RLPNC 16-10: What is Next for Products – Market Scan

Final Report

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SUBMITTED TO:
Massachusetts Program Administrators and EEAC

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ES Executive Summary

The goal of the Massachusetts (MA) *RLPNC 16-10: What's Next for Products Study* is to aid the Massachusetts Program Administrators as they plan for the future of the residential lighting and residential consumer products initiatives, given significant market changes and increasing federal standards. This includes the identification of products for possible inclusion in the MA residential program portfolio in the 2019 to 2021 plan cycle that could successfully achieve savings. This report expands on the Task 1 Documentation of Codes and Standards memo (included as Appendix A), which examined existing codes and standards, as well as other metrics, to measure and identify potential savings opportunities. The products discussed in this report center mostly around white goods, consumer electronics, and lighting controls. Although HVAC equipment is not specifically discussed, some strategies or behavioral-based products in the report (e.g., smart thermostats) may impact HVAC system usage.

The goal of the Task 2 Market Scan and report was to gather and report market intelligence from experts and thought leaders across the United States who have examined, or are in the process of examining, new residential energy and demand savings measures. NMR completed 17 interviews with 23 respondents throughout August and September of 2017; each interview lasted approximately one hour. NMR then conducted follow-up research based on the key takeaways of these conversations, identifying reports, products and technologies, and other valuable information. Information presented in this report is meant to provide feedback on experiences in other areas and may not reflect rules and restrictions in place in Massachusetts.

This report also draws on the market intelligence gathered at the 2016 and 2017 ENERGY STAR Partners meetings, the in-progress RLPNC 16-2 Supplier Interviews study, and a literature review focused on the ENERGY STAR Retail Products Platform (ESRPP; see Section 5).

Caveats and Cautions

When reviewing this report, it is important to keep in mind that this is a qualitative review and is not intended as a potential study. Please consider the following as you review:

- While the content of this report is intended to help supplement and support ongoing potential efforts, program planning, and identification of future program offerings, it does not include cost-effectiveness testing, and we have limited the discussions of cost-effectiveness throughout.
- As many of the experts operate outside of Massachusetts, their views and recommendations may not currently be feasible in Massachusetts. However, their insight is still valuable as it showcases thinking from other parts of the country.

- This report includes some products and strategies currently used in Massachusetts; we believe their inclusion will help aid in future planning by showing areas where savings are being achieved and administrative or programmatic costs are being reduced.
- While the overall tone of the respondents and the resulting report is positive, and mentions many opportunities, it is NMR's opinion that none of the opportunities identified would result in energy savings that savings that match or outperform those achieved in the current residential lighting initiative. Further, many of the measures identified in this report are already sponsored in Massachusetts.
    - The findings indicate that, in many cases, Massachusetts is a leader in identifying and sponsoring the most efficacious measures. While the MA program's innovative nature is advantageous, it also makes it difficult to find new opportunities to include in future consumer products programs.
    - Overall, these findings suggest that many measures can continue to achieve savings, but that it may take innovative new products and new program designs to capture new or additional savings. The effort and substantial incentives that the MA PAs have put towards smart thermostats indicates a positive step – many experts believe this newer technology has great promise.
- The data in the body of this report regarding federal DOE standards, ENERGY STAR standards, and additional CEE specifications, as well as the discussions surrounding them, are current as of December 31st, 2017. While finalizing this report, new CEE specifications for washing machines were introduced and put into effect. NMR does not feel that this affects the technical savings assessment that was made for washing machines, but we have added additional discussion regarding the new CEE specifications in the footnotes of the washing machine section and throughout the rest of the report, where appropriate.

OVERALL ASSESSMENT

While respondents agree that savings from products are unlikely to reach the level of savings from lighting programs, there are still opportunities to achieve savings by leveraging the most efficient products on the market through well-structured programs. Increasing consumer awareness of efficiency and having the utility be *present* when they are researching or purchasing a new product was deemed critical in these efforts. Many respondents also advocated for switching some products to a midstream approach (specifically the ENERGY STAR Retail Products Platform [ESRPP] approach) as a way to increase market influence at lower per-unit costs. Finally, respondents thought that embracing new program designs and/or technologies would provide a substantial opportunity for energy efficiency and demand-response. Interviewees specifically mentioned smart thermostats, connected home devices, advanced power strips, EV chargers, and EV infrastructure and grid management strategies in general.

KEY FINDINGS

- ***Increasing baselines and saturation of ENERGY STAR products makes it challenging to operate a downstream products program, but there are still opportunities to operate successful programs with the right design and assortment of products.*** *There is no single silver bullet product to replace the level of savings from prior and current lighting programs, but savings opportunities do still exist from many white goods and other traditional products/appliances that programs have focused on in the past.*
- ***Being able to claim specific per-model or per-tier savings makes products programs more viable.*** *Claiming only the deemed savings value of the lowest qualified ENERGY STAR model, or an average of ENERGY STAR models, will hurt the program if more efficient products are being sold. Using CEE tiers to identify sales of these highly efficient products may require more work in both planning and the EM&V process, but can also help programs recognize the greater savings that they may already be achieving.*
- ***Making ENERGY STAR Most Efficient and high-tiered CEE products more widely available and accessible can increase the success of products programs.*** *Interviewees identified a lack of availability of higher CEE tiered products due to few being manufactured or a lack of awareness from retailers, implementers, and/or consumers. Working with these parties (especially manufacturers, retailers, and implementers) to focus on CEE products in programs will help their success. ENERGY STAR Most Efficient products benefit from the ENERGY STAR label and inclusion in the program, and may offer an easier way to get products to consumers that are more efficient than ENERGY STAR.*
- ***Finding methods to influence the decision-making process in the early stages can help encourage customers to make more efficient purchases****. The decision to purchase a specific product is often executed long before the consumer reaches the store. Putting more efficient products in front of customers could lead to more efficient decisions, even if consumers are unaware of it.*
- ***Rearranging the assortment of products that consumers see to favor efficiency can create more savings.*** *Using online marketplaces, or working with manufacturers and retailers to redesign display options to have consumers see efficient products first, can be a way to reach customers who would not have considered efficiency before.*
- ***The ENERGY STAR RPP approach may offer savings opportunities for many products that are no longer, or have never been, viable through downstream programs, but its success is yet to be proven.*** *Although the per-unit and administrative costs are lower, the increased free-ridership from paying incentives on all products means that significant market transformation is needed for this approach to be successful.*

- ***Customer engagement is critical to program success.*** *With the rise of connected/smart devices, low-cost effective energy-efficiency and demand-response savings should become more readily available through new technologies, but customers need to be educated in how to properly utilize new technologies.*
- ***New and emerging technologies (connected home/internet of things, EVs, batteries) will play into energy-efficiency and demand-response programs, but industry experts are unsure of exactly how, and what approaches PAs should enact.*** *Most interviewees expressed that it is best to address their inclusion early, but also don't want to prematurely support technologies or back the wrong horse. In the connected home market, utilities could play a key role in centralizing devices and advocating to manufacturers or EPA to create opportunities to increase efficiency.*

1 Introduction

The What's Next for Products study was envisioned as an iterative process, with initial tasks laying the groundwork for follow-up research. The initial documentation of codes and standards served as stage 1 of this process, and the current report focuses on the results of NMR's market scan interviews with industry experts. The results presented here are supplemented at points by sources recommended by the interview participants, as well as some additional research to expand on insights that came up during those interviews. While the codes and standards memo was most heavily focused on technical potential, this report begins to address products and methods that have been proven to be successful, by exploring the measures that interview participants cited as having the most potential now and in the future. It also seeks to address emerging technologies that may offer substantial, low-cost savings, improve delivery methods, and affect behavioral changes to achieve future savings. While we asked participants to consider cost-effectiveness and economic potential during the interviews, it is important to note that this is a qualitative review and some of the measures identified as having potential may not align with the results of the cost-effectiveness screening from the MA potential studies.

This report predominately focuses on the key findings from the nationwide interviews with PAs and industry experts regarding the products and strategies that they have found to be successful, or believe will be successful soon. Many of the products and strategies discussed are already being utilized in Massachusetts. *We include them in our discussion to help aid in future planning by showing areas where savings are being achieved nationwide*. Additionally, we asked respondents about measures or strategies that were currently achieving savings while reducing program and administrative costs in their regions. Accordingly, *the findings reported throughout this memo typically focus on opportunities,* though many barriers undoubtedly exist and several challenges have been noted.

We also recognize that some of the PAs are currently conducting potential studies. As the results of the potential studies become available, we will adjust the results of the market scan to include only measures that pass cost-effectiveness screening. At times in this report, we refer to the *potential study,* which is meant as a catch-all for each of the individual PA efforts.

The report is laid out as follows:

- Section 2: **Traditional Products and Emerging Technologies** serves as a follow up to the initial codes and standards memo by drawing on discussions surrounding specific products and technologies in the market scan interviews.
- Section 3: **Effectively Leveraging Efficient Products** provides strategies identified by respondents aimed at the best methods for programs to operate and successfully deliver efficient products to consumers.
- Section 4: **Claiming Savings/Reducing Program Costs** discusses the barriers identified that can prevent programs from succeeding (e.g., free-ridership) and program designs that can help to overcome these barriers.

- Section 5: **Retail Product Platform** gives an overview of the ENERGY STAR RPP program and provides insight from PAs who are currently administering the program.
- Appendix A: **What's Next for Products and Lighting Task 1 Documentation of Codes and Standards** is the task 1 memo previously submitted to the PAs, and is included as a reference given the iterative nature of the current research.
- Appendix B: **Additional Information** provides more in-depth analysis of select topics.

1.1 OBJECTIVES

The goal of the Task 2 Market Scan and report was to gather and report market intelligence from experts and thought leaders that have examined, or are in the process of examining, new residential energy and demand savings measures. Topics covered include gas and electric appliances and products, residential energy storage and backup systems, connected home products, innovative demand response solutions, and innovative program designs and strategies. Interviewees included Program Administrators from across the nation, ENERGY STAR consultants, members of regional and national energy efficiency organizations, evaluators, and smart power strip manufacturers. NMR completed 17 interviews with 23 respondents throughout August and September of 2017; each interview lasted for approximately one hour. The team also conducted follow-up research based on the key takeaways of these conversations, identifying reports, products and technologies, and other information of value. This information is provided throughout the report. The following topics were discussed in the interviews:

- Products that have shown substantial savings in their own programs
- Products that have shown or have promise in demand response solutions
- Products interviewees intend to continue to focus on or place greater emphasis on in future planning
- How interviewees think programs can best influence consumer choice and purchasing behavior
- How products programs can best succeed and reduce program and administrative costs moving forward

This report also draws on the market intelligence gathered at the 2016 and 2017 ENERGY STAR Partners meeting, the in-progress RLPNC 16-2 Supplier Interviews study, and a literature review focused on the ENERGY STAR Retail Products Platform (ESRPP; see Section 5). This review focuses on the strengths and potential drawbacks of the RPP/ESRPP approach, and includes insights from the EPA and other contacts heavily involved with the design and delivery of those programs. The review includes information on the results of the various evaluations of existing RPP programs.

NMR will also provide updates to the current reporting as the results of the MA Potential Studies become available to eliminate measures that will not pass cost-effectiveness screening.

1.2 METHODOLOGY

NMR completed 17 interviews with 24 participants throughout August and September of 2017. Table 1 shows the sectors in which the interview participants primarily work.

Table 1: Role of Interview Participants

Contact Sector	Organizations	Participants
Total	*17*	*24*
Program Administrators (Outside of New England)	5	7
Regional or National Energy Efficiency Organizations	5	9
Power Strip Manufacturers	2	3
Efficient Technology Designers	2	2
Consultants/Evaluators	3	3

NMR created the potential interview pool by drawing on the insights gained through the documentation of codes and standards in the task 1 memo, and with guidance from the MA PAs and EEAC. Respondents included PAs running successful programs with measures identified in that memo, PAs with innovative approaches or program designs, and industry experts and evaluators who had substantial knowledge of efficient products and emerging technologies. In many cases the respondents authored materials used in the codes and standards memo and we sought to gain further insight into a specific idea, technology, or approach.

Interviews covered a wide range of topics, including savings potential of efficient products, demand-response opportunities, the role of emerging technologies, behavioral approaches, innovative program designs, achieving cost-effectiveness, evaluating programs and claiming savings, and the state of downstream rebates and the potential to move upstream. Although the market scan interviews were intended as a follow-up to the initial documentation of codes and standards, in many cases, interview participants were hesitant to address the specific savings of a particular measure or technology. They often cited a lack of familiarity with Massachusetts and the TRM, uncertainty about the exact efficiency or savings of a particular technology, and/or a belief that traditional downstream approaches have a relatively bleak outlook for some products and appliances. Section 2 seeks to serve as a direct expansion on the Codes and Standards memo, outlining insights gained on specific products or technologies; however, due to the nature of the interviews, a large focus of the remainder of this report is centered around program designs and the best ways to overcome barriers facing products-programs moving forward.

2 Traditional Products and Emerging Technologies

This section expands upon the initial codes and standards memo by reporting interviewees' insights regarding specific products and appliances and identifying other strategies (e.g., behavioral changes) utilized by existing programs to target efficiency, or to enact demand response solutions. While we attempt to integrate discussions surrounding delivery methods, this section is primarily focused on reporting the current state, potential, and opportunities of existing technologies and strategies used in existing products and related programs. The word cloud on the right side of this page, shows the terms most commonly used in the market scan interviews.[1]

Figure 1: Most Common Interview Terms Interviews

Key findings:

- ***Respondents agree that there is no "silver bullet" to replace the lighting savings PAs have been obtaining.*** *Some existing products and emerging technologies may achieve substantial savings, but no one product or approach will fully replace lighting programs. This calls out the need for a multi-pronged approach, which still may struggle to reach the savings potential of lighting programs. "We get the same amount of savings from a refrigerator as we get from about 3 LEDs," said one respondent.*
- ***As identified in the codes and standards memo, existing products and appliances with CEE tiers above ENERGY STAR or with low ENERGY STAR saturation typically present the best savings opportunity.*** *Getting these highly efficient products to consumers often proves challenging because there are often very few models manufactured and widely available that meet the highest tier of efficiency, and consumer awareness of CEE tiers is low. Addressing these challenges will be key for successful program intervention. Working with manufacturers and retailers to increase the amount of higher tiered products manufactured and distributed, decrease their costs, and increase their promotion and in-store position, could help to overcome these barriers.*
- ***Participants frequently identified midstream approaches or an RPP approach as the best way to stay involved with many products.*** *Participants cited the lower*

[1] Generated using http://worditout.com

costs of this model and its potential to reach more of the market through influencing retailers and creating long-term market transformation (see Section 5 for more).

- ***New technologies (e.g., smart thermostats, advanced power strips, EV chargers, and heat pump dryers) increasingly present opportunities for both energy-efficiency and demand-response solutions as the technology improves and their saturation increases.*** *Interview participants identified the value of the new ENERGY STAR specifications for smart thermostats, heat pump dryers, and EV chargers for future program activity. They identified smart thermostats and EVs as future grid-stabilization tools, and called the massive increases in EV market penetration "inevitable." They have also found smart thermostats, heat pump dryers, and advanced power strips to achieve some of the greatest savings of any products on the market, and advocated for using the ENERGY STAR standard to leverage those. The ENERGY STAR Most Efficient label may help turn heat pump dryers into a viable option in future years.*
- ***Connected home devices are quickly becoming widespread; customers desire their centralization, and they provide energy-saving and demand-response potential. Utilities should become major stakeholders in this market.*** *With the fast-increasing presence of connected home devices, utilities could become a major player in this space since consumers are seeking a central way to control their many devices. Connected home products will play a role in both plug-load efficiency and demand-response. PAs have an opportunity to work together to promote efficiency in this space, whether it is working with manufacturers or trying to create ENERGY STAR specifications.*
- ***Behavioral changes will take on a new role and increasing importance, as many new technologies require proper setup and use to fully take advantage of their energy-saving or demand-reducing capabilities.*** *New technologies, including smart thermostats, advanced power strips, and smart home devices, will work best as energy-efficiency or demand-response tools when set up properly, especially as manufacturers begin to enable them to easily interact with time-of use pricing signals.[2] Whether it is through a downstream rebate, direct install, or marketing campaigns, keeping the customer aware of proper use and setup when they are purchasing or installing these devices will help them achieve their maximum potential.*
- ***Plug load is a growing concern as efficiency of smaller products proves harder to tackle than white goods and other large products.*** *Due to the small per-unit savings of these devices, most suggested targeting them through midstream efforts. However, some also stated that advanced power strips, connected home devices, or other energy-monitoring technologies (e.g., Sense Device, Kill-Switches, see 2.2.7)*

[2] For example, see: https://www.energystar.gov/sites/default/files/asset/document/4.%20Rick%20Counihan_Connected.pdf (about 2/3 of the way down). Ecobee and Honeywell offer similar options.

could significantly reduce plug-loads without requiring the plug-load products to become more efficient.

