - Visual insulation inspection
  - Customized renter report and program offers brochure
  - Follow-up with landlord to pursue whole building improvement opportunities

<sup>8</sup> With regard to this priority the EEAC also highlighted programs and initiatives targeting the multifamily sector and segment-specific approaches for small business and mid-size commercial customers. Those topics will be addressed in other workshops.

<sup>9</sup> Cape Light Compact began offering programs for these population groups in the 2010-2012 plan.

<sup>10</sup> Renters in buildings with 5 or more units are served through the Multi-family Retrofit Initiative, which has a different program design.

**Table 7. Renter Initiative Results April 2016-September 2017**

Key Performance Indicator	Apr-Sept 2016	Oct 2016-Mar 2017	Apr-Sept 2017	18 Month Total
# of renter visits provided	433	373	424	<b>1,230</b>
# of full Home Energy Assessments (HEAs) provided to landlords	1,783	2,139	2,752	<b>6,674</b>
# of whole building incentives completed/processed for rental units	58	94	257	<b>409</b>
% of renter visits that convert to a full HEA with a landlord	1.2%	3%	3%	<b>2.4%</b>
% of full landlord HEAs that result in weatherization jobs	12%	14%	14%	<b>13.3%</b>
Avg # of Instant Savings Measures installed per rental visit	12.1	12.9	16.7	<b>13.9</b>
# of enhanced renter rebates processed	14	41	22	<b>77</b>
Refrigerator	14	23	8	<b>45</b>
Clothes Washer	0	18	14	<b>32</b>
# of rental units getting weatherization	215	296	384	<b>895</b>
Avg. non-whole building measure incentives to landlords (e.g., air sealing) per landlord HEA	0.1	0.1	0.1	<b>0.1</b>

These results have been presented to the EEAC every six months since the initiative launched. These data have been paired with qualitative reports from the field to assess and implement continuous improvements to the initiative. For example, after a year of renter initiative implementation, data indicated that 806 renter visits (by account) had been provided and 3,922 full Home Energy Assessments (by account) had been provided to renters with landlord participation. As a result, the PAs worked with the Mass Save call center staff to clarify that landlord participation is not required for a renter visit. There has not been an increase in the ratio of renter visits to full HEAs provided to landlords since that clarification was made this past spring—in fact it decreased from 17.4% in the second reporting period to 15.4% in the third. While landlord participation in the process should be considered a positive outcome, further assessment is warranted to provide a clearer picture of whether renters who wish to proceed without participation of the landlord are being fully served.

In addition, the PAs' declining ability to claim lighting savings is likely to have a similar impact on the renter initiative as expected for HES and for the residential programs at a whole. While the viability and design of the current renter initiative without claimable lighting savings will need to be reassessed, there remains a strong need to serve this large and distinct customer segment. According to the PAs' residential evaluation contractors' analysis of U.S. Census American Community Survey data for 2011-2015, there are an estimated 347,000 renters in 1-4 unit buildings with incomes of more than 60% of State Median Income.

#### **MODERATE INCOME INITIATIVE**

The moderate income initiative was also launched at the end of the first quarter of 2016. The initiative serves customers earning 61-80% of state median income (currently \$55,537-\$74,049 annual household income for a family of 3) whose homes have weatherization opportunities identified through a Home Energy Services Home Energy Assessment. The initiative is designed to leave customers in control of the process of increasing the energy efficiency of their homes while providing additional financial support to enable them to realize energy efficiency opportunities. It provides customers with the full range of offers available to all HES participants once the customer qualifies through an income verification process that is administered by LEAN under contract to the PAs. Table 8 shows the enhanced incentives for the moderate income initiative.

**Table 8. Moderate Income Enhanced Incentives**

Measure	Moderate Income Enhanced Incentives	Standard HES Incentives
<b>Efficient refrigerator</b>	\$200	\$150
<b>Efficient clothes washer</b>	\$400	\$350
<b>Insulation</b>	Original offer: 90% of measure cost up to \$3,000 Test offer from select PAs: 100% of measure cost (some PAs: no cap; other PAs: \$3,000 cap)	75% of measure cost up to \$2,000
<b>Duct insulation</b>	90% of measure cost up to \$1,000	75% of measure cost up to \$1,000

Table 9 provides results from the first 18 months of the moderate income initiative. Full results by individual PA will be provided by the PAs in the 2017 Third Quarter report.

**Table 9. Moderate Income Initiative Results April 2016-September 2017**

Key Performance Indicator	Apr-Sept 2016	Oct 2016 - Mar 2017	Apr-Sept 2017	18 month total
# approved moderate income applicants	76	171	144	<b>391</b>
% of approved moderate income applicants resulting in weatherization jobs	50%	60%	67%	<b>60%</b>
Avg. Instant Savings Measure installation per approved moderate income household	21.8	20.3	20.4	<b>20.9</b>
# of approved enhanced moderate income rebates processed (i.e., refrigerators and clothes washers)	0	3	3	<b>6</b>
Refrigerator	0	0	0	<b>0</b>
Clothes Washer	0	3	3	<b>6</b>
# of approved moderate income weatherization incentives	38	102	96	<b>236</b>

As with the renter initiative, these moderate income initiative results have been presented to the EEAC every six months since launch of the initiative and data have been paired with qualitative reports from the field to assess and implement continuous improvements to the initiative. In the first 18 months of the program 391 customers were approved to receive the moderate income enhanced incentives with an average of 60% of those completing weatherization work. Only six customers have taken advantage of enhanced appliance rebates over the 18 months.

Since the inception of this initiative, the PAs have made a number of improvements to boost participation. These include translating program fliers for both initiatives into seven other languages,<sup>11</sup> and asking the CAP agencies to insert fliers for the moderate income and renter initiatives into Fuel Assistance denial letters so that customers who are not eligible for Fuel Assistance and the Income Eligible/Low Income Program will be informed about opportunities for energy savings and these enhanced incentives. Other improvements include offering customers information about the moderate income offer in advance of receiving an HEA and reducing the amount of information required for income verification. Additionally, some PAs are testing a 100% insulation incentive (some without a cap and some with) to determine whether the increased incentive leads to increased participation. This 100% insulation incentive rate will be offered through the end of this year at which time it will be reassessed.

Unfortunately, PA efforts to increase participation have not been successful to date. The number of approved moderate income applicants—391 in the 18 months since program inception—continues to be small when

<sup>11</sup> Spanish, Traditional Chinese, Portuguese, Cape Verdean Creole, and Russian

compared to the estimated eligible population of 235,000 customers statewide.<sup>12</sup> The period-over-period statewide data for two of the key performance indicators—approved moderate income applications and approved moderate income weatherization incentives—decreased from the second to third six-month period. These results raise serious questions about the design of the moderate income initiative. The Moderate Income Market Characterization evaluation that will be completed in November will provide additional insights that will warrant careful consideration by the PAs and the EEAC. These insights should be paired with additional input from stakeholder groups as part of a reassessment process for both initiatives.

Initiative costs and savings information are not available specifically for the renter and moderate income initiatives since initiative costs are not tracked separately from the larger Home Energy Services Initiative. The Consultants requested semi-annual reporting of average per unit savings information when the Consultants and PAs worked together to identify key performance indicators for the new initiatives, but the PAs declined to provide any savings information that was not evaluated. An evaluation is planned that will compare depth of savings between offers.

#### **OPPORTUNITIES TO SERVE ADDITIONAL MARKET SEGMENTS**

U.S. Census data also provide quantitative information about other populations in Massachusetts that could be considered hard to reach. In 2015, there were 985,418 people age 65 and over. In that same year, 1.43 million residents—almost 23% of the total Massachusetts population—spoke a language other than English at home. Just over one-third of this group (more than 500,000 people) spoke Spanish at home, with the remainder speaking other languages. More than 750,000 Massachusetts residents reported having a disability in 2015. Some portion of these residents may qualify for low-income services. This should not be considered a comprehensive list of hard to reach populations that could benefit from a segmented approach from Mass Save, but rather an indicator of the range of opportunities to target distinct segments with strategies that could resonate with their individual circumstances and experiences.

#### **FINANCING**

This briefing document includes information on the status of financing for energy efficiency improvements in Massachusetts. Customers with incomes of 60% or below state median income can qualify for a full range of no-cost energy efficiency improvements through the Mass Save Low Income Program. Even with enhanced incentives through the moderate income initiative, however, ability to pay for recommended improvements is a recognized barrier for customers who may fall just over the 60% mark. At the same time, discussing financing for moderate income populations requires a cautionary approach. As a recent report from the State and Local Energy Efficiency Action Network (SEE Action) states, “many households simply cannot afford the capital expense of an improvement or any new regular payments to finance the capital cost.”<sup>13</sup> The report continues “even with that caution, there is good reason to believe that financing—the use of loans or products that enable investments in energy improvements, which are recouped from the household over a schedule—could help many low and moderate income households, whether living in single-family or multifamily housing, benefit from energy efficiency improvements.”