- ***Interviewees suggested that the opportunities to create savings using traditional downstream rebates are generally diminishing as ENERGY STAR market penetration increases alongside tighter federal baselines.*** *Some products are approaching tech-max, limiting the savings potential of even the most efficient levels. In other cases, despite the existence of highly efficient technologies (and sometimes CEE tiers and ENERGY STAR Most Efficient designations), production of the most efficient products is not high enough to expect their penetration or saturation to widely increase in the current market. Despite these challenges, which we discuss in greater detail in* Section 4*, there are still opportunities to achieve savings with traditional products.*

2.1 High Savings Products Identified in Codes and Standards Documentation

Table 2 outlines the measures identified during the market scan interviews, along with key takeaway(s), and the program potential NMR had identified for the measure in the initial codes and standards memo (Appendix A). As noted in Table 2, many of the measures identified throughout this section are already sponsored in Massachusetts. While respondents highlighted that all of these measures had savings potential and believed they could be successful components in a products program, they rarely discussed the incremental costs.

Table 2: Savings Opportunities for Identified Products

Measure	Passes Cost-Effective Screening?[3]	Savings Potential Identified in Codes and Standards Memo (See Appendix A)	In Current MA Program?	Market Scan Insight
CEE Tier Products / Appliances (2.1.1)	TBD	High	*N/A*	*"Any product with higher CEE tiers is worth looking into for program inclusion…we often leave savings on the table by just doing ENERGY STAR."*
Clothes Washers (2.1.2)	TBD	High	*No*	*"People are still buying inefficient [top-load] washers because the most efficient [top load] models are not being widely made."*
Clothes Dryers (2.1.3)	TBD	High	*Yes*	*ENERGY STAR Most Efficient, SEDI initiative, and heat pump dryers all offer opportunities to greatly increase dryer efficiency.*
Heat Pump Dryers (2.1.3)	*Not Included in Screening*	High	*No*	*"Consumers don't understand them, they still don't trust them yet, but once they do that is, I think they're a really big savings potential product."*
Refrigerators and Freezers (2.1.4)	TBD	High	*No (Recycling only)*	*CEE tiers 2 and 3 offer potential, but "are pretty much non-existent" in the market. Typically, refrigerators with the most advanced features (likely the most desirable models) are ENERGY STAR, which could serve as a blueprint for a successful model in increased appliance efficiency.*
Room ACs (2.1.5)	TBD	High	*Yes*	*"We continue to see good savings from room Air Conditioners."*
Pool Pumps (2.1.6)	TBD	High	*Yes*	*"Are they a national thing, or are they an Arizona thing? The answer seems to be that it's national, savings are available*

[3] We will populate this column with results from the ongoing MA Potential Studies.

Measure	Passes Cost-Effective Screening?[3]	Savings Potential Identified in Codes and Standards Memo (See Appendix A)	In Current MA Program?	Market Scan Insight
				in most places. There's a shortage of efficient products to make it worth our while."
Smart Thermostats (2.2.1)	TBD	Undefined	*Yes*	*"Smart thermostats are going gangbusters and we're seeing pretty good savings out of them."* *"I think a rebate could really move the needle here. Right around $100 is when sales start to jump off for smart thermostats."*[4]
Dehumidifiers (2.2.2)	TBD	Moderate	*Yes*	*"For 2018, we filed to bring back dehumidifiers. The incremental cost had been so low we hadn't been able to justify them, but that now has shifted, so here downstream is working."*[5]
TVs (2.2.3)	TBD	*High as Part of Plug Load*	*No*	*"I know that some of the new highly efficient models of televisions are showing good enough savings that they are worth exploring again. They stopped being a good opportunity a few years ago, but have now become viable again."*
Air Purifiers (2.2.4)	TBD	Moderate	*Yes*	*Per Unit savings have shown to be substantial.*
EV Chargers (2.2.5)	*Not Included in Screening*	Undefined	*No**	*"EV's are definitely going to take off in the small car sector and maybe natural gas for the larger ones."* *"I think the role in EVs right now is new construction readiness and promoting the ENERGY STAR specification."*

[4] Massachusetts offers a substantial rebate for smart thermostats, which many respondents suggested will remain one of the most practical products to include in a downstream rebate program moving forward.
[5] This was said by a PA outside Massachusetts.

Measure	Passes Cost-Effective Screening?[3]	Savings Potential Identified in Codes and Standards Memo (See Appendix A)	In Current MA Program?	Market Scan Insight
Advanced Power Strips (2.2.6)	TBD	Undefined	*Yes*	*"We're seeing huge savings from tier 2 power strips in early studies."* *"Advanced power strips have shown to be [better options] than LEDs in some cases."*
Emerging Technologies (2.2.7)	TBD	Undefined	*N/A*	*Kill-switch devices, load-disaggregating products and other new technologies could have increasing impact on energy savings.*
Connected Home Devices (2.5)	*Not Included in Screening*	*High as Part of Plug Load Reduction*[6]	*N/A*	*Connected home devices will become mainstream, they will impact plug-loads and demand-response, and the utility can be a key player in this space.*
Connected Lighting (2.5.1)	*Not Included in Screening*	Undefined	*No*	*"[It is unclear] that they even save energy [after accounting for] the always-on standby component while controlling LEDs with already low wattages."* *"There's not much more you can do with reducing wattage so you have to focus on the hours."*
Residential Batteries (2.5.2)	*Not Included in Screening*	Undefined	*No*	*"Batteries look like they will very soon be [a viable measure for program activity]...it's happening so fast it seems like it's an 'in the next few years thing,' not a long-term thing."*

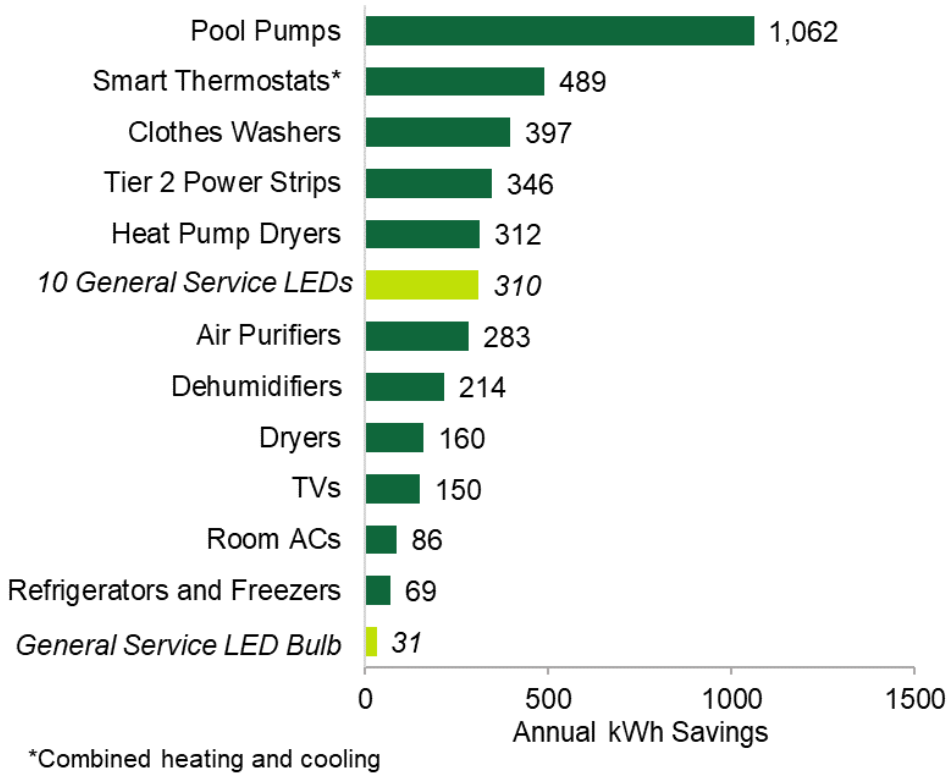
[6] In the initial documentation of codes and standards, we identified reducing plug load as a high potential opportunity. Connected home devices could aid in doing this, however we did not specifically identify their potential as a measure, largely because the lack of any codes or standards applying to them.

In NMR's initial documentation of Codes and Standards, we identified clothes washers and dryers, refrigerators, room air conditioners, and pool pumps as the measures with the greatest technical savings potential, mostly due to the existence of CEE tiers above ENERGY STAR, and/or room to increase market penetration of ENERGY STAR models (see A.2.1). All of these measures were corroborated to show potential by one or more interviewees. Several of these products are also included in the ENERGY STAR Retail Products Platform (ESRPP) portfolio, offering another opportunity to stay involved with the products (see Section 5).

Additionally, we include smart thermostats, dehumidifiers, TVs, air purifiers, EV chargers, advanced power strips, connected home technologies, and residential batteries in this section (see 2.2) as respondents frequently identified these products as having potential. In many cases, these products are emerging technologies (e.g., smart thermostats and other connected products, EV chargers, batteries), that are rapidly improving with low program activity, or with program activity that is difficult to define. This creates greater new savings opportunities. In other cases, these were more traditional products where new advancements have made their savings more viable (e.g., dehumidifiers and TVs).

As noted above, there were relatively few discussions of the incremental costs associated with these products. Figure 2 displays the savings of a model meeting the highest ENERGY STAR or CEE tier. This figure shows that most measures discussed achieve roughly the same level of savings as – or a lower level of savings than – 10 LED light bulbs would, despite substantially higher costs for many of these products. This further highlights the challenges of replacing the savings produced from lighting.

Figure 2: Per Unit Savings of High Savings Measures[7]



2.1.1 CEE Tiers

As identified in the codes and standards memo, many interviewees first identified products with CEE tiers above ENERGY STAR as those with the greatest potential, *if* those higher tiered products can be properly leveraged. "*Any product with higher CEE tiers is worth looking into [for program inclusion]*," said one respondent. "*I think we often leave savings on the table when we just do ENERGY STAR*," added another, claiming that programs often create more savings than they take credit for because the sales of the most efficient products are not separately accounted for within the program. Several participants also noted the challenges of promoting higher CEE tiers that stemmed from the need to educate consumers and retailers, or from a lack of availability of the highest tier of products. These challenges and potential solutions are discussed in-depth in Section 3.

[7] Connected home, connected lighting, EV chargers, and residential batteries are not included due to a lack of reliable savings estimates. All values are from the initial Codes and Standards memo, with the exception of LEDs and power strips (from MA TRM, 2017 values), smart thermostats (http://aceee.org/sites/default/files/publications/researchreports/u1507.pdf; p. 13; based on combined electric/heat savings), and heat pump dryers (https://aceee.org/files/proceedings/2016/data/papers/1_160.pdf). Note that the heat pump dryer study was completed in FL and savings may vary by region. The DOE calculator projects a 5.7 CEF ventless heat pump dryer to save 349 kWh. Additionally, smart thermostat savings can vary significantly by technology and region. Savings reflect the level from a model meeting highest ENERGY STAR level or CEE tier as of December 31, 2017.

2.1.2 Clothes Washers

Clothes washers were frequently mentioned as a measure with good savings potential due to the existence of CEE tier 2 and 3 standards and an ENERGY STAR Most Efficient label.[8] Interviewees' data also showed that a large portion of the market continues to purchase inefficient top loading washers. Respondents identified manufacturing constraints as barriers that have slowed the adoption of highly efficient models. One evaluator indicated that top loading washers, "*still aren't being designed to the way that we want them to be designed. There are still markets of people that are buying washers that aren't efficient because they still aren't being made.*" This respondent went on to add that she believes washers are still a product where a downstream rebate can move the price-point to a place where consumers would be interested in purchasing a specific model.[9] Another PA told us that although their program promotes higher tier washers, not many models above tier 1 (i.e., the ENERGY STAR standard) exist. Therefore, consumers are often unaware of these models or struggle to find them, limiting the program's success. This may present an opportunity to work directly with manufacturers. She added that this is a challenge for the program as the higher tiered models are necessary to achieve substantial savings in their portfolio. The new ENERGY STAR Most Efficient label may help to incentivize manufacturers to produce more efficient products.

2.1.3 Clothes Dryers

Several respondents identified dryers as a measure that shows savings potential. Although there are no CEE tiers above ENERGY STAR, there is an ENERGY STAR Most Efficient designation that can be used in dryer incentives. Interviewees identified the potential for heat pump dryers, although they also noted that an educational process would be required to make this technology more mainstream.[10] One summarized this as follows:

"There can be a lot of intervention on [heat-pump dryers] on the downstream"

> *I think heat-pump dryers could be a place where there is some growth. Right now, they're still such a small presence…Consumers don't understand or trust them, once they do I think they're a really big savings potential product. There can be a lot of intervention*

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[8] Note: As of February 5, 2018, CEE has changed their clothes washer specifications to include a tier 1, tier 2, and CEE Advanced Tier, rather than tiers 1,2, and 3. The new tier 2 specification, as well as the current ENERGY STAR Most Efficient standard, are both equal to the former CEE Tier 3 specification that is outlined in the codes and standards memo and referenced in this report (≥2.92 IMEF). The new CEE Advanced Tier (≥3.10 IMEF) would offer a substantial level of savings, but currently only one product meets that criterion. https://library.cee1.org/system/files/library/13445/CEE_ResidentialClothesWasherSpecification_05Feb2018.pdf

[9] Per CEE; as of October 2017, there were 182 models meeting tier 1 specifications, 81 meeting tier 2 specs, and 45 meeting tier 3. Two tier 2 models were top-loading, and no top-loading washing machines met the tier 3 specification. These counts do not account for the availability of each model. See: https://library.cee1.org/system/files/library/9268/2017_October_CEE_ResidentialClothesWashers.pdf.

[10] Currently, the high costs of heat pump dryers limit their potential, although they have decreased as more manufacturers have moved into the space. The cheapest heat pump dryers are currently over $700, while all six heat pump dryers achieving the ENERGY STAR Most Efficient specification cost $1,100+. (https://enervee.com/dryers/?sortBy=relevance&filters=technology_type%3DHeat%2520Pump). With these high costs, rebates offered have reached $450 in some cases (https://energy.gov/savings/puget-sound-energy-residential-energy-efficiency-rebate-programs), although most seem closer to $100-$200.

on that product on the downstream for consumers, with education, once people start to trust it, that's when the retailers start to change their assortment and add a larger proportion of heat pump dryers.

Another identified the Super-Efficient Dryer Initiative (SEDI) as providing some opportunities to identify highly efficient dryers and potentially create a multi-tiered specification.[11] In the codes and standards memo, we identified that inefficient testing methods meant that dryers likely have more opportunities than previously identified. Although this was not specifically mentioned by any participants, it is also a focus of the SEDI report.[12]

2.1.4 Refrigerators and Freezers

Refrigerators were also identified as having potential by some respondents, due to the existence of tier 2 and 3 specifications. Although, one PA called the tier 3 specification "*pretty much non-existent in the market.*" Several respondents discussed influencing consumer's purchases of efficient refrigerators. One advocated for switching to a midstream model because "*there's not a lot of effect for giving a $50 rebate for a $1000 refrigerator*." While that argument was not disputed, others pointed to refrigerators as a product where strategies to increase efficiency have been successful, as they identified the high ENERGY STAR saturation of refrigerators as a blueprint for a successful model in increased appliance efficiency. "*I think the reason ENERGY STAR is so successful with fridges is because those are the nice fridges. They have all the nice features and those are the features people want. That's where I think having the manufacturer strategies comes in. We're successful with refrigerators because it's bundled with a lot of other features,*" said one PA. This suggests that a similar model, where manufacturers add new features and efficiency simultaneously, may make tier 2 and 3 refrigerators more prominent in the market without the need for much program intervention. ENERGY STAR is also focusing on future refrigeration technology, and has chosen solid-state refrigerators as the 2017 ENERGY STAR Emerging Technology Award Category. These refrigerators must save at least 15% over the existing ENERGY STAR specification, and have potential to achieve more savings and reduce harmful refrigerants.[13]

Although no respondents specifically dismissed refrigerators, two did share some concern that with the cost of a refrigerator (and the coinciding rebate amount that it may take to influence a customer), it is important to be sure a program including refrigerators is making an impact with its achieved savings. "*We get the same amount of savings from a refrigerator as we get from about 3 LEDs*," said one respondent.

One PA also identified the potential for stand-alone freezers. She stated that her utility was bringing this product back in 2018, after previously removing the measure, as the most efficient models now pass their screening.

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[11] See A.2.1.2 for more on SEDI.
[12] "Super-Efficient Dryers", *NEEA*, http://neea.org/initiatives/residential/super-efficient-dryers, (Accessed Jun. 29, 2017).
[13] "2017-2018 Solid-State Refrigeration," *ENERGY STAR,* https://www.energystar.gov/about/awards/energy_star_emerging_technology_award_consumers/solid_state_refrigeration (Accessed Oct. 26, 2017).)

2.1.5 Room ACs

Two respondents stated that room air conditioners are continuing to show good savings. Two others identified their increasing potential as a demand-response option, as connected home devices allow greater controllability. Room ACs are included in the ESRPP portfolio, and several discussed their potential in that capacity (Section 5).

2.1.6 Pool Pumps

Several respondents identified pool pumps as a measure that shows significant opportunities that may have been underappreciated in the past. "*One thing we've been asked when looking at pool pumps is, are they a national thing, or are they an Arizona thing? The answer seems to be that it's national, savings are available in most places. There's a shortage of efficient products to make it worth our while*," said one national efficiency organization director. Respondents specifically identified the substantial increases in per-unit efficiency of variable-speed pumps, bearing in mind the added costs of such measures as well.

Some respondents advocated moving pool pumps upstream, identifying them as an easier product to work with retailers or manufacturers than some others, due to the relatively small number of stakeholders in the space. One PA told us that her utility had been running a successful program working with just two large retailers that accounted for most of the local pool-related equipment sales. Although respondents liked the short-term opportunities available in pool-pumps, two raised concerns that the opportunities may cease to exist over time. One PA told us that their state commission is planning to raise the baseline against which pool pumps are measured (from single-speed to multi-speed) due to market transformation, which will significantly limit the savings opportunities of even the most efficient variable speed models. For this reason, her utility is planning to sunset the measure soon. Another told us that the finite number of pools, especially in cold-weather states, severely limits long-term opportunities in this space. A third concern is that the upcoming DOE standard (if enacted) will limit the ability to obtain additional pool-pump savings. However, variable-speed pumps will still offer some savings, and many pool pump motors are replaced before the entire pump. The DOE standard will not apply to replacement motors and there might be opportunities to influence the replacement motor market through mid or upstream intervention or by setting a state standard.

2.2 Other Measures Identified in Interviews

Respondents identified the savings potential from some measures that NMR initially deemed to have moderate to low savings potential in the initial memo, specifically dehumidifiers and TVs (see A.2.2). They also identified some measures that were briefly discussed in the codes and standards memo but did not have specific savings potential attached. These included smart thermostats; advanced power strips; and emerging technologies, such as connected home devices.

2.2.1 Smart Thermostats

"I think it's thermostats…[as] the big things I see helping on the portfolio level"

Smart thermostats were the product most frequently discussed in our interviews. Participants identified their potential to increase heating and cooling efficiency, their utility as a demand-response tool, and their ability to collect data and to identify opportunities to promote behavioral changes. They specifically highlighted the value of the newly created ENERGY STAR specification for smart thermostats, which makes them an easier product to promote, as well as one with more clearly defined savings to be used in evaluation.[14] Respondents noted that smart thermostats were a product that fits the downstream model well for two reasons: (1) they are at a price where a $20-$50 incentive could make a real difference in the number sold – "*I think a rebate could really move the needle here. Right around $100 is when sales start to jump off for smart thermostats,*" said one participant – and (2) they are a product where consumer awareness and education for proper use is valuable and therefore the visibility of the utility is beneficial. Currently, the rebates offered in Massachusetts exceed the value suggested by this respondent. The rebates are also among the highest in the country.[15] The PAs also offer smart thermostats through their direct install programs.

Three PAs specifically mentioned the value in having smart thermostats as a downstream measure. Nearly every respondent mentioned the savings potential of smart thermostats, including every PA we interviewed. "*Smart thermostats are going gangbusters and we're seeing pretty good savings out of them*," said one PA. *"I think it's thermostats and non-res lighting, those are the big things I see helping on the portfolio level,*" said another. One respondent, who identified the behavioral opportunities stemming from smart thermostats, explained, "*smart thermostats are starting to show that they can achieve energy savings. Studies show that smart thermostats are more engaging and bring more people in. They're fun, people like getting the little green leaf*." While leveraging the ENERGY STAR specification was recommended by several respondents to help with smart thermostat programs, some also noted that certain thermostats – even those that have reached the specification – may not perform as well as others or may not have the same capabilities (e.g., learning capabilities, two-way Wi-Fi connectivity). Additionally, electric savings could be limited due to the fairly low penetration of electric heating. Therefore, respondents concluded that careful planning is critical before rolling out a smart thermostat rebate, especially if there will be efforts to use them as both an energy efficiency and demand response tool.[16]

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[14] The ENERGY STAR specification requires a demonstrated run time reduction from a weighted national average of at least 8% for heating and 10% for cooling. "Smart Thermostats Key Product Criteria," *ENERGY STAR,* https://www.energystar.gov/products/heating_cooling/smart_thermostats/key_product_criteria (accessed Oct. 11, 2017).

[15] For example, see: https://www.ecobee.com/rebates/ and https://nest.com/rebates-and-rewards/

[16] For an example of the differences between smart thermostats, see: Noah Lieb, Scott Dimetrosky, and Dan Rubado, "Thriller in Asilomar: Battle of Smart Thermostats," *Apex Analytics, Energy Trust of Oregon* and *ACEEE,* http://aceee.org/files/proceedings/2016/data/papers/2_420.pdf (2016).

2.2.2 Dehumidifiers

Three respondents identified dehumidifiers as a product with good savings potential. In the initial codes and standards memo, NMR had classified dehumidifiers as a product with moderate potential due to the federal standard increase scheduled for 2019. Participants suggested that the most efficient models still present good savings opportunities that may continue beyond that point. Dehumidifiers also offer demand-response opportunities as they can be cycled off briefly with virtually no noticeable changes to comfort. Another participant noted that with the current administration, he did not believe scheduled standards changes to be a given. This is something that could apply to any product with an upcoming standards change. One PA spoke specifically to the efficiency and savings opportunities from newer models, saying, "*For 2018, we filed to bring back dehumidifiers, which we had previously taken out. The incremental cost had been so low we hadn't been able to justify them, but that now has shifted, so here downstream is working.*" Another respondent told us, "*There are some opportunities to educate consumers more, like with dehumidifiers where there is some significant difference at the most efficient level*."

2.2.3 Televisions

Respondents suggested that televisions are a measure once again becoming viable. One stated, "*I know that some of the new highly efficient models of televisions are showing good enough savings that they are worth exploring again. They stopped being a good opportunity a few years ago, but have now become viable again.*" Another echoed this sentiment, saying, "*Maybe it's worth looking at TVs again, even though I was one of the people telling the PAs to move on in the past. We might want to look now at the TVs above ENERGY STAR*." A third respondent also identified TVs as an area where program action may be valuable, specifically identifying TVs as a major contributor to plug-load; one that is large enough to target individually.

2.2.4 Air Purifiers

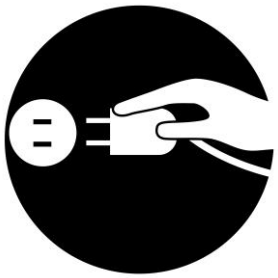
Two respondents identified air purifiers as an opportunity for savings. In the initial codes and standards memo, NMR identified air purifiers as a low to moderate savings potential measure due to the relatively low penetration of the product and non-existence of CEE tiers. However, as these respondents noted, the per-unit savings for ENERGY STAR models are substantial. There may be opportunities to leverage these savings, potentially through a midstream or RPP approach, especially as there is not a future standard set to go into effect.

2.2.5 Electric Vehicle Chargers

We asked respondents specifically about the future of Electric Vehicles (EVs) and EV chargers and their roles in energy efficiency and demand response. Responses centered around the efficiency of chargers, new construction opportunities for charging stations, and infrastructure. Several respondents agreed that there are opportunities for increasing the efficiency of EV chargers, and that this could be achieved by leveraging the new ENERGY

STAR specification in future program activity.[17] One respondent advocated for this, adding that such a program could help with EV infrastructure and understanding load changes from EVs. "*EV signals are easy to read so it wouldn't be hard for a program to support the growth of EVs and know what homes are getting EVs and adding load because of this. You could separate increases in efficiency from increases in load due to EVs. Programs can help EV infrastructure exist and become more efficient*," she said. Another respondent also advocated for program intervention in a similar way, saying, "*[I think] the role for EVs right now is in [promoting EV readiness in] new construction and promoting the ENERGY STAR spec*." Three PAs told us they are in the early stages of working to integrate EV infrastructure into their future load management plans. Although they all said that this was in the early stages, they also noted that the inevitability of EV growth in the near future makes this an important focus. Recent studies have corroborated this; the number of EV models has grown from two in 2010 to a projected 50+ by 2018, with more manufacturers entering the market and forecasts projecting EVs to account for 35% of new car sales by 2040.[18] One PA identified the growing EV market as an opportunity for utilities to establish relationships with auto manufacturers, and to attempt to work closely with them as EV efficiency and use as a grid stabilization tool becomes more efficient.

2.2.6 Advanced Power Strips



"We're seeing huge savings from tier 2 power strips in early studies"

Most respondents identified tier 1 and tier 2 advanced power strips (APS) as a product with opportunities for increasing efficiency and decreasing plug loads. "*We're seeing huge savings from tier 2 power strips in early studies, over 200 kWh per unit…You can't ignore that,*" said one respondent. NMR completed interviews with two advanced power strip manufacturers to help better understand the technology and its opportunities. "*Advanced power strips have shown to be [better options] than LEDs in some cases,*" one said. Some raised concerns over whether or not APS can actually achieve the savings that many have deemed, and whether or not it is realistic to expect that customers will actually use them in the most effective manner. Primary research in this area is limited and pre/post metering will be required to redefine savings in the future.[19] The ongoing MA RLPNC 16-3 smart power strip metering study should shed more light on the savings potential of tier 2 units in Massachusetts (see below). Most agreed that due to the educational process required, advanced power strips are not a product that is currently viable for retail; although, one PA said they were working on getting them into more stores. One manufacturer suggested that the best way to get tier 1 strips to consumers was through kit programs, while

[17] "Electric Vehicle Supply Equipment (EVSE) Key Product Criteria," *ENERGY STAR,* https://www.energystar.gov/products/evse_key_product_criteria (Dec. 27, 2016).
[18] Roland Hwang, "Future of Electric Vehicles is Bright," *NRDC,* https://www.nrdc.org/experts/roland-hwang/future-electric-vehicles-bright (Mar. 8, 2016).
[19] See: Katherine Johnson and Jim Bradford, "Tier 2 Advanced Power Strips: Examining Energy Savings Potential in a New and Changing Market," *Johnson Consulting Group* and *Mesa Point Energy,* (Sep. 21, 2017).

tier 2 worked better in direct-install programs due to the slightly more advanced nature of the technology. Another PA also raised the concern that the current design of the power strips is not viable for many, arguing that, "*two always on outlets isn't enough for some households if you want them to actually use the device in the way it's meant to be used.*"[20] For more on advanced power strips see B.1.

Note: The PAs currently offer incentives for Tier 1 and Tier 2 APS. The PAs and EEAC have identified APS as a key product of interest for additional evaluation.

The RLPNC 16-3: Smart Power Strip Metering Study has been designed to provide data to update baseload energy usage for devices that can be controlled by Smart Power Strips and the Energy Reduction Potential (ERP) of both Tier 1 and Tier 2 Smart Power Strips. Study results are expected to be available in 2018, but will not be available in time for the 2017 Annual Report. The field work and metering for this project are being conducted in conjunction with the ongoing Massachusetts Residential Baseline Study.

The RLPNC 16-4: Smart Power Strip Impact Survey will provide data to update NTG, in-service rate, and persistence.

2.2.7 Emerging Technologies

The role of the utility in the connected home market, which respondents all acknowledged is an inevitable future challenge, was a much-discussed topic in all interviews. General connected home technologies are discussed further below (see 2.5). There were two new products that were specific topics of discussion: Sense, a product you can clip onto an electric panel to see where energy usage is going, and "green-button" switches, which can shut several outlets off at once when someone is leaving their home. The application of both these products center largely on behavioral adjustments and are discussed in that subsection (2.4).

Finally, adding new technology to existing products may lead to substantial increases in efficiency in the future. At the ENERGY STAR partner's meeting, thermoelectric heat-pump technology in dishwashers, and inverter technology in room air conditioners, were both identified as technologies with potential to significantly increase efficiency in those measures.[21] These technologies may still take a number of years to become popular in residential applications (if they ever catch on), but they highlight that new, emerging technologies; can quickly make a product more viable for savings.

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[20] This respondent suggested that customers who plug in devices to a strip periodically (e.g., a fan, vacuum, or phone charger) have expressed frustration when they plug these devices into a controlled outlet and may not understand why the device doesn't work. This respondent suggested that it may make sense to only have one or two controlled outlets for some customers, especially if the customer has few peripherals. Further analysis is needed to see if worthwhile savings can be achieved by only controlling one or two peripherals.

[21] For more on Thermoelectric Heat Pump Dishwashers see: https://energy.gov/eere/buildings/downloads/thermoelectric-heat-pump-recovery-system-domestic-dishwashers. At the meeting, a manufacturer indicated that room ACs with inverter technology could achieve a SEER of 16.0, much higher than the most efficient on the market today.

2.3 "BUGGY" PRODUCTS

We asked interviewees to identify products that may not yet be ready for program inclusion due to poor performance, lack of consumer understanding, or minimal savings. This question was inspired by the poor quality Compact Fluorescent Light bulbs (CFLs) that were introduced to the market prematurely and turned consumers off from that technology for years. Two products emerged from this line of questioning. Two respondents identified some smart thermostats as an area of concern, noting that "*some brands don't meet expectations or are a little buggy*." One respondent proposed using the ENERGY STAR specification to identify models to suggest to consumers as a solution to avoid this. Several respondents were concerned that some connected home devices may be inferior to others. This is a topic we discuss further in 2.5.

Some LED lighting was also identified. One respondent identified the poor-performance of some non-ENERGY STAR models as an issue, especially with bulb-life being significantly shorter than consumers expect.[22] Another identified the issues that consumers have had with the quality of light from LEDs. "*People hate the quality of light coming from LEDs, but there needs to be more of an educational process telling people that they can actually tune the color of their light now.*"

2.4 BEHAVIORAL OPPORTUNITIES

Most respondents brought up behavioral changes as an opportunity for savings, with some identifying them as the best way to increase savings. "*I still think the overarching opportunity is behavior savings. In terms of growth, there's no minimum standard. There's a lot of debate over the decay rate (i.e., the persistence of these savings), but I think behavioral savings is too often boiled down to home-energy reports (HERs). That's a perfectly good thing, but taking a broader approach on how to leverage smart products to influence the behavior approach is definitely worthwhile*," explained one respondent. "*You can save more energy through behavior change. I think applying the lens of why smart thermostats have been so successful to other products in the marketplace, saying we have the information available, and we might be able to have several products that would promote energy savings behavior on top of any laboratory savings estimate, because you have that behavior change element*." Other respondents discussed the value of influencing purchasing behavior, which is discussed in 3.1.2.

"I still think the overarching opportunity is in behavior savings. Taking a broader approach on how to leverage smart products to influence the behavior approach is definitely worthwhile."