Qualifying homeowners in Massachusetts who choose to or need to finance recommended energy efficiency improvements for their homes have the option of obtaining a 0% interest HEAT Loan. Mass Save customers must receive a Home Energy Assessment in order to qualify for a HEAT Loan. Measures available for financing include heating equipment (furnaces, boilers, heat pumps, and controls), water heaters (various types including heat pump water heaters and solar), central air conditioners, heat pumps (ducted and ductless), insulation and air sealing, and qualified replacement windows. Loans are available up to \$25,000 with terms up to 7 years depending on the loan provider. In order to receive a HEAT Loan, an interested customer must complete several steps, generally including finding contractor(s) to complete the work, obtaining a signed proposal, finding a lender

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<sup>12</sup> Preliminary results for the in-process Moderate Income Market Characterization evaluation study used Census data to determine that there are more than 317,000 Massachusetts residents in this moderate income range. According to customer surveys for this same evaluation, 83% of people in this income range own their homes. Subtracting out approximately 10% of the population who are customers or municipal utilities, this means there are approximately 235,000 potential customers who could qualify for the moderate income initiative. Moderate Income Characterization Study (Res 40) Preliminary Findings (October 11, 2017)

<sup>13</sup> [Energy Efficiency Financing for Low- and Moderate-Income Households: Current State of the Market, Issues, and Opportunities](#) (SEE Action, Aug. 2017), p. 17.

and submitting the HEAT loan application, paying for the balance, arranging the work, and receiving the verification visit as required by lenders. These steps and the time required to complete them mean the HEAT Loan is generally not a viable option for replace on failure situations for central heating and air conditioning equipment as well as water heating equipment. Alternative financing products such as on-bill financing merit further assessment for these situations.

The 0% interest rate is made possible by an interest rate buydown from the PAs. HEAT Loans are an initiative within the Hard to Measure Program in the residential sector and therefore no savings are counted. In 2013-2015, HEAT Loan expenditures within the electric sector were more than \$49 million, representing 8.3% of total residential electric sector spending. In 2015, \$17 million in PA expenditures for the HEAT Loan supported 10,000 loans totaling almost \$100 million. Central heating equipment is the most popular HEAT Loan measure category.

DOER has also provided funding for an expanded HEAT Loan and grant program. A pre-weatherization barriers grant of up to \$3,000 is now available to only moderate income customers, and covers the most common barriers of knob and tube wiring decommissioning and asbestos abatement (including vermiculite removal) when recommended weatherization improvements are made. The expanded HEAT Loan from DOER also provides loans of up to \$50,000 for 2-4 unit buildings, and wood pellet furnaces and boilers. Data compiled by DOER this spring indicated that uptake for the pre-weatherization barriers grant, which until this summer was not means-tested, varied by geography with no grants made in several zip codes across the Commonwealth and notably within the City of Boston.

During the 2016-2018 plan development process there was interest from councilors in providing a loan loss reserve to customers who couldn't qualify for the HEAT Loan. At that time, the PAs reported that 87% of applications for the HEAT Loan were approved, and the loan loss reserve was not included in the plan. With 10,000 loans in 2015, a non-approval rate of 13% means approximately 1,300 customers ready to proceed with energy efficiency improvements were denied financing. We don't know the reasons for denial or whether they moved forward regardless. An in-progress EM&V study due in the spring should provide more information on this. We do know now that Renew Boston staff has received reports from constituents that they were denied HEAT Loans due to their debt-to-income ratio or low credit score. The City of Boston is eager to address this barrier.

### **Comparison Area Information**

Massachusetts is not alone in finding certain customer segments more challenging to reach than others. In many ways Massachusetts is a leader in this area with its successful Low Income Program and dedicated efforts to serve renters and moderate income customers. Even from a leadership position, there are examples from other program administrators and stakeholders that merit examination by the Massachusetts PAs.

Wisconsin's Focus on Energy (a statewide energy efficiency utility) provides offers targeting both renters and moderate income customers. Renters are encouraged to order a pack/box of free energy savings products that will be delivered to their home.<sup>14</sup> There are six different energy savings packs to choose from, all including free lighting with options for including water saving measures, pipe insulation, and power strips in the pack. Customers pick the pack they want and place their order online, with delivery in 4-6 weeks. Videos posted on the website instruct customers on proper installation of the products they ordered. Focus on Energy also offers an Enhanced Rewards Program for customers earning 80% or less of State Median Income. The income eligibility application is available online and can be returned by mail, e-mail, or fax. For measures eligible for the enhanced rewards, Focus on Energy lists both standard and "Tier 2" Cash-Back Rewards. In addition to insulation and air sealing, Tier 2 incentives are available for heating and cooling equipment, and can be as much as \$500 higher than the standard incentive offer.<sup>15</sup>

With regard to financing, the Energy Efficiency Financing for Low- and Moderate-Income Households report published by SEE Action this summer includes a close examination of barriers, opportunities, and considerations for financing energy efficiency program improvements for these populations. For single family households, the

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<sup>14</sup> <https://focusonenergy.com/residential/simple-energy-efficiency>. This offer is also available to homeowners.

<sup>15</sup> <https://focusonenergy.com/residential/efficient-products-appliances/residential-rewards>

report provides information and examples of unsecured loans (of which the HEAT Loan is an example), on-bill financing and repayment, Residential PACE (secured financing), and energy service agreements, which are savings-backed arrangements in which service providers take on the risk of energy savings not materializing.<sup>16</sup>

### Relevant Evaluation Findings and Activities

In 2015 the first Residential Customer Profile Study for the Massachusetts residential energy efficiency programs was completed for calendar year 2013 participation. By joining records from electric and gas programs at the premises level, and then aggregating data to the Census block group level, this study provided the first statewide view of the residential (and low-income) program impacts across all PAs, including geographic analysis. The data assembled for this study are provided through the Mass Save Data website and allow site visitors to view usage, savings, and incentive information at the municipal level.

The customer profile study broke participants into five quintiles of energy efficiency program participation and provided demographic information for each of the quintiles. This quintile analysis generally indicated that the quintile with the highest level of energy efficiency program participation also had the highest median income of the 5 quintiles; was least likely to be a renter, live in a multi-family dwelling, or live in a household that didn't speak English as a first language; and was most likely to live in a home built after 1970.<sup>17</sup> There is general agreement that one year of data does not support definitive conclusions about participation by demographic criteria. The next residential customer profile study includes participation data for 2013-2015 and is scheduled for completion this fall. It should provide a further basis for assessing demographic and geographic equity in serving Massachusetts ratepayers.

Table 10 summarizes the in-progress EM&V studies that should provide additional information relevant to increasing savings and participation by hard to reach populations:

**Table 10. Summary of Evaluation Studies Related to Hard to Reach Populations**

Study	Summary Description	Scheduled Completion
<b>HES Process Evaluation</b>	Comprehensive process evaluation of Home Energy Services Initiative including assessment of performance of new offers for moderate income and renter-occupied households	January 2018
<b>Moderate Income Market Characterization</b>	Assess potential for expanding the moderate income offering to households from 81%-100% and 101%-120% of the state median income and opportunities to increase appeal to and participation by moderate income customers	October 2017
<b>HEAT Loan Analysis</b>	Assess HEAT Loan non-participation and reasons therefor, including opportunities to adjust delivery	April 2018

### Consultant Findings

Massachusetts has made some progress in increasing services for hard to serve populations, and the EEAC Consultants have identified the following barriers and opportunities for further progress moving into 2019-2021:

<sup>16</sup> SEE Action, pp. 26-48.

<sup>17</sup> [Residential Customer Profile Study – Final Report](#) (Cadmus, October 2, 2015), p.27.

**Table 11. Barriers and Opportunities to Increase Services to Hard to Reach Populations**

Barriers	Opportunities
<p><b>Program awareness and actual or perceived participation requirements:</b> Although conceived to serve renters, landlord participation in the renter initiative is exceeding renter initiated visits; moderate income participation to date has been low; the 2013 Residential Customer Profile Study preliminarily signals varying participation levels by several demographic groups</p>	<ul style="list-style-type: none"> <li>• Reassess renter and moderate income initiatives                             <ul style="list-style-type: none"> <li>○ Increase appeal to and uptake by target populations</li> <li>○ Consider changes prompted by decline in claimable lighting savings</li> <li>○ Continue to boost promotion specifically to renters</li> <li>○ Fully assess and address income verification process as a potential barrier in the moderate income initiative</li> <li>○ Assess findings and implement recommendations from forthcoming evaluations</li> </ul> </li> <li>• Additional market segmentation                             <ul style="list-style-type: none"> <li>○ E.g., non-English speakers, elderly customers, specific building types, other?</li> </ul> </li> <li>• Expand and target outreach to all hard to reach populations                             <ul style="list-style-type: none"> <li>○ Bolster partnerships with community based organizations, municipalities, and other organizations</li> </ul> </li> </ul>
<p><b>Access to financing:</b> The HEAT Loan is very successful for many—but not all—customers, leaving some of them without an option to finance identified energy efficiency improvement opportunities</p>	<ul style="list-style-type: none"> <li>• Simplify the application process and automate where possible</li> <li>• Examine loan activity by geography/demography                             <ul style="list-style-type: none"> <li>○ Are Home Energy Specialists and HPCs effectively promoting to all customers?</li> <li>○ Are banks offering HEAT Loans in all areas?</li> </ul> </li> <li>• Allow HEAT loan for measure packages (e.g. bundling of measures that may include combining non-cost-effective with more cost-effective measures to capture deeper savings overall)</li> <li>• Develop additional financing strategies                             <ul style="list-style-type: none"> <li>○ Conduct needs assessment</li> <li>○ Determine method to serve approx. 13% of customers whose HEAT Loans are not approved: loan loss reserves, revised lending criteria by banks, other?</li> <li>○ Address situations like replacement on failure, multi-stage projects, measure packages, etc.</li> </ul> </li> <li>• Consider making HEAT Loan a sliding-scale interest product</li> </ul>

### Summary of Consultant Recommendations

The PAs have made progress in serving renters and moderate income customers during 2016-2017, and the Consultants recommend the PAs build on this progress by:

- Increasing participation and savings for hard to reach populations by:
  - Implementing stakeholder engagement process to reassess program design and improve participation in renter and moderate income customer initiatives
  - Identifying underserved demographic groups and developing new segmented approaches to serve them, and

- Increasing outreach and partnerships with community based organizations, municipalities, and other organizations
- Implementing methods to increase access to and use of financing across all customer segments

## LIGHTING AND CONSUMER PRODUCTS

## Overview

This brief addresses savings opportunities in the residential lighting and electric consumer products areas consisting principally of retail lighting, appliances, and consumer electronics. These technologies and measures are currently promoted through two of the three electric Residential Products Program Initiatives: Retail Lighting and Consumer Products. While this brief covers both of these Initiatives, components of the brief address retail lighting and appliances/consumer electronics separately. Note that lighting measures installed through Whole House Initiatives are not addressed below.