Respondents discussed specific products with regards to behavioral opportunities. The PA using the Sense product told us, "*We're running a small pilot, trying to understand*

[22] This shortfall likely occurs when consumers learn the bulb-life of ENERGY STAR LEDs, then associate that with all LEDs, and are disappointed when non-ENERGY STAR models do not meet this performance level, even if the bulbs aren't labeled to show a 25,000-hour lifetime.

disaggregating customer loads in their homes and putting them on different rates (TOU, etc.) and seeing how that information has them respond. This is a little bit different of a type of product that we're testing out, it targets behavior, but we want to see how people change their behavior and what it means for products [with demand response-capabilities] like refrigerators and freezers [where ice-making can be delayed, or temperatures can be cycled briefly]; we can offer discounts if the usage is high there." Sense shows users exactly what product or appliance is using energy in real-time, sending data to a smart-phone app, which allows customers to more easily make behavioral adjustments without having to figure out where they are consuming energy. This, and similar emerging technologies, could build upon the many behavioral, energy-monitoring/reporting type programs that have shown savings in the past.[23]

In addition to Sense, a respondent also highlighted the relatively low cost and high savings that could be achieved through disaggregating loads using smart meter analysis software. This participant discussed the Home Intel technology by HEA, which recently won a bid to participate in PG&E's P4P pilot (see 3.2). In small pilots, this technology had seen average savings of 12.8% across electric and gas measures. Other respondents alluded to new technologies capable of providing more home use information or disaggregation, though they did not specifically mention the names of any products. As noted in the initial codes and standards memo (A.3.3), a PG&E pilot with Bidgely yielded 7.7% average savings, while the DTE Insight App has yielded between 5% and 10% savings using Powerley's technology.[24] Both these companies have been involved in a series of pilots, and there are a variety of options available on the market becoming more widely available and consumer-friendly.

Two respondents identified the potential of a green-switch or kill-switch type technology that shuts off multiple outlets at once as a tool to target plug loads. *"I could see coffee makers or toasters that are going to have their own sort of kill-switches when they're not on, or have outlets where you can walk out of your house and a switch right next to your door would turn off all the outlets around the house that you wanted to turn off. I think those things will come back or maybe be a bigger opportunity for programs in the future. I think it just has to be something more integrated and easier to use*," said one PA. He went on to acknowledge that this type of product becomes difficult in homes with multiple occupants on different schedules, as more coordination or understanding is required, which inevitably will decrease convenience.

Respondents also discussed home energy reports as a way to increase behavioral savings. This is an opportunity that has increased as smart thermostats and other technologies

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[23] For a summary of some of these programs, see: Skip Schick and Summer Goodwin, "Residential Behavior Based Energy Efficiency Program Profiles", *Bonneville Power Administration,* https://www.bpa.gov/EE/Technology/EE-emerging-technologies/Projects-Reports-Archives/Behavior-Based-EE-Programs/Documents/BBEE_Res_Profiles_Dec_2011.pdf (Dec. 2011). For an example in MA see: "Antje Siems, "Evaluation of the Massachusetts PowerCost Monitor Pilot Program," *Opinion Dynamics,* http://aceee.org/files/pdf/conferences/mt/2009/E3_Siems.pdf (2009).

[24] See: Neil Strother, "PG&E-Bidgely Pilot Yields Energy Savings, Now It Needs to Scale", *Navigant Blog,* https://www.navigantresearch.com/blog/pge-bidgely-pilot-yields-energy-savings-now-it-needs-to-scale (Apr. 20, 2015) and "DTE App Earns Efficiency Nod", *The Monroe News,* http://www.monroenews.com/news/20160225/dte-app-earns-efficiency-nod (Feb. 25, 2016).

provide more insight into exactly where end-use energy is being consumed (see B.3 for more).

2.5 CONNECTED HOME/LIGHTING

Connected homes were one of the most frequently discussed topics throughout the interviews. Nearly all interview participants were in agreement that connected home devices will play a critical role in both efficiency and demand response solutions in the future (see 2.6.1 for more on connected homes as a DR tool). It may take a redefining effort for the utility to become more engaged in this space, but respondents agree that future homes will be largely connected with new technologies, and intervening in this market will be critically important for utilities. Participants agreed that this technology is taking off and that utilities could play a central role because customers will want a single app or device, rather than relying on multiple technologies to aggregate the devices in their home. Utilities could intervene to help this fluidity, perhaps through advocating to manufacturers, or working to promote open standards or to develop an ENERGY STAR specification for voice activated or controlling devices. There was also consensus that these technologies will become extremely prevalent sooner rather than later. Evidence supports this – a 2017 report found 35.6 million Americans will use a voice-activated device at least once per month (up 129% from 2016), while another suggests that these devices "stand a chance of achieving over 100 million units a year in the upcoming few years."[25][26]

Despite this, there was also agreement that the best way for the utility to intervene in this market is yet to be seen. *"I think this space is still kind of blurry at this point. You have Amazon Alexa, Google Home, a lot of these smart devices have different communication protocols and we're still trying to figure out exactly how this connected home strategy will work. [These technologies] are not ready but need some work or a boost to get them to a readier state*," said one west-coast PA. Not only have the best strategies not yet been defined, but also a dominant technology is yet to emerge (see B.2 for more on the challenges in the connected home market). Although early engagement will be important in involvement into the connected home market, there is also a risk in becoming involved too early and engaging the incorrect technology. One PA summarized it as follows:

> *I think of [connected home technologies] like a VCR in beta. There were a few different types in the market and eventually VHS won out. I think what we're waiting for is to see what platforms rise to the top. You've got integrated products, standalone products, different companies involved like Amazon and Google, so it's kind of piecemeal right now and I think there's hesitation…in pushing our customers in one way or another and then finding out that their product they invested in either doesn't work with something. I think there's just a little hesitation to go full boar with it until a little more is worked out and we understand what's trending or what's expected to trend for quite a while.*

Although supporting the wrong technology is a risk, thus far Amazon's Alexa seems to be dominating the market (70.6% of all voice-enable speaker devices), with Google Home, a

[25] Sarah Perez, "Amazon to control 70 percent of the voice-controlled speaker market this year", *TechCrunch* https://techcrunch.com/2017/05/08/amazon-to-control-70-percent-of-the-voice-controlled-speaker-market-this-year/ (May8, 2017).
[26] Cage Chao and Joseph Tsai, "Amazon Echo Series Device Shipments Expected to Surpass 10 Million in 2017," *DigiTimes*, http://www.digitimes.com/news/a20170601PD218.html (Jun. 1, 2017).

distant second (23.8%), still well ahead of the rest of the competition (Lenovo, LG, Harmon Kardon, and Mattel combined account for 5.6% of users).[27] Additionally, companies from other industries may become involved in this market. For example, Nest has recently added a home-security component, which could lead to Nest devices controlling most of a home.[28]

2.5.1 Connected Lighting

Connected lighting was one of the more polarizing technologies discussed during market scan interviews. Some saw the technology as a total nonstarter due to either small draws that the technology would be controlling – "*Best case scenario you're changing a 9W bulb into a 4W bulb, which is really not that impactful*"– or because the standby draws might totally negate the energy that connected lighting technologies do save. "*There's still a case to be made that they even save energy with the always-on standby component while controlling LEDs with already low wattages,*" added the same respondent. "*Connected lighting is cool and funky and has nothing to do with energy efficiency. Reducing the run time of an LED has almost no savings and you're adding standby/parasitic draw. In the end, it's a losing proposition.*"

Some did take a more optimistic approach towards connected lighting. One respondent identified connected lighting technologies as one of the greatest residential opportunities moving forward, stating that *"there's not much more you can do with reducing wattage so you have to focus on the hours.*" We spoke to two utility PAs who are both exploring program involvement in the connected lighting market; although, both acknowledged their current involvement is very much focused on testing the waters for this market. "*Is it reasonable to put huge incentives on these bulbs when not everyone is going to buy them?*" asked one PA. She went on to acknowledge that connected lighting may only apply to a small niche market, which is a large reason for her utility's hesitancy to become fully involved. "*They really benefit that element of the market that's trying new and innovative things, so what we're proposing to do is set our incentives at a level where we can incentivize something at a minimal level, like the Philips Hue, so we can see in-store purchases and how many people do buy this bulb then we can see how the market responds to connected lighting and how it continues to grow,*" she said. Another PA explained that the involvement in connected lighting is largely just an offshoot of regular residential lighting programs, although it may allow the utility to gauge customer interest in the technology. "*We do currently offer rebates on connected lighting, but only at the same rebate level as the standard Energy Star LEDs. For example, if a connected lighting kit contains one A-Lamp LED, we offer the standard A-Lamp LED rebate of $1.25,*" she explained.

Although it was not mentioned specifically by any participants, connected lighting may be best applied to exterior fixtures, where lights are typically on for long hours, sometimes

[27] Perez, "Amazon to control 70 percent of the voice-controlled speaker market this year."
[28] See: https://nest.com/alarm-system/overview/

unnecessarily. In a recent connected lighting pilot, some customers indicated a preference for exterior lights when using connected technologies.[29]

2.5.2 Residential Batteries

We also asked respondents about the future role of residential batteries. Although none of the interview participants had yet implemented or evaluated a residential battery pilot or program, some shared their thoughts on the importance of residential batteries in the future. "*Batteries look like they will very soon be [a viable measure for program activity], we'll see how that will interplay with solar units and shaping loads, but it's happening so fast it seems like it's an 'in the next few years thing' not a long-term thing, and that's how we're treating it internally*," said one PA. Another was less confident about their role, stating, "*There may be a future opportunity. It depends on the trajectory that these technologies take in terms of whether they materialize or not. There are so many bigger picture discussions that these matters often get complicated*."

Another told us simply that further research is needed to see how valuable batteries could be as a demand-response tool. "*I think the smart thing is do a lot of analysis on a lot of different types of batteries and see when does it make more sense to just get batteries in everyone's home versus having all these small products slightly manipulating load*." Currently, utility-installed residential batteries are rare but increasing. A 2016 report estimated there to be 1,762 currently installed accounting for 11.2 MW of storage.[30]

2.6 Demand Response

Demand response discussions centered around two main themes: (1) the ability to use or repurpose existing technologies or appliances to be effective demand response tools, and (2) the relationships between efficiency, demand-response, and load shaping moving forward. Several interviewees noted the potential in putting a switch on something like an old, inefficient water heater to make that an effective demand response tool. "*Make 'dumb' water heaters into connected smart water heaters*," said one respondent, who advocated for installing a switch during in-home audits. "*By making sure water is not being reheated in the middle of the night with nobody home etc., you achieve small net energy savings but a very significant demand response option*." Another participant picked up the water heater example to ask a long-term question when it comes to deciding how efficiency and demand-response can or cannot work side by side:

> *Do I want an inefficient water heater that uses a ton of energy but is a great battery, or an instantaneous highly efficient water heater that uses basically no energy to run? We don't have the answer to how to quantify the tradeoffs, but the pattern we see is people are striving for both efficiency and demand-response. Let's not ignore that inefficient products [that are already in place]*

[29] Bonn, Lara and Rivest, Jasmine, "Smart Lighting and Smart Hub DIY Install: Does it Yield?" *Efficiency Vermont,* https://www.efficiencyvermont.com/Media/Default/docs/white-papers/efficiency-vermont-hems-pilot-white-paper.pdf (Aug. 16, 2017), pp. 19-20, 39.
[30] Nick Esch, Jon Fortune, Brenda Chew and Madison Lynch, "2017 Utility Energy Storage Market Snapshot," *Smart Electric Power Alliance,* (Sep. 2017).

> *can serve as a great grid resource. Inefficient water heaters are a great grid management resource. I think as energy prices go up and TOU prices become more common, we'll see more segmented programs addressing both efficiency and storage and that might lead to [DR] program activity in relatively inefficient product space. In the future, we may have to make tough decisions between energy-efficiency or storage or try to do a balancing act with both. We may need to see what is more valuable and where, [as making an inefficient product capable of DR may be a cheaper, more effective solution than replacing the unit].*

This theme led to one PA discussing a "multipronged" approach to use both energy-efficiency and demand response options to achieve load shaping. She discussed the value of being able to control demand by making barely noticeable changes to active devices or appliances across a wide range of customers who have installed efficient options.

In other words, energy efficiency can serve a different purpose if it can be deployed as a resource or a form of "supply" to help smooth loads that may be impacted by solar and other renewables. Once a large enough mass of customers has been reached with efficient products, "energy efficiency's true potential will shift from baseload savings toward a market-oriented approach, where the value of saving energy at the right times – and in the right parts of the grid – will climb dramatically."[31]

This PA went on to add that with the future integration of smart thermostats, residential batteries and EVs, we might be close to a future where this could be achieved on a great scale without needing to use any existing in-home technologies for demand response. Another utility PA also told us that they were looking to use electric circuit breakers to do demand-response with a wide range of products. For more information on smart thermostats and specific products identified as capable of demand response see B.4.

2.6.1 Connected Homes as an Energy Efficiency or Demand-Response Solution

Respondents foresaw the greatest opportunities in using connected home technologies as tools for energy efficiency; in the ability to control small products that were typically difficult to include in efficiency programs in the past; and to correct for bad behavior in terms of inefficient energy practices, such as leaving the lights on when leaving for an evening or keeping the heating or cooling system on a normal schedule when going on vacation. One interviewee addressed both opportunities, saying, "*Alexa, for example, is right at the tipping point where you have one place where you can control a whole slew of different things. And that's going to have an energy impact. If I'm in the geographical location of my home, the lights come on, if I leave, the lights go off. My plug load will be connected to this, the connected home will help impact that.*" Another added, "*The loads are small enough that if you can't coordinate across measures it won't be worth chasing this…If you think of every product in the home as a little piece of a smart grid, the odds of them being utilized go way*

[31] Matt Golden, "How Energy Efficiency Can Help Manage the Duck Curve", *Greentech Media.* https://www.greentechmedia.com/articles/read/the-grid-has-changed-how-energy-efficiency-can-help-manage-the-duck#gs.ZltkCqw (Jan. 21, 2016).

up if there are open standards and the devices can communicate with each other and people have lots of choices on how to connect."

While the energy savings from a connected home may prove to be significant, or may expand as new technologies are created and utilized, many respondents noted that the greatest opportunities in utilizing connected home technologies lie in demand-response. "*Connected appliances go into the increasingly important side of demand-response…Serious consideration needs to be given for demand enabled products, assuming that the demand enabled technology would actually leverage demand-response solutions…It would be good to be able to turn off someone's dehumidifier for a couple of hours, it won't affect comfort*," explained one participant. Others discussed the potential of cycling refrigerator temperatures up by a few degrees, or automatically running washer, dryer, or dishwasher cycles in off-peak times. Although these options are possible with current technologies, adding elements of connectivity by allowing the devices to "talk" to each other and to the utility allows this to be achieved more easily, and with more convenience to the consumer. For example, with connected home technology communicating with the utility about current rates, a consumer could easily have their dishwasher run automatically at a more convenient time, without any reminder necessary. "*Within [my utility] there is an effort to see how we can leverage these connected home devices. In CA, the residential customers are going to be defaulted to a TOU rate in 2019, so with all these smart devices coming out, devices will learn to interplay with the TOU default, but I don't think we have it all figured out yet*," explained one PA.

2.7 PLUG LOAD

As identified in the codes and standards memo, plug load (or miscellaneous loads) has been a growing concern and a hard to target area, as the small draws of the many household products that are frequently plugged in makes them difficult to address through program activity (see A.3 for more). "*The latest studies in CA show that something like 70% of load growth in the next cycle (through 2025) is projected to be due to plug load and appliances; it's becoming a bigger share of the residential consumption per household*," explained one respondent. Nearly all interviewees agreed that plug loads are an area worth addressing due to the number of devices that we plug in, but there was some debate as to whether these products are actually inefficient and whether or not plug-load is indeed increasing. "*We've been so effective in increasing efficiency of larger products that plug loads are going to be a bigger piece of the pie in future years. It's a difficult issue; unlike with larger products, you don't just plug a more efficient unit in and immediately get savings so it's a tricky issue*," said one utility PA, acknowledging that more could be done to curb plug-loads.

While several others echoed that plug-loads are increasing, some believed that despite more devices being plugged in, overall consumption is staying largely the same due to the increased efficiency of what is being plugged in. "*I would question that plug loads are increasing. I know more is being plugged in, but the products/appliances are more efficient...Some large loads like desktops are rarely used now. I'm not that concerned about growing plug loads, but there is still room for efficiency in larger products like room air-conditioners, room dehumidifiers, and so on... I know we plug more in, but I know we've*

nailed some things down like making chargers much more efficient and smarter," said one participant. Another PA echoed this saying, "*I think plug load is actually declining but I don't know that for a fact, it's just my sense. Things have gone from inefficient TVs to more efficient, we've switched from computers to tablets, chargers are much more efficient. These trends are continuing to decrease plug-load per product*." She went on to add that plug-load is worth addressing, but cautioned that with the ever-changing popularity in home electronics there are risks attached to investing too heavily. She stated,

> *If you're going to be putting ratepayer money towards this (consumer electronics), you really need to understand the structure of the model and the global trends, because if you're paying a ton of money to get people off of one type of energy hog equipment, you have to be sure the trend wasn't changing anyways [and people weren't moving on from these devices]. I think that's where you have to think about the structure of how you do your incentives program and whether you can support such a quickly moving market anyway.*

This PA added that she believed an RPP approach is the best way to target plug-loads. This was the most common suggestion from interviewees in terms of addressing plug-loads. We discuss this in in greater detail later in 0. One advanced power strip manufacturer suggested that newer products, which had not existed previously (such as sound bars), are leading to growing plug loads. "*We just completed a field trial and saw plug load increased a lot in some targeted areas in just the last few years. Plug load is a big issue and becoming bigger, especially now that we've addressed lighting. Devices are getting smarter. I would look at platform management and a way to scale across all platforms. It's about the energy-efficiency journey for the customer. Once we're in the home, we can target the customer with the thing for their needs in plug loads."*

In terms of addressing plug loads, the most frequently suggested solutions were advanced power strips, connected home strategies, behavioral programs, and an RPP approach to target many small products.

3 Effectively Leveraging Efficient Products

As increasing baselines and saturation of efficient products make it more difficult to run a successful products program, good program design and effective delivery take on increasing significance. *"It's going to be a hard go for a while, or maybe forever, because cheap energy savings are gone. The key now is trying to be comprehensive*," explained one respondent. This section outlines the strategies provided in the market scan interviews to more effectively leverage efficient products and strategies to help programs achieve successful savings or demand-reduction in a low-cost manner. It is important to note that RPP was a frequently discussed topic in program-design strategies, which is touched on in this section but discussed at length in Section 5.

Key findings:

- ***Many consumers do not consider efficiency when deciding what product to buy, or think of it only as an afterthought****. To combat this, the utility or the program needs to insert themselves into the decision process at an early stage, while research is being conducted and the decision of what to purchase is being made. This can be achieved by presenting consumers with more materials and resources on efficiency during their research or by presenting them with a more efficient array of choices to promote an efficient decision even if the consumer does not know that they are making one.*
- ***In many cases, efficient products exist that meet customer's criteria in terms of price and features; however, due to a greater number of inefficient products meeting the same criteria, there are often cases where the consumer is unaware that an efficient product that suits their needs and budget exists.*** *Working with online retailers to rearrange the order in which search results appear to include efficiency, or making efficient product placement more prominent in-store, could help solve this problem.*
- ***Online tools, social media messaging, and similar strategies can help integrate the utility and energy-efficiency into the consumers' thought process.*** *Purchase decisions are usually made before the consumer reaches the store, so finding ways to reach them sooner is essential.*
- ***There is still a role for downstream rebates, but the precise timing and placement where they are effective need to be carefully understood.*** *Incremental costs have to be considered in downstream programs to ensure that rebates are influencing decisions and achieving savings. Choosing between downstream, midstream, or upstream options should not be viewed as black or white, but rather there should be some interaction across methods to best target opportunities.*
- ***Customer targeting and Pay-for-Performance models are on the rise, but as with downstream rebates, these are not "catch all" solutions.*** *Customers are*

becoming more comfortable with their data being shared. This creates opportunities in big data solutions, such as targeting high use customers or allowing a third party to use these approaches and paying them for results.

- ***Interviewees agree that more can be done in the multifamily market, although most were unsure of the best ways to target this group.*** *Many suggested broad market transformations to be the best solution here so that the array of products everyone is selecting from is more efficient, whether they are shopping for a single or multifamily home. Behavioral approaches were also cited.*

Table 3 provides the overall outline for this section, which highlights the strategies that interview respondents provided as the best ways to leverage efficient products and efficient decision-making.

Table 3: Interview Participant Strategies to Leverage Efficiency

Approach/Topic	Market Scan Insight
Overall Utility Role in Decision Making (Section 3)	*"The idea is having the PAs present when the decision of what to buy is made, maybe through going to a website that an energy-efficiency program expert helped design, so that you infiltrate the place where customers are making their decision to have efficiency all around them."*
Increasing Efficiency in Online Market Places (3.1.1)	*Most research is done online so "getting a retailer to alter the options displayed from a search to move efficient results into the first few options displayed, you can get many more customers buying efficient units without paying more or sacrificing features."*
Influencing Purchasing Behavior (3.1.2)	*"I don't want to demonize rebates, I think there's a time and a place for them. But what we've observed is that marketing and engagement, of customers, retailers, installers, manufacturers, is very important instead of just using buy-downs."*
Using Social Media Campaigns (3.1.3)	*"They're not costly, there's no paper, and we can hit a large population of customers with just one campaign."*
Pay for Performance Models (3.2)	*The P4P approach offers opportunities moving forward but is not an end-all solution to energy efficiency programs.*
Targeting High Use/Less Efficient Customers (3.2.1)	*"We now have better data about customers who are increasingly okay with utilities and others using that data to figure out what's best for them and to make recommendations."*
Reaching the Multifamily Market (3.3)	*"This is where I would say if you have a good midstream/upstream strategy [renters or landlords] buy stuff in the same place as single-family homeowners buy stuff."*
Reaching the Low-Income Market (3.4)	*"The people buying efficient products are not low-income, they have money to buy efficiently already, so I think free-ridership is very high. Having a rebate at the point of sale makes efficiency more available to those who wouldn't be able to afford the product right away."*

3.1 THE ROLE OF THE UTILITY IN CONSUMER DECISION MAKING

Interviewees frequently discussed the need for the utility to be "present" when people are deciding what product to purchase. "[*T]he idea is having the PAs present when the decision of what to buy is made, maybe through going to a website that an energy-efficiency program expert helped design, so that you infiltrate the place where customers are making their decision to have efficiency all around them, instead of having them go to the store and saying, 'oh by the way, there's a rebate,'*" suggested one respondent. Another stated, "*We're trying to create another identity for efficient products and let customers know what [we] recommend for them, where we've provided these discounts. So, we're trying to become [more of] an educational resource [both in retail and online].*"

"[T]he idea is having the PAs present when the decision of what to buy is made, so that you infiltrate the place where customers are making their decision to have efficiency all around them."

Another respondent agreed that the utility moving into a more educational role will be beneficial in getting the correct products into consumer's hands. "*I don't think of going to my utility to educate me about what refrigerator to buy. I go to Sears or Best Buy, then look at efficiency later. I think that's some of what RPP is focusing on. Working at a national level is the play,*" he stated. Since customers often do their research online and reach their decision before entering the store, many identified the need for efficiency to be a focus in online markets and resources. Once a customer reaches the store, it is likely too late for a rebate to make a difference. This is especially true for customers who do not prioritize efficiency. Understanding the decision-making process, being "present" or influential at key touch points, and putting the right assortment of products in front of consumers are all critical to getting the right product into the consumer's hands. One evaluator stated,

> *I think the first thing is you have to understand what the customer actually wants, we're past the days of "here's a widget, who's going to buy it?" Customers have access to a lot more information and there are a lot more tools to sway customers. The second thing, you have to understand the transaction that occurs when a customer is making a product or a service transaction. The more you understand about a transaction, the more effective you can be.*

Another efficiency partnership director added to this, also highlighting the importance of making sure people are seeing the right assortment of products:

> *You have to change the consumer's choices to see better, more efficient models. Maybe consumers don't want to buy the worst option [in terms of features or design], and if all the better options are more efficient models that could be helpful… Putting good options in front of people is much more impactful than anything else…People are deciding what to buy way before they get to the store shelves. Putting the best options in front of people while they're doing their initial searches is the best approach, lots of small decisions are being made and you're interested in the person with no interest in efficiency in decision making. We want to pull these people in who are not focused on energy efficiency at all.*

Although there are still places where offering downstream incentives is practical, moving beyond a framework that relies solely on this tool to shift a customer's purchasing behavior can present greater opportunities to stay involved in products programs and increase their

effectiveness both in terms of costs and impacts. One PA, who was a proponent of using RPP to shift the assortment of products in front of consumers, explained the need to find new ways to motivate people, a sentiment that was shared by nearly all participants:

> *I think this is where RPP type stuff is helpful. I think that our industry is not very efficient at how we understand how people make decisions and so we use incentives as the lever pretty strongly because we're making this underlying assumption that people are economically rational and that's not really how people move. For some products, I think people might behave more economically rational than for others, and so it's not that incentives aren't a tool, it's just that it shouldn't be such a heavily used tool, particularly when you've got these really small incentives. Thirty-five dollars probably isn't changing anything on big ticket items like a refrigerator. That's not making people think about things differently. Marketing and product placements and social media campaigns are more likely to work here…So, where do we do that, where do we try to impact more through doing really thoughtful studies, like how do you intervene at the right choice point and where do you use the incentive lever and where do you say, "that's just throwing away $35?"*

3.1.1 Online Marketplaces/Research

The most frequently identified intervention point was in the online marketplace, where customers are often making their purchases or at least researching what they will buy before going to the store. Some participants talked about internal efforts to promote online platforms, while several highlighted the potential of using the Enervee platform or a similar tool. Enervee is an online efficiency products marketplace used by several utilities, but open to anyone, which assigns an energy score to products and appliances across a multitude of categories to simplify efficient shopping.[32] Speaking from his personal experience, one respondent told us, "*I'm in the process of buying some white goods myself. I do all my research online. The best way to influence my buying decision is to influence the material that I'm seeing online, same for most customers*." He went on to explain that he was using the Enervee platform, and called it a "*nice, helpful product*" due to the centralized nature of all the information he needed for purchasing, including, but not limited to, information on efficiency.

"By getting a retailer to alter the options displayed from a search to move efficient results into the first few options displayed, you can get many more customers buying efficient units without paying more or sacrificing features."

Another respondent noted that she likes online platforms and their "*ability to influence consumers where they're doing most of their research,"* highlighting online platforms that have energy scores, which makes it easier to raise consumer awareness for efficiency and making efficiency more translatable across products. One PA, who is involved in running an online tool that is not an actual marketplace, explained that PAs can play different roles online and have to understand what they're doing. "*I think deciding what your role is, or what your roles are is important [working online]. Do you want to be an educator or an influencer? Take the necessary steps to move your program into that role. We don't influence consumer choice ever in the sense that we don't want them to buy one specific brand over the other, but we*

[32] https://enervee.com/

do want them to buy a specific level of efficiency. We try to adopt standards across the board that influences the consumer's choice. You want to give them choices, but you want to have them make good choices," he explained. He also noted that they have seen good organic growth with their online resource. "*People probably have pre-conceptions before walking into stores – most are probably not making their decision in a brick and mortar store. Probably the best place to [change these perceptions] is online. I like the idea of putting a calculator on websites where decisions are made to help engage customers about savings*," he said.

Although many utilities have successfully built and promoted in-house or regional online efficiency marketplaces or resources, expanding efficiency messaging, visibility, or influencing the outcomes in search results on major online retailer's websites would be very helpful in promoting efficiency, as these are often the only sites customers visit. One respondent, who works specifically with efficiency in online market places, told us that there are often efficient products that fit exactly what people are looking for (e.g., price, features, etc.). However, the customer may never see the efficient option, even at their specific price point, because there are often many more inefficient products that fit the same criteria at the same price. Customers may simply buy the first inefficient model that they find that meets their criterion, without ever knowing that it is inefficient or that more efficient models were available with the same features and price point. This participant told us, "*in some places if you give people the options, they see that there are efficient options available that are just as cheap as others, even if the average efficient product is more expensive…by getting a retailer to alter the options displayed from a search to move efficient results into the first few options displayed [whether or not the product's efficiency is explicitly displayed] you can get many more customers buying efficient units without paying more or sacrificing features.*"

3.1.2 Purchasing Behavior

Although behavior in energy-efficiency is typically thought of in terms of influencing the way that a consumer acts in their home, there is also value in targeting customer behavior while they are shopping for products. One respondent explained,

> *I personally have heard the same argument from all industries except lighting that the rebates are just not big enough to move the needle. The rebates aren't going to get bigger, that's what our members say clearly. If you put something on sale you can cause consumers to devalue it. I think we need to look at marketing and other communication strategies that other industries have used to get people to buy products. I don't want to demonize rebates, I think it's clear that there's a time and a place for them. But what we've observed is marketing and engagement, not just of customers but also of retailers, installers, manufacturers, is very important instead of just using buy-downs.*

Although there may not be a direct mechanism that would be as effective at influencing consumer behavior as downstream rebates have been, many interviewees recognized that finding other ways to influence consumer behavior is important. As mentioned above, using online marketplaces was frequently discussed as a way to do this, as was changing the assortment of products a consumer sees.

One respondent also discussed the strategy of working more closely with implementers to raise awareness and prevalence of higher CEE tiers. In addition, a utility PA mentioned an interesting new strategy that their marketing team has worked on to see what products people

have been searching for and then send them a push message on their phone detailing when and where the product is available. The push message strategy would work to keep the utility visible while people are purchasing new products or appliances. Several respondents noted the risks of losing the consumer-facing element if downstream rebates are eliminated or scaled back. *"[PAs should] make sure not to treat midstream as the black or white/mutually exclusive choice between midstream or downstream*," explained one respondent. "*I think you find a lot of utilities in a lot of states have a midstream element to consumer facing rebate programs, and I think many are hesitant to abandon this because they want customers to know who helped them make this efficient decision, and who was there for them when they needed help.*" Another commented on the value of staying visible while making efficiency more of a consideration for consumers. "*We're trying to create another identity for efficient products and let customers know what [we] recommend for them*," he said.

3.1.3 Social Media

One place where utilities can stay engaged, or even increase engagement, may be through social media. Two PAs mentioned the value that they see in using social media to engage customers. One explained that marketing and social media campaigns were the best ways to raise consumer awareness to help increase efficient purchases where downstream rebates have fallen short. Another echoed this sentiment, and added that her utility had seen value in using social media campaigns to engage customers through their demand-response program to increase participation during demand-response events. She states,

> *One thing which is pretty prominent right now for getting new customers into [our residential demand-response program] is social media campaigns. They're not costly, there's no paper, and we can hit a large population of customers with just one campaign. When we do social media polls we get a lot of likes and a lot of comments are added from customers going back and forth to each other telling family and friends if we're having a demand-response event. Then after the event there's a lot of chatter about how much they saved and it actually becomes almost a competition on social media, where each customer will chime in with how much they saved because it was more than the other customer did. I would say interest is pretty high around specific event days.*

Another respondent mentioned social media in the context of engaging millennials, something she believed to be very important. With the large population of millennials and their general interest in efficiency and green-behavior, she felt that millennials are an underutilized population when it comes to efficiency, largely due to many being renters, and a lack of targeted approaches. "*In [the case of millennials]…Maybe spend less on educating, I think that's a losing proposition. Make things engaging rather than educating*," she said. A recent study on engaging millennials included recommendations that programs must be mobile friendly, and that programs need to incorporate a retail component because "*that's where millennials look for solutions, not necessarily utilities.*"[33]

[33] Elizabeth McDonald, Why millennials matter when it comes to energy efficiency", *CEEA,* http://energyefficiency.org/millennials-matter-comes-energy-efficiency/ (Mar. 30, 2017), for the full report see Elizabeth McDonald, "Engaging Millenials, *CEEA* and *IESO*, http://energyefficiency.org/wp-content/uploads/2017/04/Engaging-Millennials-final-report-2017.pdf (Feb. 6, 2017).

3.2 PAY FOR PERFORMANCE

The pay for performance model (P4P) was discussed by some interviewees as an opportunity to help utilities meet their energy-efficiency targets. In a P4P model, the utility pays a third party on an ongoing basis for energy-saving or demand-reductions achieved. This model can take many forms, as the actual structure of the program is left mostly open to the third-party. The utility merely sets targets and incentives, and solicits bids.[34] PG&E recently launched a P4P pilot, where they put out an RFP stating a price/kWh saved that they were willing to pay, and asked companies to submit bids, with few other requirements.[35] In theory, this approach can reduce administrative and planning costs, and reduce risk, as the utility doesn't have to pay if the savings are not achieved. The outcome of the PG&E pilot could provide a good barometer for the potential of P4P programs; it will be interesting to monitor the pilot in the near future.