Retail lighting is the current mainstay of Residential Sector electricity savings. However, over the 2019-2021 Plan timeframe savings opportunities for retail lighting are expected to decline, most likely quite dramatically. This decline will be driven by a number of factors. The most prominent are the rapid commercialization of light emitting diode (LED) lamps and the impending 2020 Energy Independence and Security Act (EISA) 2020 lamp standards. These factors will likely justify the PAs significantly reducing, and potentially withdrawing, support for most LED lamps types in most markets by the end of the 2016-2018 Plan. This will result in a corresponding reduction in claimable savings and the need for the PAs to undertake an orderly transition from the retail lighting market. However, the exact trajectory of this “disengagement” from the lighting market – both its end point and its slope - is not known with certainty. This uncertainty creates potential challenges in forecasting both sector and portfolio level savings goals for the 2019-2021 Plan.

Claimable savings for traditional appliances—refrigerators, freezers, dishwashers, and clothes washers—have diminished significantly over the past two decades due to technology innovation, often driven, at least in part, by multiple rounds of federal efficiency standards. As a result, the small remaining savings from most traditional appliances, and the often high market penetration of ENERGY STAR® models, resulted in the PAs withdrawing support for most of these measures. During the 2019-2021 Plan, savings are still likely to remain for appliance recycling measures and for non-appliance measures such as pool pumps and advanced power strips. Additional savings opportunities may also be available through moving incentives upstream to retailers or manufacturers through such platforms as ENERGY STAR’s Retail Product Platform.

In addition to energy savings, there may also be opportunities to pursue active demand management in tandem with the promotion of efficient lighting and appliances. Finally, any engagement with customers at retail affords the PAs the opportunity to promote other PA efficiency activities.

## Status in Massachusetts

Massachusetts PAs have been supporting efficient lighting at retail for over two decades, with incentives and marketing initially directed to compact fluorescent lamps (CFLs). In 2017, PA support of retail lighting had fully migrated to LEDs. CFLs are no longer supported by the initiative and their market presence has declined as manufacturers like GE have ceased CFL production and retailers such as Walmart have stopped stocking CFLs. All PA supported lighting products are ENERGY STAR qualified.

Most program-supported retail lighting products move through home improvement, big box, and discount club market channels. In addition to these channels, the PAs also target retailers and locations that serve hard to reach markets, primarily consisting of lower income and non-English speaking populations. Incentives for lighting products at brick and mortar retailers are all upstream. In addition to an ongoing presence in over 1,000 retailers across the state, the PAs also promote efficient lighting through short-term promotions at job sites and at pop-up events, school fundraisers, and online. The PAs have also recently distributed free LEDs at food banks, which were accompanied by program marketing collateral in order to bring more people into the programs.

Monthly Initiative reporting through the end of September has 9.3 million lighting units invoiced. This compares to the PAs’ 2016-2018 Plan goal for 2017 of 9.7 million lighting units. The PAs are on track to move approximately 12 million LEDs through the Initiative by year’s end.

In 2016, retail lighting represented 56% of total sector annual savings and 60% of sector lifetime savings, the highest of any residential initiative. In turn, retail lighting savings represented 24% and 17%, respectively, of total portfolio 2016 annual and lifetime savings (Table 12). These savings were achieved through the sale of over 9.0 million efficient lamps and fixtures involving incentives of \$34.4 million in 2016. Of the 9.0 million efficient lighting

products moved through the program, nearly 690,000 were tracked to Hard To Reach customers, with additional products that were not tracked separately also reaching those customers.

**Table 12. 2016 Massachusetts Residential Retail Lighting Summary Statistics**

Initiative Metric	2016 Evaluated Value
% of Residential Sector Annual MWh Savings	56%
% of Residential Sector Lifetime MWh Savings	60%
% Of Residential Sector Benefits	34%
Lifetime Cost to Achieve (\$/kWh)	\$0.02

As shown in Table 13, the savings from PA support of efficient appliances and consumer electronics are considerably smaller than that from lighting, representing 2% and 3% of sector annual and lifetime savings, respectively. Of these lifetime savings, 32% comes from refrigerator recycling of refrigerators, freezers and dehumidifiers, 24% comes from dehumidifiers 15% from advanced power strips, and 14% from pool pumps. 2016 Consumer Products incentive payments were \$2.6 million.

**Table 13. 2016 Massachusetts Residential Consumer Products Summary Statistics**

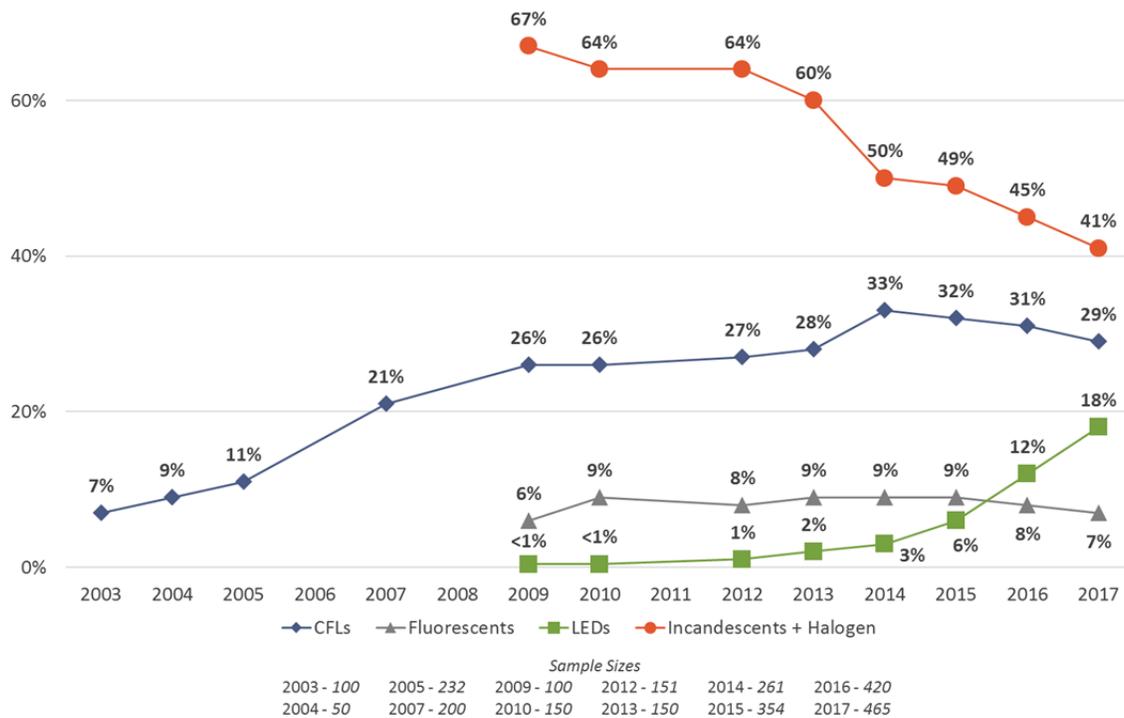
Initiative Metric	2016 Evaluated Value
% of Residential Sector Annual MWh Savings	2%
% of Residential Sector Lifetime MWh Savings	3%
% of Residential Sector Benefits	2%
Lifetime Cost to Achieve (\$/kWh)	\$0.06

Note that the Lighting and Consumer Products Initiatives are supported by the same field support and marketing contractors. The reduction in prioritization and support of the retail lighting market provides an important opportunity to reassess and restructure relationships with retail partners.

### Market Characterization

One indication of the transformation of the residential lighting market is the saturation of efficient lamp types in homes. Figure 3 presents Massachusetts efficient lamps saturations going back to 2003. By early 2017, efficient lighting was in the majority (54%) of sockets in Massachusetts households.

**Figure 3. Massachusetts Residential Efficient Lamp Saturation**



Source: 2016-17 Massachusetts Residential Lighting Market Assessment

Efficient lamp saturation data indicates:

- Total efficient lamp saturation (LEDs, CFLs and other fluorescent lamps) increased from 45% in 2014 to 54% in 2017.
- LED saturation increased from 3% in 2014 to 18% in 2017.
- CFL saturation declined from 33% in 2014 to 29% in 2017.
- Combined incandescent and halogen lamp saturation declined from 50% in 2014 to 41% in 2017.

For appliances and consumer electronics, the 2016 ENERGY STAR market penetration data provide important information as to the status of efficient product penetration, at least on the national level, for many key product categories. These data reflect the percentage of reported 2016 national shipments that are ENERGY STAR qualified products. As shown in Table 14, the market penetration of ENERGY STAR qualified products for several key appliance and consumer electronics categories is already quite high, potentially limiting savings opportunities through current program delivery models.

**Table 14. 2016 National ENERGY STAR Market Penetration Rates**

Product	2016 ENERGY STAR Market Penetration
Refrigerators	48%
Freezers	35%
Dehumidifiers	63%
Dishwashers	87%
Room air conditioners	38%
Room air cleaners	33%
Clothes washers	41%
Clothes dryers	32%
Soundbars <sup>18</sup>	40%

### Comparison Area Information

A key consideration for 2019-2021 planning efforts is to increasingly move PA appliance and consumer electronics engagement upstream. Such an approach is potentially both more cost-effective and cost-efficient in addressing the small per unit net savings from many appliance and consumer electronics measures. The best example of such an upstream effort is the ENERGY STAR Retail Products Platform (RPP).

RPP, first deployed in 2016, is a national collaboration of PAs and retailers that provides incentives to stock and sell a specified set of efficient appliances and consumer electronics. Current retailer participants are:

- Best Buy
- Sears
- The Home Depot
- Nationwide Marketing Group, a purchasing consortium for independent retailers

Covered products are:

- Clothes dryers
- Freezers
- Refrigerators
- Clothes washers
- Room air conditioners
- Air purifiers
- Sound bars

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<sup>18</sup> A soundbar is a type of speaker system that is mounted above or below a display device such as a television or computer monitor.

By the end of 2017, approximately one-third of the U.S. market will be participating in RPP. Regional participants include Efficiency Vermont, ConEdison, and the New Jersey Clean Energy Program. National Grid has included consideration of RPP in their recently filed Rhode Island 2018-2020 Three-year Plan. The ENERGY STAR Retail Products Platform is also under consideration in Connecticut. Assessment of the RPP for Massachusetts, or other mid or upstream Initiative approaches, will need to consider the extent to which higher free-ridership rates may erode greater savings achieved through increased participation.

## Relevant Evaluation Findings and Activities

Massachusetts has one of the, if not the, most active residential lighting evaluation and market research effort underway in the country. Evaluation activities characterize both current program activities and inform forward-looking program planning. Provided below in Table 15 is a subset of recently completed or soon to be completed evaluation and market research activities that are likely to be relevant to 2019-2021 planning for both lighting and consumer products.

**Table 15. Relevant Lighting and Consumer Products EM&V Activities**

Study	Summary Description	Scheduled Completion
<b>Lighting Market Assessment Consumer Survey and On-site Saturation Study</b>	Onsite surveys that informed updated socket saturation estimates, lamp purchasing patterns, storage patterns, and in-service rate estimates.	March 2017
<b>2019 to 2021 Planning and 2017 Annual Report Market Adoption Models</b>	Consensus panel activity that integrates data from multiple sources to estimate LED market shares with and without program intervention. These market share estimates inform per lamp energy savings and measure life estimates	January 2018
<b>LED NTG Consensus Estimation Process</b>	The study will use a consensus-building process to develop prospective NTGRs for 2019 to 2021 for standard and reflector LEDs.	March 2018
<b>What's Next for Products</b>	To aid in the development and design of a lighting and products program given significant market changes and increasing federal standards. This includes the identification of products for possible inclusion in the residential program portfolio in the 2019 to 2021 cycle that will achieve cost-effective savings	November 2017
<b>Smart Power Strip Literature Review [Fast Track Study] and Customer Survey</b>	The focus of this study will be on developing estimates for key impact evaluation inputs for smart strips including: in-service rates, persistence, and NTG ratios.	January 2018

## Consultant Findings

The Massachusetts PAs have made substantial progress in promoting efficient consumer products to their customers. The rapid transformation of the residential lighting market will limit future claimable savings from LEDs in the next Plan.

Consultants have identified the following barriers and opportunities in Table 16 for further progress moving into 2019-2021:

**Table 16. Opportunities for Energy Savings from Lighting and Consumer Products**

Barriers	Opportunities
<p><b>Rapid transformation of the retail lighting market will limit savings in many markets and for many technologies.</b></p>	<ul style="list-style-type: none"> <li>Continue to closely monitor the market to ensure that support is maintained for those technologies and markets still requiring PA intervention. For those transformed markets and technologies, work with retailer and manufacturer partners to ensure an orderly exit from the retail lighting market.</li> </ul>
<p><b>Declining per unit net savings for many appliances and consumer electronic measures limits PA support.</b> Federal standards and moderate to high penetrations of ENERGY STAR qualified products have continued to shrink this savings opportunity and challenge cost effectiveness.</p>	<ul style="list-style-type: none"> <li>Examine upstream engagement strategies to determine if it would be possible to deliver greater savings more cost efficiently. The national ENERGY STAR Retail Products Platform provides such a strategy. The PAs should also explore whether participating retailers would be willing to engage customers to promote other PA efficiency efforts.</li> </ul>
<p><b>Possible higher program costs for Consumer Products as the Lighting Initiative’s retailer and manufacturer engagement declines.</b></p>	<ul style="list-style-type: none"> <li>Upstream efforts, particularly RPP, may help reduce some of these costs.</li> </ul>
<p><b>PA Consumer Products activities have historically focused on energy savings with limited consideration of active demand management savings.</b></p>	<ul style="list-style-type: none"> <li>Connected lighting and appliances may provide active demand management savings.</li> </ul>

### Summary of Consultant Recommendations

The PAs’ 20+-year engagement in the consumer products market has yielded significant savings. It has also contributed to the long-term transformation of these markets, particularly those for retail lighting. These successes will create both challenges and opportunities in the next Plan.

Moving into the 2019-2021 Plan period, the Council would like to see the PAs focus their efforts to:

- Clearly articulate an exit strategy for residential lighting, while pursuing remaining savings opportunities for lighting technologies and markets that merit continued program intervention
- Identify and support new and enhanced measures and further leverage retail relationships to bring more customers into the Mass Save program platform

## BEHAVIOR PROGRAMS

## Overview

This brief addresses residential behavior programs in Massachusetts. PAs in Massachusetts have been claiming both electric and gas savings from behavioral approaches since 2009, starting with National Grid, NSTAR (now Eversource), and Cape Light Compact. These behavioral approaches represent a departure from traditional energy efficiency programs providing financial incentives for customers to choose and purchase energy efficient equipment or measures. Rather, behavior programs provide customers with information and other incentives to prompt them to take actions (e.g., turning down thermostat in heating months or up in cooling months) that save energy.

A 2013 study published by McKinsey and Company estimated available savings of 1.8 to 2.2 quadrillion British thermal units a year for U.S. households from behavioral energy efficiency programs, equivalent to 16-20% of U.S. residential energy demand.<sup>19</sup> Behavioral savings have made significant contributions at the statewide level to annual gas and electric savings in Massachusetts. With a measure life of only one year, however, the impact on lifetime savings has been more limited. This brief provides Councilors with additional information on PA behavioral programs in Massachusetts, identifies barriers and additional opportunities, and supplies additional information and context to help assess the Consultants' recommended strategies for the 2019-2021 Plan.

## Status in Massachusetts

The Massachusetts PAs have used a variety of behavioral approaches and vendors in the eight years since behavior programs were originally launched in the Commonwealth and now serve more than 1.4 million participants annually. Given that behavioral programs were relatively new when Massachusetts first began offering them, the PAs deployed and assessed different models. An overview of these is provided in Table 17.

**Table 17. Massachusetts Behavior Programs Overview**

PA	Behavior Program Name (Vendor)	Description	Status/Notes
<b>National Grid</b>	Home Energy Reports (Opower) 2009-present	Home Energy Reports are periodically provided by mail or e-mail and personal energy usage comparisons and "Ways to Save" tips	Ongoing [note savings and persistence]
<b>Eversource/NSTAR</b>	Home Energy Reports (Opower) 2009-present	See above	Ongoing
<b>Eversource/WMECo</b>	WMECo: Western Mass Saves (C3) 2012-2013 Eversource: Home Energy Reports (Opower)	Western Mass Saves included an online web platform available to all WMECo customers Energy Savings Reports distributed by mail to randomly assigned treatment customers.	Eversource transitioned to the Home Energy Reports model when it acquired WMECo
<b>Cape Light Compact</b>	1. Smart Energy Home Energy Monitoring Pilot (SHEMP) (Grounded Power) 2009-2012 2. SHEMP Energize (Tendril) 3. Creating Awareness for Power (CAPE) Initiative (People Power)	1. SHEMP provided near real-time feedback with a social networking component to encourage energy use reductions 2. SHEMP Energize provided near real-time feedback via an in-home display and Tendril's "Energize" platform, but did not	In early 2017 Cape Light Compact suspended enrollment in CAPE due to high costs and evaluations that found less-than-anticipated savings. Existing participants will be served for the remainder of the 2016-2018 Three-Year

<sup>19</sup> Sizing the Potential of Behavioral Energy-efficiency Initiatives in the US Residential Market (McKinsey & Company 2013), pp. 1-2.

	2014-2017	have a social networking component 3. CAPE offered a mobile app to customers providing near real-time feedback with a social networking component	Plan term. Behavior budget was reallocation to demand response efforts.
<b>Berkshire Gas</b>	Home Energy Reports (Opower) 2014-present	See above	Berkshire Gas launched its program in 2014 after pursuing a procurement through its parent company and has been claiming savings since 2015. The first process and impact evaluation showed opportunities for improvements. The 2016 evaluated BCR for Berkshire's Behavior/Feedback Initiative was 0.44.
<b>Columbia Gas</b>	No program offered	N/A	
<b>Liberty Utilities</b>	No program offered	N/A	
<b>Unitil</b>	No program offered	N/A	Unitil has a combined behavior program for its Massachusetts and New Hampshire service territories out for bid.