This approach has been popular in commercial programs for many years, but is now becoming more of a factor on the residential side, especially as California has moved more towards P4P as an option in efficiency. "*The energy commission has given us the directive to transition more to a model where you let the market create the solutions*," one California PA told us. "*I think the pay for performance model is a big part of that…We like this third-party implementation approach going forward*." She also said that the decreased risk they saw with P4P made the model appealing. We also talked to the president of one company who is running a pilot for this utilities' P4P initiative. Her company uses smart-meter data to identify why baseload may be abnormally high (vampire devices, inefficient behavior), and sends customers reports and tips, or refers them to "coaches" to deal with these issues. She explained,

> *What we found is some of the most [low-cost] and easy to do savings steps didn't fall into the category of any utility-sponsored energy savings programs or specific products. We found that there was a big opportunity in reducing plug load or reducing a home's base load, and residents were generally able to make changes on their own to reduce energy use. So when [we saw the opportunity for a utility-sponsored] P4P program, where there are no measures you need to perform you just need to show you can get savings, it seemed like a perfect match for I don't think [the utility] really expected the type of program we put out there, but they have worked very hard to try to make it successful*

This respondent indicated customers have seen an average of 12.8% energy savings (gas and electric combined) by operating in the "slipstream" (i.e., not a traditional downstream or midstream program) market as opposed to taking a downstream or upstream approach on efficiency.

There are also problems associated with these approaches. This same respondent noted that "*there's probably a group of people this will never work for*." Another largely dismissed

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[34] Julia Szinai, Merrian Borgeson, Emily Levin, "Putting Your Money Where Your Meter Is: A Study of Pay-For-Performance Energy Efficiency Programs in the United States," *NRDC,* https://www.nrdc.org/sites/default/files/pay-for-performance-efficiency-report.pdf (Jan. 2017), p. ii.
[35] Katherine Tweed, "PG&E's Pay-for-Performance Pilot Is a Big Deal for Energy Efficiency," *Greentech Media,* https://www.greentechmedia.com/articles/read/pge-moves-to-pay-for-performance-for-home-efficiency#gs.0OxY8RU (Dec. 1, 2015).

the idea of P4P models, stating, "*The cost is the cost, it's all about a shift in risk. A P4P contract just shifts the risk to a contractor, and the risk is the cost. In the end, I guess there could be more savings just by shifting administrative functions like marketing to a third-party and maybe cutting both some costs and risks that way, but I'm not sure that this is the silver bullet for the residential sector*."

A recent report weighed these strengths and weaknesses, concluding, "*P4P is not a panacea, but is a promising tool that can achieve savings…Though P4P is not a substitute for all traditional energy-efficiency programs, a 'second-generation' P4P effort, incorporating certain features described above, may be a promising way to achieve larger-scale savings, attract additional investment, and encourage new business models.*"[36]

3.2.1 Targeting

Another strategy that came up through discussions of ways to enhance more traditional rebate options, was targeting high use customers. This approach could help to bring in high-use customers who would not have been involved in efficiency or demand-response programs in the past, or to limit free-ridership by aiming program efforts at these customers who were unlikely to participate in programs on their own. One PA, who said that targeting has traditionally been a policy concern, explained,

"We now have better data about customers who are increasingly okay with utilities and others using that data to figure out what's best for them and to make recommendations."

> *We now have better data about customers who are increasingly okay with utilities and others using that data to figure out what's best for them and to make recommendations. Traditionally [targeting customers] had been a loser of an idea because privacy issues crept in, but now it's a viable idea and by targeting customers less likely to be free-riders you can cut down on that. It's been done a lot in terms of grid-benefits. If we have a congested circuit or substation, we can go after that area as part of a pilot to tackle a grid issue, but there's also a cost component and there's value in going after customers who are most [valuable] to the PA.*

Another PA also talked about using online tools, social media, or the push-message approach to target customers in the way that other industries do when trying to increase sales. The interview participant running the pay-for-performance model told us that although their technology would be available to all, it was most beneficial for her company to target high users to achieve the savings promised to the utility.

3.3 MULTIFAMILY

We asked respondents about the opportunities they saw for greater products program expansion or general intervention into the multifamily market. Respondents had different strategies for best engaging the multifamily market, but they all agreed that the market is worth targeting, and that program intervention hasn't fully figured out how to reach those

[36] *Ibid.,* p. 11.

customers. One respondent told us that although he is hearing PAs ask more frequently about tapping into the MF market, and he believes this is an area programs need to do a better job addressing, he is yet to hear from anyone who has successfully reached these customers.

One key suggestion that came up in discussions about successfully reaching the multifamily market was the need for PAs to understand the relationships involved and the actors that need to be engaged, to successful reach multifamily customers. *"If you really want to impact multifamily, you really have to understand the business model*," said one evaluator. Specifically addressing multifamily construction, she said, "*MF new construction developers are extremely shrewd, they understand their business really well. If they build lots of multifamily, multisite facilities, the only way you can change their behavior is if you can get them interested in a product that works well, is cheap, and is easy to install and reliable*." Another PA, who is running a successful demand-response program with a specific aim towards multifamily customers, also emphasized the importance in establishing good relationships with all the stakeholders involved who ultimately influence the tenant and their energy use:

> *Before we even get a product within a multifamily unit, the most successful approach on our side is first to make sure that we have conversations with the property owner, leasing office managers, as well as the maintenance staff. If those parties are not in sync with what our program is and what we need from them, it becomes a disaster for us in terms of what we need in inventory control as well as customer experience…A good contract is required; you really need to treat it as a contract negotiation with the property to understand what they need to do to be in this relationship with you, and you have to do sufficient training with them, especially with the maintenance staff. They're always willing to listen to [us, the utility], in terms of what products we offer because it's a selling point for them to be able to market their complexes as green living, low bills, or anything else where they can incentivize a customer to sign a lease with them*.

Some respondents said that it was important to connect simultaneously to both the tenants and the owner, "*We've seen some member PAs looking to design a program aimed at owner of the building and the tenant and trying to find the message that best resonates with both those groups," said an efficiency consortium participant, adding "we're hearing more and more interest in multifamily*." Another participant noted the value in green leasing, or related strategies aimed at engaging both the owner and the renter, as it creates a structure that allows them to share the incentives.

Some participants discussed specific strategies to get efficient products into multifamily units. Many discussed general market transformation framework, whether through RPP or other strategies, as the best way to get to renters and multifamily units. "*This is where I would say if you have a good midstream/upstream strategy, you can do research to make sure you're hitting all of your markets, but that would be the most efficient way to get to your renters or multifamily. They buy stuff in the same place as single-family homeowners buy stuff*," said one participant, who also acknowledged the value in working with large rental companies to get more efficient white goods into rental units or shared spaces. Working with wholesalers was mentioned by two other respondents as a solution to reach large multifamily buildings.

While several respondents noted that making the market more efficient would translate to more efficiency in multifamily residences, some advocated for taking a more hands-on approach. One PA told us that they are bringing multifamily customers into their kit program, replacing the direct-install program that had been used for multifamily customers in the past. This PA indicated that while the DI program had been relatively successful, it only reached a pool of landlords/owners who continually reapplied to the program. By giving renters the option to choose from any of the six kits offered to single families, they hoped to bring more end-use customers into a program. *"DI was great, but we kept getting the same building managers or landlords coming into the program and getting their stuff updated. You have this huge mass of the market that just didn't participate because the landlords either didn't care, or weren't aware of the program, or whatever and so we had to reassess…I feel like this [move to kits] is sort of our first step in doing that*." He also alluded to broader market transformation, adding, "*as we go more midstream and upstream with products programs, it really doesn't matter anymore if they're a multifamily or SF owner as long as the equipment is being installed into wherever the building is… It's interesting because it is a challenge if you can't get landlords or property owners to participate*." Another participant advocated for doing direct installs of newer technologies into multifamily units, stating, "*I could see some value in thermostats and comprehensive energy swap outs and makeovers, that just makes a ton of sense*." If smart devices or connected technologies are installed into a multifamily unit, the opportunities for savings become similar to single-family homes. "*At the end of the day, multifamily and single-family are pretty much the same,*" said one PA, referring to the home energy report program he oversees.

3.4 LOW-INCOME

One respondent, a designer of efficient technology, identified the low-income market as a place where products programs and interventions in general have fallen short of success. "*We are doing a dismal job in the low-income market; we usually just give people energy bill subsidies, which can do more harm than good*," she explained. If low-income funds were redirected to help low-income customers purchase more efficient products, than their consumption would decrease and this would reduce the amount needed to be paid in bill subsidies.[37] She went on to detail how low-income customers could be brought into products programs and how free-ridership may be limited by focusing on low-income customers, saying, "*the people buying efficient products are not low-income, they have the money to buy efficiently already, so I think free-ridership is very high. Having a rebate at the point of sale makes efficiency more available to those who wouldn't be able to afford the product right away*." Although point of sale rebates carry the risk of increasing free-ridership, using targeting and limiting these rebates to low-income customers may allow greater access to these customers and reduce free-ridership as a whole by bringing in customers who purchases products on the lowest sticker-price alone. This participant advocated for the online-marketplace being the place to directly offer low-income shoppers incentives so that

[37] "How better low-income programs turn $1 into $5: The compelling case for getting super-efficient products into lower income households," *Enervee,* https://blog.enervee.com/how-1-turns-into-6-or-more-aa650ad2ef86 (Aug. 28, 2017)

they could purchase an efficient unit by receiving the rebate at the point of sale. One PA told us her utility offers coupon codes for instant rebates on smart-thermostats and is looking to expand that model to other appliances, which could serve as a solution to this type of problem. Massachusetts does offer some expanded products rebates based on income guidelines, another positive sign that MA is identifying opportunities in key areas.[38]

[38] See: https://www.masssave.com/en/saving/energy-assessments/enhanced-residential-program/

4 Claiming Savings/ Reducing Program Costs

We asked respondents how products programs can best succeed and reduce administrative and program costs, and what the greatest barriers are to doing so. The most commonly identified barriers included (1) increasing baselines, (2) the rapidly changing market and greater saturation of ENERGY STAR models, (3) the inability of programs to fully claim their impacts, and (4) free-ridership.

Key findings:

- ***Innovative program design can help tackle program cost concerns by preempting barriers.*** *Many advocated for switching to a mid-stream model, but other strategies like increasing marketing, educational, and social media efforts, along with finding ways to make efficient products more accessible by increasing their visibility in assortments or providing point of sale rebates, were mentioned as strategies.*
- ***PAs need to take advantage of any savings that they can claim to achieve program success.*** *This may involve breaking program sales down into more categories to claim credit for the most efficient tiers or models being sold, or attempting to expand the NEIs that can be claimed through a program, with a focus on grid/transmission flexibility.*
- ***Being able to claim credit for standards changes is a valuable asset.*** *There may be greater opportunities to get involved in standards advocacy or to track how a program has influenced a national codes or standards change, allowing for program savings.*[39]
- ***Free-ridership is a major hindrance to achieving success, especially as the market penetration of ENERGY STAR products increases.*** *Using targeting to reduce free-ridership or using a market baseline approach to measure changes, where appropriate, were among the solutions suggested by respondents to target free-ridership.*

Table 4 provides a general outline of the section, identifying the areas in which respondents discussed strategies to help programs succeed.

[39] NMR understands the PAs have already shown interest in pursuing standards advocacy.

Table 4: Strategies for Successful Products Programs

Approach	Market Scan Insight
Claiming Savings (Section 4)	*"As baselines tighten and savings shrink, ensuring that all savings and program impacts are being captured becomes increasingly important."*
Expanding the Definition of Benefits (4.1.1)	*"The more you can quantify the benefits the more likely your program is to succeed. If there are capacity constraints or transmission constraints [you are mitigating], the more you can incorporate that into your analysis the more likely things will pass."*
Standards Change Attribution (4.1.2)	*"What we could be better at is the narrative of why standards changes are made. Why DOE felt it's in the best interest of the consumer to increase these standards…often it is state-level decisions driving this."*
More Efficient Products (4.1.3)	*"It almost never makes sense to run a program for the highest efficiency level only...you can let the volume of ENERGY STAR products justify the program, but by adding in higher tiers, it will allow you to get savings from the most efficient products. You're already doing everything to promote the program, why not be able to claim/capture some more savings within your existing ENERGY STAR program?"*
Overcoming Free-Ridership (4.1.4)	*"Free-ridership with the downstream program, that has been our biggest downfall."* *"If you're staying ahead on incentive design and making sure you're not overpaying to move a certain volume, then free-ridership becomes moot."*

4.1 Claiming Savings

As mentioned above, interviewees frequently stated the necessity of successfully quantifying benefits, and the ability to claim the savings as important components of a successful program. This theme mostly fell into the categories of expanding what was considered a benefit, finding ways to claim attribution from standards changes, and getting savings from sales of products that reach higher tiers than ENERGY STAR. Moving midstream, to an RPP model, was also a frequently discussed topic in reducing program and administrative costs (though its ability to do so is yet to be proven), and is discussed further below (see 5.3.1).

In many cases, Massachusetts already utilizes the strategies discussed in this section. This is especially true in the case of expanded definitions of benefits (4.1.1), where NEIs and transmission and distribution costs are included in cost-effective calculations, and carbon is included in avoided costs. Additionally, Massachusetts often incentivizes products above ENERGY STAR, and has a successful RNC codes and standards program that could soon be expanded into products. PAs and industry experts across the country cited many of these strategies as the best ways to achieve program success. This validates Massachusetts' framework and encourages continued probing as new opportunities or challenges arise (e.g., recognizing the new NEIs that may come from connected technologies, or supporting greater market influence if the DOE does not enforce new standards under the current administration). Ultimately, the interviews affirmed that there is difficulty in achieving

substantial savings through products programs, and that Massachusetts is employing many of the most-effective strategies – in many cases leading the way in finding successful methods.

4.1.1 Expanding the Definition of Benefits

Expanding the benefits that a program can claim was a concept identified by many respondents, although usually with the caveat that it is mostly a policy issue and can be extremely challenging for PAs to address. Several respondents emphasized the importance of including NEIs in attribution models and discussed some areas where benefits are underreported by programs.

Grid stabilization and other grid benefits were identified by several respondents as areas that programs could claim their demand-response and sometimes energy-efficiency impacts to a greater extent. "*In general, I think…the more you can quantify the benefits the more likely your program is to succeed. So, for instance, if there are capacity constraints or transmission constraints [you are mitigating], the more you can incorporate that into your analysis, the more likely things will pass,*" said one PA, adding, "*[also] make sure your benefits are including NEIs.*" Another respondent mentioned that with the rise of smart technologies, there may be more cases where a customer is a free-rider for their initial purchase of a device, but they may later use that device's smart technology to opt-in to a DR or load-shaping program. This means that the customer can still be a participant (non-free-rider) in a program with their new device, despite being a free-rider in purchasing.

4.1.2 Standards Changes

We asked participants about claiming savings from standards changes. While respondents all agreed that claiming savings for standards changes is an opportunity, some were skeptical about both the policy barriers and the actual ability to make an influence in the market with increased standards. Some noted that a larger collaborative effort with other states or regions, or partnering with the ENERGY STAR RPP initiative, may make market transformation and accelerated standards changes more likely, which would be an opportunity to claim savings (see Section 5 for more).

Some respondents were very optimistic about the opportunity to increase local standards and claim savings. One participant identified this as one of two key ways for products programs to operate effectively. They specifically advocated for the potential shown by the 2018 Appliance Standards Awareness Project (ASAP) standards package for MA, which projects savings "*approximately equal to what you lost through lighting [if the program is able to claim 50% of the predicted savings]*." Another interview participant identified standards changes as an opportunity and identified the ASAP package for Massachusetts.[40] One PA, who was also in favor of standards changes in some cases, stated, "*How much effort is it going to be to develop that new spec vs. how much effort will it take to justify that to regulators? One of the things with consumer goods is any time you have those white goods, those consumer goods, programs only touch a portion of it, and so it seems like if you make the spec and get the*

[40] See: https://appliance-standards.org/sites/default/files/state_savings_state_standards/Massachusetts.pdf

whole market to shift up a little bit there, you can get savings you otherwise could not." She also detailed a market-shifting TV initiative she had been involved in, which was found to have accelerated a standard change by about six months. This demonstrated that there was potential in using this approach for consumer products, even at a regional level.

Several participants mentioned California as a model, but also cautioned that what has been achieved there may not be practical for Massachusetts. "*We aren't CA, we don't have the pull and set-up to do all that they do. We don't have the legislative packages, and not being able to put things forward makes it more difficult to claim savings. I'm not aware of anyone else other than CA claiming standards attribution*," said one participant. "*I'm all for it if we can accelerate the rate at which state standards can be adopted in MA. We want to make sure that a standards attribution model is grounded in reality, though*."