Presently, the Home Energy Reports behavioral program model is the only one being provided in Massachusetts to customers of Eversource, National Grid, and Berkshire Gas in treatment groups.<sup>20</sup> Figure 4 shows an example of the personal usage comparison in an Eversource electric customer's Home Energy Report, which is provided to customers in hard copy or by email. In customer surveys for a 2015 process evaluation of the Eversource and National Grid behavior programs, 55-58% of customers (across fuel groups) classified the reports overall as useful. In addition, the process evaluation found treatment customers took a significantly higher number of energy saving actions in 2014 across both behavior change and energy efficient equipment purchase/measure installation categories compared to the control groups.<sup>21</sup>

<sup>20</sup> For purposes of evaluation, customers are divided between treatment and control groups.

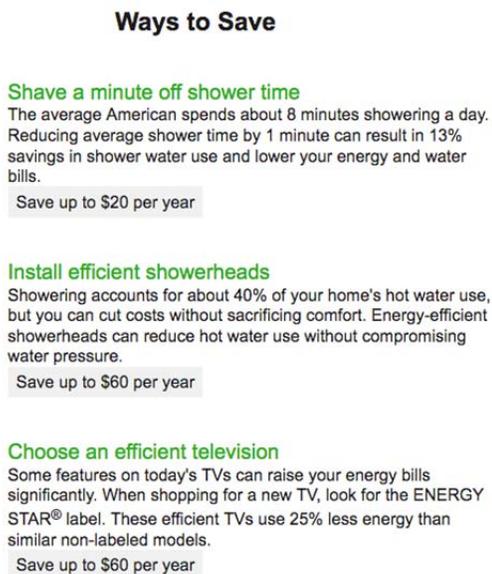
<sup>21</sup> [Massachusetts Behavioral Programs Process Evaluation](#) (2015), pp. 3-4.

**Figure 4. Home Energy Report Personal Usage Comparison**



The Home Energy Report also includes a section indicating “Ways to Save,” examples of which are shown in the same Eversource customer’s Home Energy Report depicted in Figure 5.

**Figure 5. Home Energy Report Ways to Save**



The Ways to Save suggestions are not specifically linked to actual equipment in a customer’s home. Increasingly, there is interest in exploring additions to the core behavioral program model in use in Massachusetts, including the nature of the information provided to customers (e.g., personalization and real-time data) and the means by which it is provided (e.g., web portals, smart phone apps).

As indicated in Table 17, Columbia Gas, Cape Light Compact, Liberty Utilities, and Unitil are not currently offering behavior programs. Cape Light Compact has piloted several program models other than the Home Energy

Reports model, but has not yet found a long-term cost effective solution for its customers and has suspended its behavior program efforts. Unitil is in the process of conducting a procurement for behavior program services jointly with its New Hampshire affiliate. Within the past several years, Columbia Gas and Liberty have participated in discussions with Berkshire and Unitil about the possibility of a joint procurement. The group was unable to identify a collective and cost effective solution to meet its needs, and Unitil and Berkshire pursued other opportunities with their parent or sister companies. This business model merits further consideration by Columbia and Liberty, as does a statewide procurement by all PAs.

## Statistics and Other Relevant Information

As shown in Table 18, the Residential Behavior/Feedback Initiative is a significant source of annual electric and gas savings statewide. However, the initiative accounts for only 3% of the Residential Sector's lifetime savings due in large part to application of a one year measure life for behavior.

**Table 18. 2016 Behavior Savings and Benefits**

Initiative	Annual Savings	% of Sector	Lifetime Savings	% of Sector	Total Benefits*	% of Sector
<b>Electric Behavior</b>	140,547 MWh	21%	140,811 MWh	3%	\$22,642,177	10%
<b>Gas Behavior</b>	5,696,333 therms	39%	5,696,333 therms	3%	\$7,457,109	6%

In 2016, the electric and gas Behavior/Feedback Initiatives had the lowest annual cost to deliver in the electric and gas Residential Sectors.

**Table 19. 2016 Behavior Expenditures and Cost to Deliver**

Initiative	Total Expenditures	% of Sector	Annual Cost to Deliver (Initiative)	Annual Cost to Deliver (Sector)	Lifetime Cost to Deliver (Initiative)	Lifetime Cost to Deliver (Sector)
<b>Electric Behavior</b>	\$9,440,312	4%	\$0.07	\$0.32	\$0.07	\$0.05
<b>Gas Behavior</b>	\$3,320,941	3%	\$0.58	\$8.07	\$0.58	\$0.67

## Comparison Area Information

Program administrators in the United States and Canada use a number of different behavioral approaches for consideration by the Massachusetts PAs. For example, Alliant Energy's Alliant Energy Advisor uses a behavioral marketing platform that includes email marketing, persona-based content libraries, and marketing automation to deliver ongoing messaging about utility products and services, a personalized energy plan customized for each person, and tools to drive customer participation in energy efficiency programs and alter everyday behavioral actions to reduce energy use. Alliant launched its pilot to 125,000 customers in 2014 and achieved evaluated aggregate savings of roughly 525,000 kWh and 32,000 therms. In addition, participation in the Focus on Energy efficiency program doubled the rate of the control group with high customer satisfaction.<sup>22</sup> Alliant has since extended the program to its entire service territory.

BC Hydro in British Columbia, Canada, invites customers to join Team Power Smart, with a \$50 reward if customers successfully reduce their electricity usage by 10% in one year. Team Power Smart participants use an online portal allowing them to monitor energy use and compare with similar households and receive exclusive access to monthly contests, member-only offers, energy-saving tips, advice and tools and member communications, including a monthly newsletter and bi-annual member magazine. Through the program nearly 62,000 participants saved an average of 109 kWh per participant in 2011 and nearly 79,000 participants saving

<sup>22</sup> <http://www.businesswire.com/news/home/20160225006057/en/Alliant-Energy-Advisor-wins-2016-MEEA-Inspiring>

an average of 55 kWh per participant in 2012.<sup>23</sup> BC Hydro continues to offer this program.

If advanced metering infrastructure (AMI) is eventually approved in Massachusetts, AMI/smart meter data can support personalized and targeted behavior approaches and recommendations. Baltimore Gas and Electric Company’s Smart Energy Manager online portal allows customers to track energy usage on a next-day basis, comparing usage trends and discovering the results of energy-saving practices almost immediately. Smart Energy Manager provides customers with a comparison of monthly bills and the opportunity to explore why bills may fluctuate from month to month. Customers can conduct a straight comparison, but also see how other factors affect the bill, such as billing period duration, temperature data, and rate changes.<sup>24</sup> BG&E also has an active demand response program, Smart Energy Rewards. As an alternative to the online portal, DTE Energy uses a smart phone app to provide customers with real-time energy monitoring and other information and functionality to allow them to take actions to increase efficiency. An evaluation by Navigant of the DTE Energy Insight app determined that it generates approximately 1% electric savings.<sup>25</sup>

Some states have also begun to consider the behavior savings that persist after the initial year of program treatment. For example, Illinois has decided to use specific deemed values for persistence for their residential behavior programs. The effects of persistent savings have implications for costs to achieve and cost-effectiveness. Some have suggested that by cycling customers on and off of program intervention, the costs to achieve are reduced in off years while some savings persist across all years. Rotating the populations treated could also help to reduce costs while still claiming some savings if persistence values can be applied.<sup>26</sup>

## Savings Potential

Several PAs are not offering behavior programs at this time. In addition, a 2016 EM&V study found potential for Eversource and National Grid to move customers from control groups (from which savings are not claimed) to control groups (from which savings are claimed).<sup>27</sup> National Grid has done so, Eversource to date has not. Across all PAs claiming behavior savings in 2016, the average savings per participant was 124 kWh annual/participant and 11.3 therms (annual and lifetime). In an effort to quantify additional behavior savings for 2019-2021, the Consultants multiplied these savings per participant figures by the number of residential customers the Consultants estimate would be placed in treatment groups. For Eversource, that number includes all recommended customers noted in the 2016 EM&V study. For Columbia Gas, Unitil, and Liberty, we assumed 75% of residential heating customers would be placed in treatment groups. Given the seasonal nature of much of Cape Light Compact’s residential population we used a figure of 50%. The savings potential presented in Table 20 should be considered a rough estimate. Behavior program design and evaluation is very complex and actual savings per participant and numbers of treatment customers will vary depending on a number of factors.

**Table 20. Behavior Savings Potential**

PA	Est. Residential Treatment Customers	Potential Savings (annual and lifetime)
<b>Eversource</b>	39,000 electric 10,000 gas	4,800 MWh 113,000 therms
<b>Columbia Gas</b>	173,000	1,955,000 therms
<b>Cape Light Compact</b>	87,500	10,850 MWh
<b>Unitil</b>	18,750 electric	2,300 MWh

<sup>23</sup> [Comprehensive Review of Behavior and Education Programs Cross-Cutting Research in the Areas of Behavior and Education](#) (2015), p. 2-12.