One focus for some interview participants was creating a better narrative for what is behind standards changes, and what went into them being enacted. One participant, who also noted California might not be a realistic model for other states, said, "*Policy allowing you to get credit is great, but hard to come by. One thing we should be able to do is be aware of why the standard was able to go up. Utilities are laying the groundwork for these changes…what we could be better at is the narrative of why standards changes are made. Why DOE [felt] it's in the best interest of the consumer to increase these standards. In my experience, it's much more of a state by state regulatory discussion instead of a CEE or ENERGY STAR discussion to drive standards*." Another respondent said that after finding non-program new construction was being built to a more efficient level than the state's new construction program required, his organization was frustrated that they were unable to claim credit for a market shift, and resulting standards change, that had likely been driven by the program. "*We've set up protocols now moving forward that will be assessing the market every two to three years and attempting to claim savings on transforming the market through training, outreach, doing baseline studies and market transformation studies to see [our impact]. There's data on several different things we'll be collecting and analyzing over the next few years to see what we can claim savings from,*" he explained.

4.1.3 More Efficient Products

Respondents also suggested that some products programs may be claiming less savings than they are actually producing by not properly accounting for the program sales of products that are more efficient than ENERGY STAR. Several respondents talked about the value of running a program for CEE tier 2 or tier 3 products, but also claimed that having a program designed only for those tiers (excluding tier 1 products or those just meeting ENERGY STAR requirements) made most programs unviable due to the lack of tier 2 or 3 models on the market and the associated low participation that would be expected. As explained by one participant,

> *It almost never makes sense to run a program for the highest efficiency level only because participation would be so low, so as a consortium we have looked at getting back more. Programs don't just promote ENERGY STAR, but by promoting more efficient products, you can let the volume of ENERGY STAR products justify the program, but by adding in higher tiers, it will allow*

you to get savings from the most efficient products. I think we often leave savings on the table by only doing ENERGY STAR.

This participant also noted that some of this shortfall in including or reaching higher tiers in a program may be a result of a lack of awareness from the implementation community. "*Why don't more PAs promote CEE tiers?*" he asked. "*One possible explanation is awareness across the implementation community. [A large utility] is employing maybe a dozen implementers, it's completely possible that someone, CEE or other, has to do a better job sharing why CEE tiers are beneficial. From my experience, people are hiring implementers based on hassle reduction, and the tiers are a hassle. People aren't always interested in the long-term effects, they're more interested in how to get people to buy ENERGY STAR products at Best Buy.*"

One advanced power strip manufacturer also focused on leaving the savings of the most efficient products on the table, looking through the lens of newer technologies, such as smart thermostats or advanced power strips, areas he claimed innovation could be rewarded. He discussed the opportunities available through some of these newer technologies, but said that it was important to recognize the best technologies, instead of trying to appease all manufacturers. He explained that many new, smart or behavioral-based products (e.g., smart thermostats or smart power strips) achieve substantially different savings. Rather than averaging the savings of several models of a product, this participant advocated for only supporting the products achieving the highest level of savings.

4.1.4 Free-Ridership

We asked all the respondents about dealing with free-ridership. Most noted that free-ridership is one of the greatest challenges that products programs face, especially with the increasing penetration of ENERGY STAR products on the market. "*In terms of free-ridership with the downstream program, that has been our biggest downfall because tier 1 has been eating up our budget by the millions,*" said one PA, adding, "*when we pull tier 1, that's when our participation numbers drop significantly*." Some respondents offered solutions to free-ridership. Two advocated for raising incentive levels, which has proven to reduce the percent of participants who are free-riders. "*Quantitative examples [have shown] the higher the incentive the lower the free-ridership,*" said one.[41] Although raising incentive levels brings more customers into a program (reducing the percentage of free-ridership), the actual number of free-riders does not decrease; higher incentives also means higher program costs. Another PA suggested that the best solution he has found for dealing with free-ridership is to work closely with the implementers to avoid it. "*We're doing a lot before launching to see how to try to hit it on the front end instead of waiting for it to hit us in evaluation,*" he said. The strategies discussed throughout Section 3 and Section 4 in this report for designing more innovative and low-cost programs are all aimed in some sense at reducing free-ridership.

[41] For example, see: "Project R4 HES/HES-IE Process Evaluation and R31 Real-time Research," *Submitted by NMR to the Connecticut Energy Efficiency Board, Eversource, and United Illuminating.* https://www.energizect.com/sites/default/files/R4_HES-HESIE%20Process%20Evaluation,%20Final%20Report_4.13.16.pdf (Apr. 2016), pp. XLII, 67.

Most respondents advocated for good program design, and bringing in a good share of non-free-riders as the best way to eliminate its negative impacts.

Many expressed their distaste for the idea of measuring free-ridership, arguing to move away from such an evaluation framework completely and instead measure market transformation to produce a more comprehensive view of how much impact a program actually has on overall energy-efficiency in the entire market. "*I hate free-ridership, I find the whole thing ridiculous,*" said one evaluator, who went on to explain that it can be avoided if administrators stay on top of incentives and reduce or remove them when an efficient technology reaches high enough saturation levels. Another added, "*I think you have to change the way that free-ridership looks, you have to make a paradigm shift, mostly make sure you aren't dumping a lot of money into something that is already going to take off. You're no longer just tracking savings, you're trying to transform the entire market and figure out something that's bigger than yourself. If you make that paradigm shift, you want to make sure you're not dumping a ton of money into something that's already going to take off and maybe we're doing that with smart thermostats. But the way you do this is you take a market baseline and claim the incremental off that*." This framework of measuring market transformation was specifically mentioned by several respondents with regards to measuring savings from RPP or other midstream approaches where the focus of the program is impacting what is available to consumers more than their purchasing behavior; therefore, the definition of a free-rider would be muddied (see 5.4.4). Participants also suggested targeting as an approach to help mitigate free-ridership (see 3.2.1).

5 Retail Products Platform (RPP)

This section provides an overview of the strengths and weakness of the Retail Products Platform (RPP) model, focusing on both regional RPP efforts and the national ENERGY STAR Retail Products Platform (ESRPP). This was the most frequently suggested structure for maintaining a robust products program for years to come. Many identified the opportunities that it creates to stay involved in products that would otherwise not be viable These opportunities are due to the national-approach of the method, which would, in-theory, substantially reduce single utility, state, or regional costs, although it remains to be seen if this method will work as planned.

Key Findings:

- ***RPP offers opportunities to stay involved in products that likely would not be viable otherwise due to higher program costs.*** *Per-unit incentives in RPP are typically lower than those in downstream programs. Sharing planning and administrative costs through national collaboration allows PAs to continue running programs for many products that would otherwise not have been viable.*
- ***The large scale of ESRPP programs increases chances of real market transformation and allows reduced costs/streamlining, but also means loss of local utility "touch" and some ability to dictate what goes into portfolios.*** *The large scale of the program creates greater influence on the retailers and reduces costs by streamlining program design and evaluation efforts. The availability of data provided by retailers, and the ability to quickly adapt based on that information, makes it easier to measure and optimize program impacts and other opportunities, although early participants have reported some difficulty with the data portal.*
- ***Determining how to evaluate/claim savings is critical to its success and survival.*** *Traditional EM&V approaches do not necessarily apply, and free-ridership is inherently high. New approaches are needed to fully understand the platform's success. Some interviewees advocated for switching to market-baseline measurements for evaluating.*
- ***The ESRPP design means the utility will become less visible in products programs.*** *The loss of the customer-utility relationship, with the decreased focus on downstream rebates and a decreased consumer awareness of the utility's role in efficiency, means that PAs will have to stay on top of other efforts to raise awareness.*
- ***Potential exists for very high long-term rewards if full potential or market transformation is modeled. Even greater claimed savings are available if RPP drives standards changes that can be claimed by PAs.*** *The long-term potential of market transformation offers significant savings in years to come if the model works as planned. There also may be opportunities to coordinate RPP and standards advocacy efforts, as market transformation should lead to faster adoption of tighter federal and ENERGY STAR standards.*

- ***RPP is unproven and still faces many challenges.*** *The need to pay incentives on all qualified units may mean that the decreased costs will be minimal or non-existent compared to downstream programs, despite RPP's lower per-unit incentives and decreased administrative costs. However, if these challenges can be overcome, this model offers a potential way to run a successful program for products that are no longer viable downstream.*

Table 5 highlights the strengths and weaknesses of the ESRPP platform, and RPP programs in general, by the interviewees.

Table 5: Retail Products Platform Strengths and Weaknesses

Approach	Market Scan Insight
RPP Strengths and Opportunities (5.3)	
Reduced Program and Administrative Costs (5.3.1)	*"We had to drop most of these measures in 2014. [With RPP] we can now stay in the game in appliances where it would not have been [affordable] before."* *"A small incentive goes a longer distance because you're aggregating across utilities across the country… that can definitely give more bang for your buck."*
Large Scale (5.3.2)	*"From [our] perspective, shared research and guidance in standards is the largest benefit. We partner with some larger collaboratives and organizations and get some more resources and this saves us money, time, and effort in coming up with standards and strategies."* *"A critical mass is needed to influence retailers to make changes."*
Availability of Data (5.3.3)	*"You almost get real-time savings data for both qualified and non-qualified products. That's a first, retailers have never given non-sponsored data."* *"To me the most valuable part of RPP is the data you get out of it. [Beyond] thinking about the evaluation of RPP, [PAs are] using that data to plan what other markets they're going to intervene on."*
Long-term Market Transformation (5.3.4)	*"It will take several years...[With] The market transformation curve and high initial costs, there are not a lot of [early] savings, but by the end you get a lot of savings for basically no-investment."*
RPP Weaknesses and Challenges (5.4)	
Need to Redefine the Products Program Landscape (5.4.1)	*"There is hesitance to move away from the well-established path of downstream rebates to something largely unproven, and their concerns over redefining relationships and creating new evaluation framework."*
Loss of Customer/Utility Relationship (5.4.2)	*"The nice thing about downstream is it's visible to customers. I think many [utilities] are hesitant to abandon [downstream rebates] because they want customers to know who helped them make this efficient decision, and who was there for them when they needed help."*
Little Initial Impact (and Uncertainty over Long Term) (5.4.3)	*"If you want first year cost-effectiveness, don't even try this."* *"Even though people say how RPP is more likely to [succeed by reducing costs] because you're paying smaller incentives, you're still paying them on every unit, so the total attributable incentive paid, you don't know what that is yet"*
Difficulty in Evaluating (5.4.4)	*"The success of the program will hinge on whether it can be evaluated, to the relative acceptance of all the PAs or the sponsors of the program…it's frankly very hard."*

5.1 METHODOLOGY

This section draws on market scan interviews with stakeholders in existing RPP programs, including those involved in the planning and/or administering of the program. It also reviews

evaluations and evaluation plans of both existing ESRPP programs and a recent RPP pilot.[42] Although ESRPP is a national program, evaluation, and a significant amount of planning, take place at the local or regional level. As such, ESRPP is in different stages and structured slightly differently across the country, and much of the insight collected through interviews about this national program reflects this regional-specificity. While RPP was mentioned in many of our interviews, RPP/ESRPP-specific market scan interviewees included two EPA employees, two members of the ESRPP planning committee (an efficiency partnership employee and an evaluator), two ESRPP administrators who worked for agencies overseeing many utilities, one RPP administrator at a utility running ESRPP, and one at a utility lobbying to launch ESRPP in 2018.

5.2 OVERVIEW

RPP is a midstream approach aimed at transforming the market by making efficiency more attractive to retailers. By offering incentives on sales of ENERGY STAR (and more efficient) products, RPP aims to increase the retailer's gross margins on these products compared to non-qualified, inefficient models. Since retailers move large volumes of products, they can accumulate substantial incentive money by selling many qualified models. Therefore, only a smaller per-unit incentive should be necessary to influence retailers to sell efficient products, compared to what would be needed to sway customers buying a single product in a downstream program. Figure 3 depicts the progress of the program to date. As of 2017, there were eight program sponsors covering eleven states in the program, along with six retailers accounting for over 1,200 storefronts and approximately 18% of the US market. If the program works as planned, the midstream incentives would ultimately increase the share of efficient products stocked in each store, and likely improve the shelf-position and increase promotions for qualified products, contributing to an increase in the share of efficient products sold. As part of the long-term market transformation, consumers would then have a market in which they shop that carries more efficient products. Eventually, this would send signals to manufacturers to produce more efficient products, which may lead to spillover and a greater share of efficient products landing in retail stores that are not participating. The midstream aspect of the program is not new, but the large scale of the ESRPP program is a first, and could provide a framework to bring a new level of success to a strategy that has typically only seen small to modest market lifts.[43] The 2017 retailer participation numbers are encouraging, but it remains to be seen what level of program involvement will be needed to push these retailers into making significant changes to stocking practices that favor efficiency at the national-level, as is the end goal of the program.

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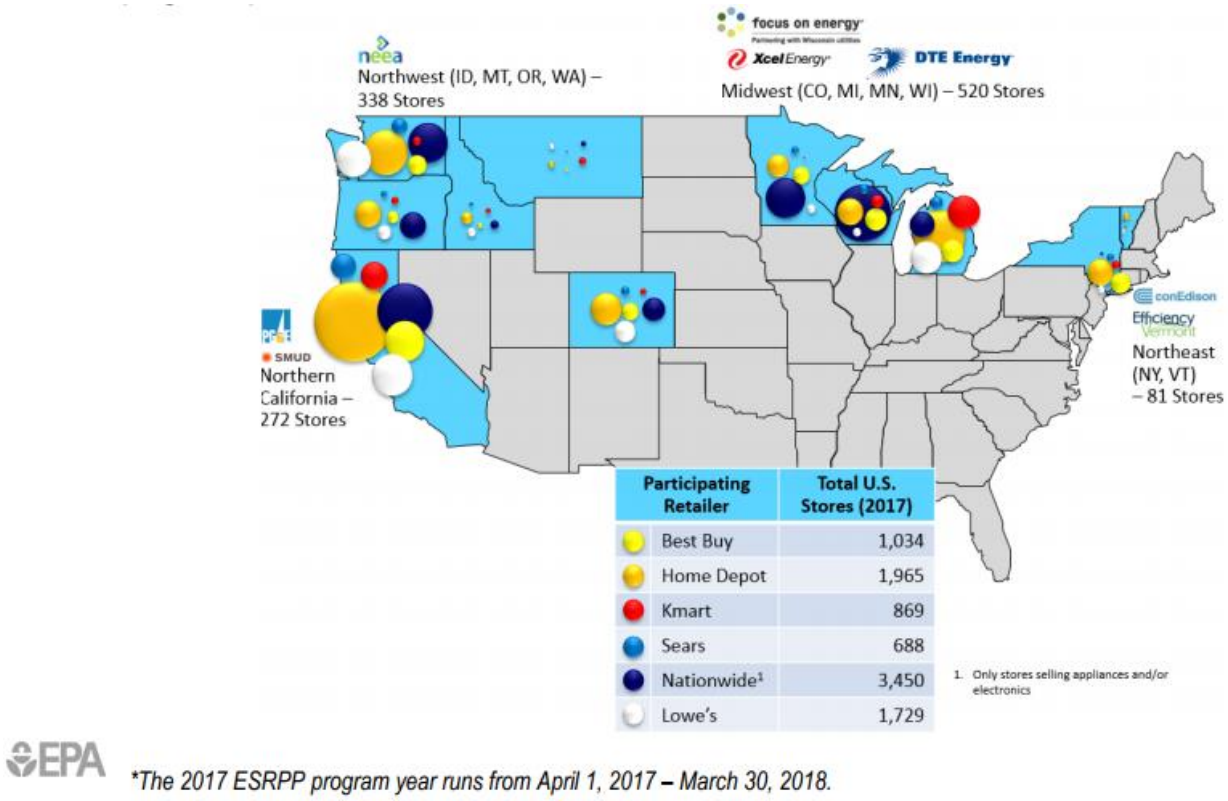
[42] Retail Products Portfolio Market Test Assessment," *Prepared for NEEA by Research Into Action, Apex Analytics, LLC, and Illume Advising, LLC* (Sep. 13, 2017), Todd Malinick and Richard Ridge, "California 2016-2019 Retail Products Platform Program Pilot" *EMI Consulting,* http://www.energydataweb.com/cpucFiles/pdaDocs/1372/RPP.2016-2019.EvalPlan.10-16-2015.pdf (Oct. 16, 2015), and Todd Malinick, Richard Ridge, and Julie Colvin, "Pacific Gas and Electric Company Retail Plug Load Portfolio (RPP) Trial: Evaluation Report", *Pacific Gas and Electric Company*, (Apr. 24, 2015).