<sup>24</sup> <https://www.bge.com/SiteCollectionDocuments/BGE%20Smart%20Energy%20Manager.pdf>

<sup>25</sup> [http://beccconference.org/wp-content/uploads/2015/10/presentation\\_olig.pdf](http://beccconference.org/wp-content/uploads/2015/10/presentation_olig.pdf)

<sup>26</sup> [https://www.iepec.org/2017-proceedings/polopoly\\_fs/1.3718069.1502900919!/filesserver/file/796587/filename/086.pdf](https://www.iepec.org/2017-proceedings/polopoly_fs/1.3718069.1502900919!/filesserver/file/796587/filename/086.pdf)

<sup>27</sup> <http://ma-eeac.org/wordpress/wp-content/uploads/Reducing-the-Size-of-the-Control-Group-in-the-Home-Energy-Report-Program-Memorandum.pdf>

	10,500 gas	119,000 therms
<b>Liberty</b>	25,000	282,500 therms
<b>TOTAL</b>		<b>17,950 MWh</b> <b>2.5 million therms</b>

## Relevant Evaluation Findings and Activities

Impact evaluations in Massachusetts and other states have shown per-home savings averaging roughly 2% for electricity and 1% for natural gas. Savings tend to ramp up over the first few years of participation, and then stabilize. Similarly, EM&V studies have shown that when messaging is stopped, savings typically decay over a period of 2-3 years before disappearing entirely. However, complications stemming from overlaps in savings between successive years of messaging have led program administrators in Massachusetts and many other states to claim only a one-year measure life. Several recent EM&V studies have explored the effects of reducing the frequency and/or cycling messaging on and off, concluding that there may be some potential to use such strategies to improve program cost-effectiveness.

In addition to regular impact evaluations, there are several behavior program evaluation studies that have been completed within the past two years or will be completed during before the end of the 2016-2018 Plan period. A summary of these studies is presented in Table 21.

**Table 21. Summary of Behavior Program Evaluations**

Study	Summary Description	Completion
<b>Comprehensive Review of Behavior and Education Programs</b>	Provided a comprehensive review of behavior and education programs for consideration in future planning, with a focus on recent changes in the landscape of behavior and education programs	2015
<b>Reducing the Size of the Control Group in the Home Energy Report Program memorandum</b>	Found Eversource has opportunity to add 49,000 customers to treatment (from control) in its existing program and National Grid has opportunity to add 100,000 customers to treatment (from control)	2016
<b>Assessment of Combined Behavior and Wi-Fi Thermostat Program</b>	Study seeks to determine whether Wi-Fi thermostat savings are different among customers who receive Home Energy Reports and assess the savings potential associated with combining behavior-change approaches and Wi-Fi thermostats through field trial	Scheduled for November 2017
<b>Understanding the Role of Weather on Air Conditioning Use Behavior and Demand Response Program Participation</b>	Develop an understanding how weather affects customer air conditioning to enable PAs to improve program design and customer messaging of both energy efficiency and demand respond programs	Scheduled for June 2018

## Consultant Findings

The EEAC Consultants have identified the following barriers and opportunities to advancing behavior programs moving into 2019-2021:

**Table 22. Barriers and Opportunities to Enhance Behavioral Programs**

Barriers	Opportunities
<p><b>Smaller PAs find behavior programs cost prohibitive</b> due in part to large fixed costs of initial setup</p>	<p>Several different approaches warrant further examination:</p> <ul style="list-style-type: none"> <li>• Examining alternative program models</li> <li>• Pursuing procurement opportunities through PA parent companies (as Berkshire Gas did)</li> <li>• Statewide behavioral program procurement</li> <li>• Extension of current one-year measure life</li> </ul>
<p><b>It is challenging to innovate a well established proven behavioral savings model</b></p>	<p>Advances in consumers' use of technology and PA investment in new platforms for engaging customers present an opportunity for program evolution:</p> <ul style="list-style-type: none"> <li>• Increase utilization of technologies including feedback devices, web portals, mobile devices and apps, and Wifi thermostats</li> <li>• Link recommendations more strongly to identified customer-specific opportunities (e.g., through a Home Energy Assessment); savings would likely be captured in other programs</li> <li>• Use behavioral messaging to bolster cross promotion of PA offers</li> <li>• Use behavioral strategies for active demand management</li> </ul>

### Summary of Consultant Recommendations

Several PAs have claimed large amounts of annual electric and gas savings from behavioral program approaches. The Consultants recommend the PAs build on this progress by:

- Broadening current behavioral program strategies to include cost-efficient new approaches for customers of all Massachusetts PAs

## NEW CONSTRUCTION

## Overview

This brief addresses savings opportunities in the Residential New Construction (RNC) market, both single family and multi-family. The current PA RNC initiative is a joint, statewide electric and gas offering. The Initiative promotes efficient building envelopes, HVAC and water heating equipment and systems, and lighting. In addition, the PAs provide code compliance support for which they claim savings and they assist municipalities to adopt the Massachusetts Stretch Code.

As in several other residential program activities, the PAs face potentially declining per participant savings due to rising, more efficient baselines. Improved baselines have been driven by more stringent energy codes, increased code compliance, greater availability of efficient equipment, and increased adoption of efficient building practices (e.g., blower door directed air sealing) that had not been common in the past.

A recently completed residential new construction baseline study and the adoption of the 2015 version of the International Energy Conservation Code, which becomes effective January 1, 2018 in Massachusetts, may further limit RNC savings opportunities. In response to rising baselines, the PAs have adopted a new incentive mechanism for both single family and multi-family buildings that is not tied to a finite number of savings percentage tiers, as had been the case previously, nor is there any longer a prescriptive compliance option.

In addition to energy savings, there may also be opportunities to pursue active demand management in tandem with the promotion of efficient new construction practices and technologies. Further, new construction provides opportunities for the co-promotion of photovoltaics (PV), and the integration of electric vehicle charging capabilities in new dwellings. Combining efficient, low load homes with PV will allow the PAs' RNC efforts to move toward a net zero energy path in the 2019-2021 Plan timeframe, including adoption of Passive House standards for multi-family buildings. Such a net zero energy path would ultimately support the adoption of a residential net zero energy code.

## Status in Massachusetts

Massachusetts PAs have been supporting efficient residential new construction practices for over two decades; first as Energy Crafted Homes, then as ENERGY STAR<sup>®</sup> Homes, and currently as the Massachusetts Residential New Construction Program. As building energy codes and construction practices have improved, the RNC Initiative has had to continue to raise the bar for program participation. Massachusetts has also been a leader in PA engagement in supporting energy code compliance and adoption, with a specific focus on municipal adoption of the Massachusetts Stretch Code.

The Residential New Construction Initiative is offered as a fuel blind, statewide program implemented with the support of a single initiative vendor. As discussed below, there are currently similar incentive structures, but different incentive amounts, for single family and multi-family participants. Home Energy Rating System (HERS) raters assist these participants with determining energy savings and ensuring compliance with program requirements such as those for mechanical ventilation. Master-metered building new construction participation is implemented through a different program path and is assisted by utility account managers or the implementation vendor.

In early to mid-2017 the PAs developed and implemented a new incentive structure for non-master metered RNC participants. This blended savings approach (BSA) became effective on July 1, 2017. The BSA has two incentive components (Table 19) that reward reduced energy use. The first incentive component pays for modeled savings for electricity (at \$0.35/annual kWh) and natural gas, oil, and propane (at \$35/annual MMBtu). The second pays for savings as a percentage reduction in energy use based on the newly revised RNC program baseline, referred to as the User Defined Reference Home (UDRH). The UDRH was updated in 2017 based on detailed surveys of program and non-program homes in 2016. Savings for this incentive component are calculated based on the percentage savings multiplied by \$3,000 for single-family units and \$2,000 for multi-family units. There is a minimum required savings of 5%. Additionally, there is a HERS rater incentive of \$350 for a single-family unit and \$100 for a multi-family unit.

**Table 23. Massachusetts Residential New Construction Blended Savings Approach (BSA) Incentives**

Variables	Single Family	Multi-Family
Electric Savings Incentive (kWh)	\$0.35	\$0.35
Gas Savings Incentive (MMBtu)	\$35.00	\$35.00
Percent Savings Incentive	\$3,000	\$2,000
Rater Incentive (per unit)	\$350	\$100

The electric RNC Initiative contributed 2% and 4%, respectively, of 2016 evaluated annual and lifetime Residential Sector savings with summary statistics presented in Table 23). Table 24 shows that most of the Initiative’s 2016 electric savings came from lighting (51% of lifetime savings), 28% from heating, and 12% from codes and standards support. This latter activity includes significant outreach and training for building code inspectors, developers, and builders, and contractors. 2016 electric RNC incentives totaled \$8.8 million.

**Table 24. Massachusetts Residential New Construction Electric Summary Statistics**

Initiative Metric	2016 Evaluated Value
% of Residential Sector Annual MWh Savings	2%
% of Residential Sector Lifetime MWh Savings	4%
% of Residential Sector Benefits	7%
Lifetime Cost to Achieve (\$/kWh)	\$0.08

**Table 25. Massachusetts Residential New Construction Electric Measure Savings Breakout**

RNC Electric Measures	Annual MWh	Lifetime MWh
Lighting	80%	51%
Heating	10%	28%
Codes and Standards	6%	12%
Cooling	4%	10%
<b>TOTAL</b>	<b>100%</b>	<b>100%</b>

Gas RNC savings represented a significantly larger percentage of 2016 evaluated gas Residential Sector savings at 7% of annual savings and 13% of lifetime savings. 2016 gas RNC incentives totaled \$12.2million (Table 26).

**Table 26. Massachusetts Residential New Construction Gas Summary Statistics**

Initiative Metric	2016 Evaluated Value
% of Residential Sector Annual Therm Savings	7%
% of Residential Sector Lifetime Therm Savings	13%
% of Residential Sector Benefits	15%
Cost to Achieve (\$/therm)	\$0.61

## Market Characterization

Over the past 11 years, the PAs’ RNC Initiative has seen steady growth based on several key metrics. Overall

participation has grown from 3,318 units in 2006 to 6,712 units in 2016 (Table 27).<sup>28</sup> Similarly, market penetration, expressed as a percentage of permitted units, has increased from 17% in 2006 to 44% in 2016. Finally, the number of firms offering HERS ratings has increased from 1 in 2006 to 62 in 2016. Note that in 2008 a HERS rating became an option to demonstrate code compliance and a HERS rating is the only means to demonstrate compliance with the Stretch Code, now in effect in most of the Commonwealth (see below).

**Table 27. Massachusetts Residential New Construction Participation**

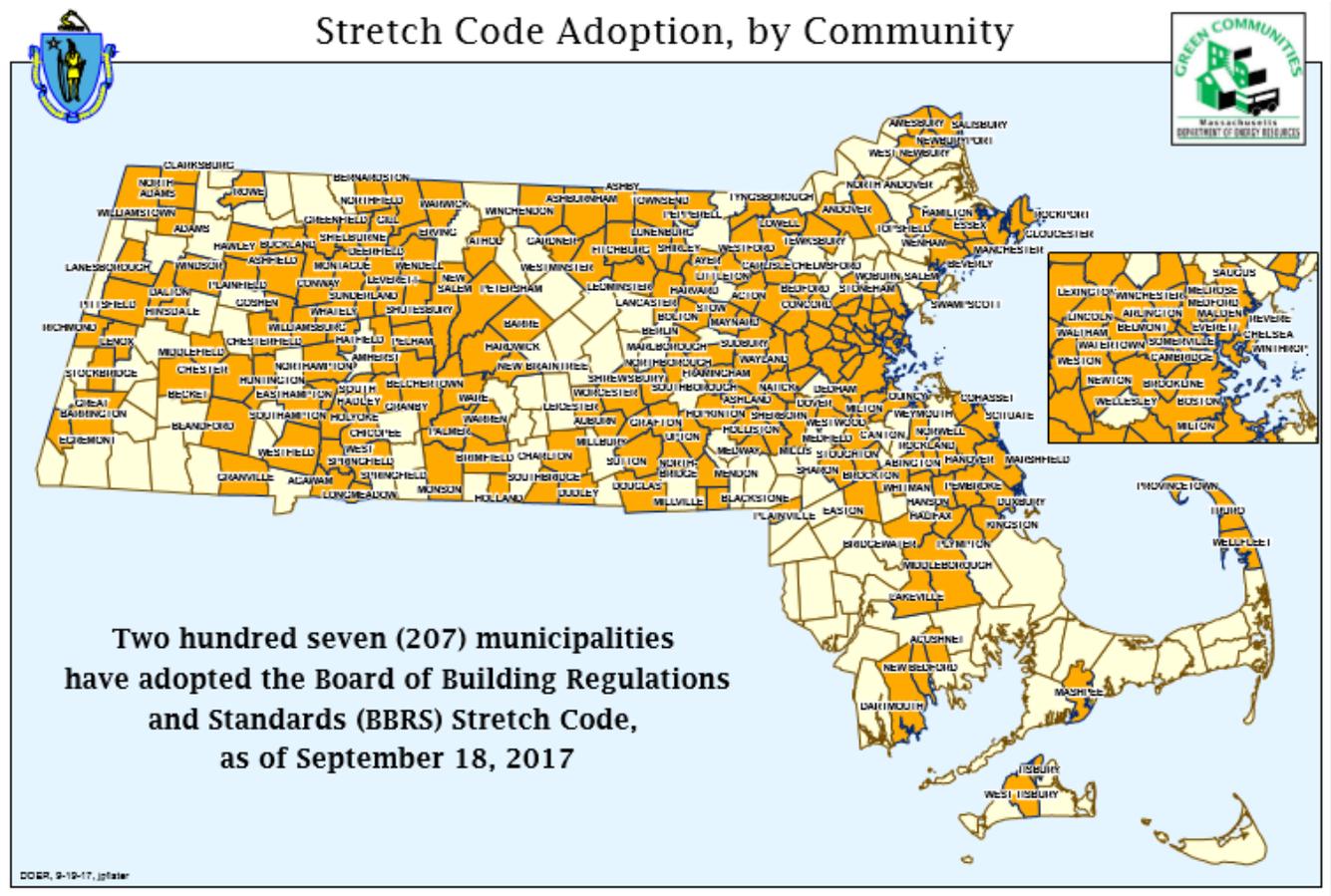
Year	# of HERS Rating Companies	Program Homes (all program units)	Housing Permits (all new housing units in MA)	Market Share
2006	1	3,318	19,580	17%
2007	2	1,616	15,358	11%
2008	9	1,369	9,883	14%
2009	16	2,194	7,941	28%
2010	20	2,622	9,075	29%
2011	40	2,576	7,725	33%
2012	45	3,259	11,111	29%
2013	46	3,719	14,569	26%
2014	54	4,942	14,237	35%
2015	59	3,693	17,424	21%
2016	62	6,712	15,407	44%

Stretch Code adoption is another indicator of the continued transformation of the residential new construction market. As of September 18, 2017, 207 municipalities had adopted the Stretch Code, representing 59% of cities and towns in Massachusetts, and 70% of the Massachusetts population (Figure 6).<sup>29</sup> In addition to PA support for Stretch Code adoption, there are other factors contributing to municipal adoption of Stretch Codes, including the availability of state grants through the Commonwealth’s Green Communities program. Stretch Code adoption is a requirement for becoming a Green Community.

<sup>28</sup> Evolving New Construction Incentives. PA presentation to the EEAC. April 26, 2017.

<sup>29</sup> <http://www.mass.gov/eea/docs/doer/green-communities/grant-program/stretch-code-towns-adoption-by-community-map-and-list.pdf>

Figure 6. Massachusetts Stretch Code Adoption



### Comparison Area Information

Several jurisdictions have already adopted residential net zero energy codes, or have a legislative mandate to do so. Typically, the effective dates of these codes are still several years out, though Boulder, Colorado instituted a net zero energy code for residences under 5,000 square feet effective on May 8, 2017. Other jurisdictions with net zero energy codes planned include California (effective in 2020) and Delaware (2025).

To support California’s 2020 zero net energy code, the state undertook a comprehensive stakeholder process beginning in 2012 to develop a New Residential Zero Net Energy Action Plan 2015-2020. The Plan developed a number of goals and associated benchmarks to ascertain success over the 2015-2020 timeframe to meet the 2020 ZNE code goal. In response, the state’s investor-owned utilities have developed and implemented a California Advanced Homes Program that “Awards incentives based on absolute performance relative to ZNE...”<sup>30</sup> The program also offers design assistance and runs demonstration pilots.

PA new construction programs in the Northeast with net zero energy or zero energy ready tiers include Connecticut and Vermont. The statewide Connecticut New Home Construction program provides incentives at four different HERS Index levels. The most stringent tier is Tier 4, with a required HERS Index of 0 or better. The home must also achieve a HERS Index of 50 or lower before the addition of renewables.

Efficiency Vermont’s (EVT’s) High Performance Certification is based on a series of stringent prescriptive requirements including R-60 ceilings, R-30 walls, and 1 air change/hour or less at 50 Pascals. EVT describes

<sup>30</sup> Asper, Conrad. Zero Net Energy (ZNE) Residential & California’s Goals. PG&E. June 5, 2017.

homes meeting this certification as "Net-zero ready: with on-site renewables, your home can make as much energy as it uses."<sup>31</sup> EVT also has a Zero Energy Modular Home program that addresses a small, but important, market segment.<sup>32</sup>

Other activities worthy of possible emulation include Connecticut's Zero Energy Challenge competition.<sup>33</sup> This annual competition, in place for nearly a decade, encourages the design and construction of net zero energy and near net zero energy homes. In 2016, five winners were awarded \$30,000 in cash prizes. Participants competed in five categories:

- Overall Winner
- Best Envelope
- Lowest HERS Index without Renewables
- Lowest HERS Index
- Lowest Cost/Square foot

Connecticut is also considering an EV-readiness criterion for some portion of its 2018 Residential New Construction Program participants.

### Relevant Evaluation Findings and Activities

The Residential New Construction Initiative has received significant amounts of evaluation and market research resources over the past several years, and this trend continues through 2017 and into 2018 to inform 2019-2021 planning. Recently completed, ongoing, or planned studies focus on baseline construction practices, updated UDRH, incremental costs, net savings attribution, and the Code Compliance Support Initiative (Table 28). Findings and recommendations from all of these studies will provide needed information to inform Initiative savings estimates and program design enhancements for the 2019-2021 Plan period.

**Table 28. Massachusetts Residential New Construction Evaluation and Market Research Activities**

Study	Summary Description	Report Date or Scheduled Completion
<b>Final 2016 UDRH Inputs: Addendum to 2015-16 Massachusetts Single Family Code Compliance/Baseline Study</b>	New UDRH inputs based on 2016 onsites of non-program participants in both Stretch Code and non-Stretch Code towns. Significant improvements observed in duct leakage, air infiltration, and flat ceiling insulation.	March 6, 2017
<b>2015-16 Massachusetts Single-Family Code Compliance/Baseline Study: Volume 3, Final Report</b>	Provides more detailed assessment of baseline construction practices and is the basis for the UDRH inputs in the above Addendum.	February 13, 2017
<b>2017 Massachusetts Single-Family New Construction Mini-Baseline/Compliance Study</b>	Provide whole-house compliance values for single-family homes built at the end of the 2012 International Energy Conservation Code (IECC) cycle. Document the efficiency and compliance levels for air leakage, duct leakage, and lighting in single-family homes built at the end of the 2012 IECC. Compare the whole-house and selected measure-level efficiencies and compliance levels to	October 2017

<sup>31</sup> <https://www.encyvermont.com/services/renovation-construction/residential-new-construction>

<sup>32</sup> <https://www.encyvermont.com/services/renovation-construction/zero-energy-modular-homes>

<sup>33</sup> <http://www.ctzeroenergychallenge.com/>

	previous compliance study results.	
<b>RNC Incremental Cost Study</b>	Identify the incremental costs associated with moving from baseline new construction practices to common practices identified in program participant housing units.	February 2018
<b>Residential New Construction and CCSI Attribution</b>	Estimate the NTG factors and savings in low-rise residential new construction (RNC) that may be attributed to the Residential New Construction Program (RNC Program) and the Code Compliance Support Initiative (CCSI) for the 2019-2021 program period.	February 2018

## Consultant Findings

The Massachusetts PAs have made substantial progress in improving new construction practices and in recruiting builders and developer to participate in the Residential New Construction Program. Further program energy savings will be predicated on moving to low load homes and increasing already impressive participation levels.

Consultants have identified the following barriers and opportunities in Table 29 for further progress moving into 2019-2021:

**Table 29. Massachusetts Residential New Construction Barriers and Opportunities**

Barriers	Opportunities
<p><b>Rising baselines continue to diminish per participant savings.</b> While BSA provides a pay for performance approach not tied to a limited number of tiers, the 5% minimum savings requirement may not encourage deeper savings.</p>	<ul style="list-style-type: none"> <li>• Develop a plan to get the majority of RNC participants to NZE by the end of the Three-year Plan. Continue work with Mass CEC and other interested stakeholders.</li> <li>• Consider Passive House as NZE requirements for multifamily buildings.</li> <li>• Assess potential PA code savings and attribution from accelerating the adoption of a Residential net zero energy code requirement.</li> <li>• Consider implementation of a Zero Energy Challenge-like competition.</li> </ul>
<p><b>HVAC system designs have not kept pace with low load home's space conditioning needs.</b> Moving away from central heating and cooling designs can avoid the need for whole house distribution systems and reduce distribution system losses and construction costs</p>	<ul style="list-style-type: none"> <li>• Provide technical assistance and guidance for the design and installation of heating and cooling equipment in low load homes.</li> <li>• Develop an all-electric new home package to capture the growing interest in cold climate heat pumps and heat pump water heaters.</li> </ul>
<p><b>The current initiative's efficiency focus doesn't address other opportunities including active demand management, solar photovoltaics, electric vehicles (EVs), and storage.</b></p>	<ul style="list-style-type: none"> <li>• Leverage new code PV-readiness requirements to better engage solar industry. Work with Mass CEC and others to co-promote PVs.</li> <li>• Asses and implement as appropriate Wifi thermostat requirements to facilitate active demand management participation (and increase energy savings).</li> <li>• Develop and implement EV-readiness criteria in anticipation of projected growth of EVs in Massachusetts.</li> </ul>

## Summary of Consultant Recommendations

The PAs' long-term engagement in the new construction market has yielded significant savings to the PAs and to new homeowners, achieved high participation rates, and has improved overall levels of code compliance. In the

2019-2021 Plan, the PAs new construction efforts will need to expand to address active demand management, fuel choice, and renewable and EV integration.

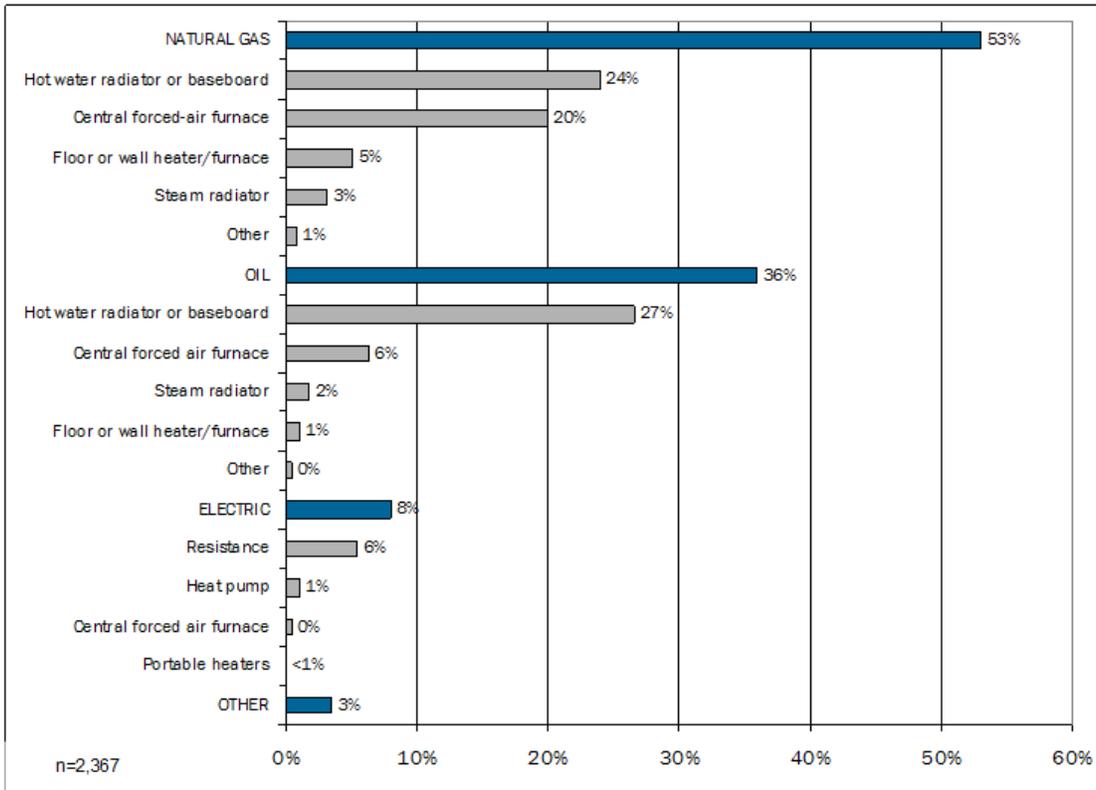
Moving into the 2019-2021 Plan period, the Consultants recommend the PAs focus their residential new construction efforts to:

- Offer specific low energy path(s) such as net zero energy and Passive House (multi-family) to drive construction of low energy buildings and eventual market transformation of building energy codes.
- Integrate active demand management measures that promote load-shifting opportunities of solar photovoltaics, electric vehicles, and storage.

## APPENDIX A: DETAILED HEATING SYSTEM AND FUEL TYPE INFORMATION

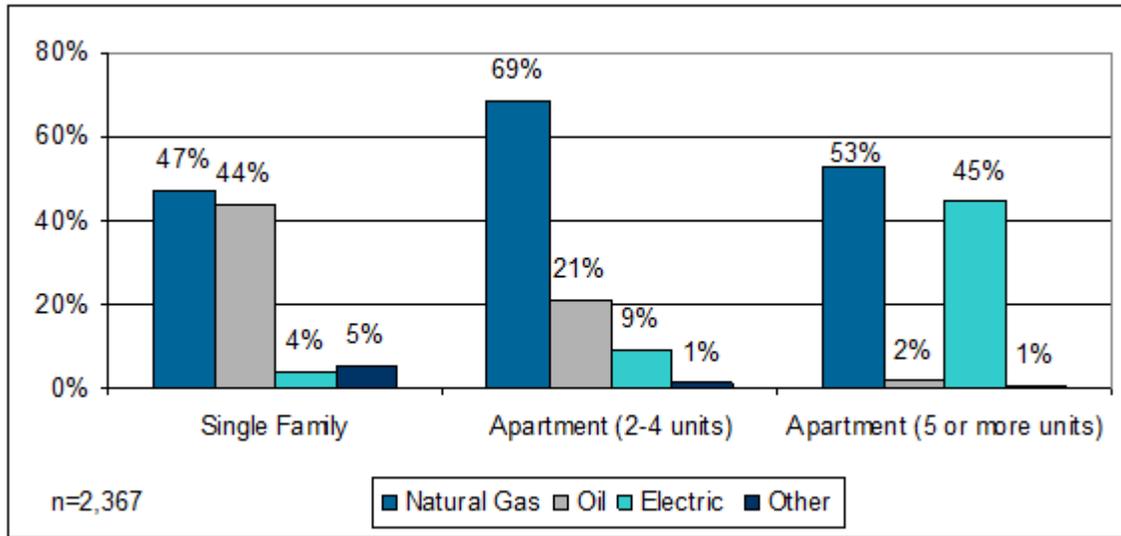
Figure A-1 provides a detailed breakout of primary heating system types in Massachusetts by fuel according to the most recent Residential Appliance Saturation Survey (RASS) in 2008.<sup>34</sup> The 53% gas heating market share has most likely increased due to fuel conversions, primarily from oil. The RASS data in Figure A-2 show that electric heat is more common and oil heat less common in multi-family buildings.

**Figure A-1. Massachusetts Heating System Types by Fuel Type**



<sup>34</sup> Massachusetts Residential Appliance Saturation Survey. Volume 1: Summary Results and Analysis. Opinion Dynamics. April 2009.

**Figure A-2. Massachusetts Primary Heating Fuel by Building Type**



Similarly, Figure A-3 shows that natural gas also dominates water heating use in Massachusetts homes with 58% of homes using natural gas for this purpose. Note that electric water heating usage is higher than it is for space heating, reflecting the tendency of some oil heated homes, particularly those with furnaces, to use electric hot water.

**Figure A-3. Massachusetts Primary Water Heating Fuel**