[43] For example, see: Scott Dimetrosky, Noah Lieb, Jacob Rowberry, Jane Peters, and Robert Scholl. "New York Products Program: Market Characterization, Assessment, Process, and Market-Based Impact Evaluation." *Apex Analytics LLC and Research Into Action, Inc.* prepared for *NYSERDA*

Figure 3: ESRPP Program Structure



Source: https://www.energystar.gov/ESRPP

This model is also an attractive way to combat growing plug load or to sponsor products with shrinking savings opportunities as baselines increase. Many products that can be included in the RPP portfolio do not have the per-unit savings to be a viable option through their own program, but with RPP framework in place, and costs shared at a national level, they become more viable for program sponsorship. Several interview participants (both RPP-specific and non-RPP specific) identified RPP or general moves to mid or upstream efforts as the most effective way to target plug loads, due to the many products contributing to plug load which draw only a small amount of energy. When PG&E and SMUD launched their RPP pilot in 2015, RPP was an acronym for "Retail Plug-Load Portfolio Program," and the portfolio included products like DVD players and other home entertainment devices.[44] "*RPP was an attempted response to plug loads, at least that was historically what it was meant to be…as RPP started to build momentum people wanted to put white goods and other things in their portfolios and so it lost its focus on smaller plug loads*," explained an RPP program designer. Although the current (2016-2019) CA RPP pilot is now branded as Retail Products Platform, the logic and structure between the 2015 pilot and existing RPP efforts are largely identical. ESRPP has a framework that could target products specifically contributing to plug-load or

[44] Malinick, Ridge, and Colvin, "Pacific Gas and Electric Company Retail Plug Load Portfolio (RPP) Trial: Evaluation Report", *Pacific Gas and Electric Company*.

anything else sold through retail. "*In the future, it would be great if all ENERGY STAR products could be involved in RPP. It wouldn't matter how large or small the product, the rebates would scale. I don't think we're too far from that*," said one ESRPP planner.

By running RPP on a large scale, the goal is to reduce the costs to PAs, allowing them to continue running programs involving products that would otherwise be too expensive for the level of savings achieved. RPP is aimed at long-term market transformation; therefore, substantial savings in the first few years is unlikely. However, if the programs work as planned, the long-term outcome should result in a transformed market dominated by highly efficient products at very little sustained cost to program administrators. As the large scale and national collaboration are key to the program's long-term success, there are some risks that budget cuts to the EPA could diminish or eliminate RPP's effectiveness. Although losing national support could be a major barrier for the program, with the framework in place, PAs could continue to coordinate to exert their influence and run the program with or without this support. Since major retailers make most of their product purchasing and stocking decisions at the national level, this model is reliant on a large-scale, which can influence national-level decision-making. With this is mind, ENERGY STAR launched the ESRPP program in 2016 to allow greater influence, cost-sharing, and streamlined program design between PAs across the country. ESRPP launched with four participating retailers and eight program sponsors in 11 states with the goal to "*transform markets by streamlining and harmonizing energy efficiency programs with retailers, making them less complex and more cost-effective*."[45] This will likely expand to roughly a dozen more sponsors in five more states in 2018.[46] As part of this national-level agreement, participating retailers have agreed to share sales data of both qualified and non-qualified models.

The ESRPP Program initially included clothes dryers, freezers, room air cleaners, room air conditioners, and sound bars. Clothes washers and refrigerators were added in 2017. These were all products identified as having potential in the market scan interviews, and were all classified as high or moderate potential in the task 1 memo. With the ESRPP framework in place, this could be an approach to use in sponsoring these products. Although ENERGY STAR suggests incentive values, these can vary based on local conditions. Table 6 and Table 7 show the ESRPP suggested incentive levels and the initial levels supported by the 2016-2019 California RPP Pilot.

[45] "The ENERGY STAR RETAIL PRODUCTS PLATFORM 2016 Progress Report," *ENERGY STAR,* https://www.energystar.gov/sites/default/files/asset/document/ESRPP%202016%20Annual%20Update_5.26.17%20-%20508%20PASSED.PDF (May 2017).
[46] *Ibid.*

Table 6: ESRPP Suggested Incentives (2016/2017)

Product	*Specifications*	*[Typical] Unit Incentive Level*	*Program Year*
Clothes Dryers	ENERGY STAR Version 1.0	[$50]	2016&2017
Freezers	ENERGY STAR Version 5.0	[$20]	2016&2017
Room Air Cleaners	ENERGY STAR Version 1.2	[$20]	2016&2017
Room Air Conditioners	ENERGY STAR Version 4.0	[$10-$40]	2016&2017
Sound Bars	ENERGY STAR Version 3.0+15%	[$15]	2016&2017
Clothes Washers	ENERGY STAR Version 7.1	TBD	2017
Refrigerators	ENERGY STAR Version 5.0	TBD	2017

Source: https://www.energystar.gov/sites/default/files/asset/document/ESRPP_Sample%20Filing%20Language.pdf

Table 7: California RPP Incentive Levels (2016)

Product Category	Draft Efficiency Specification	Draft Per-Unit Incentive
Air Cleaners		
Basic Tier	ENERGY STAR Version 1.2	$20
Advanced Tier	EVERGY STAR Version 1.2 + 30%	$30
Sound Bars		
Basic Tier	ENERGY STAR Version 3.0 + 15%	$10
Advanced Tier	ENERGY STAR Version 3.0 + 50%	$20
Freezers		
Basic Tier	ENERGY STAR Version 5.0	$20
Advanced Tier	ENERGY STAR Version 5.0 + 5%	$50
Electric Clothes Dryers		
Basic Tier	ENERGY STAR Version 1.0	$50
Advanced Tier	ENERGY STAR 2015 Emerging Tech Award	$250
Gas Clothes Dryers		
Basic Tier	ENERGY STAR Version 1.0	$50
Advanced Tier	ENERGY STAR 2015 Emerging Tech Award	TBD
Room Air Conditioners		
Basic Tier	ENERGY STAR Version 4.0	$20
Advanced Tier	ENERGY STAR Version 4.0 + 10%	TBD

Source:http://www.energydataweb.com/cpucFiles/pdaDocs/1372/RPP.2016-2019.EvalPlan.10-16-2015.pdf

As these figures demonstrate, ESRPP participants have taken advantage of the regional autonomy allowed by the program. The California structure also presents a model where RPP could help promote products that are more efficient than ENERGY STAR. Like the rest of RPP, the success of this approach remains to be seen. If successful, it could offer a way to capture savings for many products including those that are already heavily dominated by ENERGY STAR models.

5.3 STRENGTHS AND OPPORTUNITIES

5.3.1 Reduced Program and Administrative Costs

"The declining value of incentives provided to consumers are less effective for influencing consumer choice and that incentive money *may* be more influential in a midstream approach."

Every interviewee who discussed ESRPP identified the long-term reduced costs as a major potential benefit of the program. Some saw this as an opportunity to expand current efforts in products, while others acknowledged that there was no way to stay involved in products at all without RPP. One program manager told us, "*We had to drop most of these measures in 2014. [With RPP] we can now stay in the game in appliances where it would not have been [affordable] before*." A manager at another energy efficiency partnership stated that, "*a small incentive goes a longer distance because you're aggregating across utilities across the country…models like that can definitely give more bang for your buck.*" Another called RPP a "no-brainer" because of the opportunities to expand the reach of a traditional products program. "*You can't continue in the status-quo*," she went to add. When asked about the best way to address the shrinking savings available between federal baselines and ENERGY STAR standards, an EPA employee said, "*I think that's why we created this RPP program. The overall goal is to lower the transaction costs and the program costs. We recognize shrinking savings and think the best solutions are through better business to business transactions*." A program sponsor claimed that, "*for some products, the declining value of incentives provided to consumers are less effective for influencing consumer choice and that incentive money may be more influential in a midstream approach.*"[47]

Our EPA contacts also explained how RPP is the best approach for targeting these smaller products that are sold in high volume, stating that, "*some products have small per-unit savings but they are high volume like electronics, so you need to change the market to get high savings. This is unlike water heaters or HVAC, which have large savings potential but slightly lower sales volume (and might still be suited for downstream)*." The products in the RPP portfolio "*sometimes aren't a slam dunk in terms of running a traditional products program because of the small delta, but they are a great fit for RPP. They don't have a federal standard, they are in a package of standards being considered by some states now looking to set some levels. I think that with PAs pushing ceiling of products by RPP, higher ENERGY STAR standards would go into place*," said another interviewee. "*There are some other things where you really don't have that [option to offer a significant incentive], and when the incentives start looking so small that it almost disincentives people to make a decision, or they say, 'I don't think that's enough to pay me for the energy savings for that worthwhileness,' you're better putting it in a midstream type of intervention*," added a third. This forms the main rationale for the use of an RPP model. While the long-term effects remain to be seen – and we address some of the concerns of this approach below – RPP offers an opportunity to

[47] "Retail Products Portfolio Market Test Assessment," *NEEA*, pp. 16-7.

maintain the viability of program sponsorship for products where their inclusion would otherwise be impractical because of high costs.

This model also may offer greater opportunities than traditional downstream rebate programs by extending the reach to customers who would not have been aware of, or interested in, such program designs. One interviewee told us that, "*with RPP you can change the market and bring in people who are not focused on efficiency at all…[or] people who don't know to look for efficiency while shopping for products.*" This was echoed by all the RPP-specific interview participants when asked about influencing consumer choice. "*You are changing the options consumers have in order to make them make [better] decisions* [in purchasing more efficient products]*. If RPP increases ENERGY STAR share from two out of ten to four out of ten, statistically people will buy many more ENERGY STAR models,*" said one EPA employee. Several interviewees also noted that RPP may be the most effective way to target the multifamily market. "*As we go more midstream/upstream with programs like RPP, it really doesn't matter anymore what type of building it is,*" explained one respondent. By making the entire market carry more efficient qualified products, the more efficient options would reach all customers more frequently, regardless of type of home. While addressing free-ridership is a concern in RPP, bringing in this new pool of customers, who had never considered efficiency with rebates, may help offset the inherent free-riders who will purchase efficient products in RPP. This was identified by several interviewees. "*You're no longer just throwing money at people who were going to buy an efficient product anyway*," said one.

5.3.2 Large Scale

Another major draw of ESRPP comes from the benefits that can be attributed to the large scale of the program. The administrator of an RPP program in one state told us, "*from [our] perspective, shared research and guidance in standards is the largest benefit. We partner with some larger collaboratives and organizations and get some more resources and this saves us money, time, and effort in coming up with standards and strategies*." Several interviewees noted this value in streamlining the program design to reduce the costs of developing an entire program locally.

The large scale of the ESRPP program is also a benefit in terms of the influence that the program can directly assert on retailers. Since retailer decisions are typically made at the national level, "*the program…is unlikely to succeed without collaboration, as a critical mass is needed to influence retailers to make changes*."[48] Influencing retailers to buy-in to the RPP program is critical to the success of the model. If this occurs, retailers are in a position where they will work to sell efficient products in a way that has not previously occurred. One EPA employee stated,

> *Participating retailers don't commit to in-store marketing. They mostly commit to purchasing, product placement, maybe moving to the "raceway" or front of the store. That usually costs the manufacturer money to move to a better location. They don't send line-diagrams to ENERGY STAR, they are just committed to selling more and they know how to do that. One thing we as*

[48] Malinick and Ridge, "California 2016-2019 Retail Products Platform Program Pilot," *EMI Consulting,* p. 60.

> *energy-efficiency managers have to stop doing is thinking we know how to sell things at retail. Retailers know how to sell things at retail, we need to let them do that.*

Although we did not interview any retailers, our takeaway from market scan interviews was that retailers have been very receptive to the national-level ESRPP program. "*Retailers love RPP, they only have one group contacting them to do interviews. It's a lot easier for them in terms of timing and what they have to do. They also like that they can do what they want with incentives (e.g., use them towards purchasing, lowering costs, marketing, etc.). I think it probably added flexibility for retailers and made it easier for them to run many programs*," said one ESRPP sponsor. An EPA employee added,

> *One thing we see is a universal participation agreement between program sponsor and retailer. Just off the top for the retailer, that simplifies their life. They have one agreement and they can buy the same thing in many places. They don't want to hear about different terms in each state. They have had their savings limited from bottom up approach, but now that the money is flowing down they aren't helping utilities (outside RPP). Right now, energy efficiency is an overhead or cost for them, they are very interested in streamlining the whole administrative process.*

We did hear from one industry expert that this may be an overly-optimistic outlook. Challenges with the data portal have made interactions with retailers more difficult than anticipated (see 5.4 for more).

Additionally, since ESRPP is evaluated at the local or regional level, retailers still encounter multiple interview requests. While this is a challenge, retailers at the ENERGY STAR Partner's Meeting did state that they could assign a dedicated person to handle these requests.

5.3.3 Availability of Data

In the participant agreement that retailers sign to join the ESRPP program, they agree to share sales data of both qualified and non-qualified models. This includes providing this information from the year prior to joining ESRPP. "*On the data side, the data goes to the program sponsor and they can see all the sales that have flown through the system. You almost get real-time savings data for both qualified and non-qualified products. That's a first, retailers have never given non-sponsored data*," said an EPA employee. The availability of data was cited as a benefit by several interviewees. However, as early evaluations have identified, there are still kinks to be worked out of the data collection and delivery process. These mostly center around difficulty in identifying qualified versus non-qualified models, especially as the qualified models are often changing.[49] One interview participant who has been heavily involved in RPP planning and evaluation over the past several years identified the availability of the data and the usefulness of the information as the greatest strength of the RPP approach:

"To me the most valuable part of RPP is the data you get out of it… That I think has a lot of value for PA's in planning purposes."

[49] For more see: "Retail Products Portfolio Market Test Assessment," *NEEA*.

> *To me the most valuable part of RPP is the data you get out of it. One thing NEEA is doing right now with that sales data they get is not just thinking about the evaluation of RPP, they're using that data to plan what other markets they're going to intervene on. Some of the insights like [finding] that top-loading washers [are being sold as mostly inefficient models] come from their analysis of those data points. That I think has a lot of value for PA's in planning purposes; where do they want to go next?*

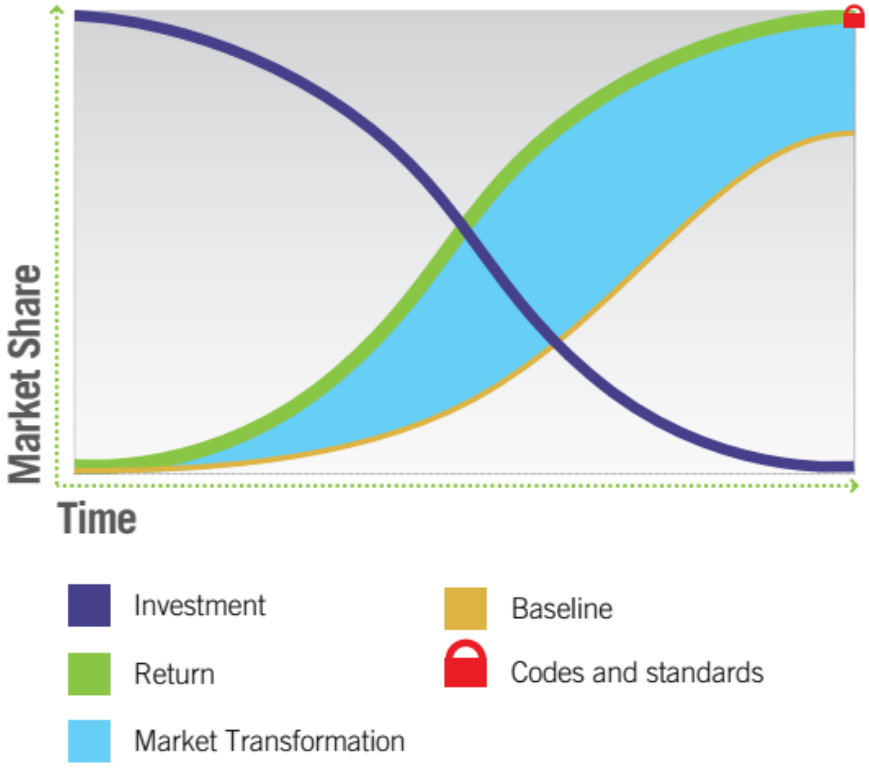
Retailers also send sales plans to ESRPP participants, although these do not have to be overly detailed or binding.[50] Although the reliability of sales data has been an issue in the early stages of ESRPP, evaluating the program's influence is a major challenge; therefore, having sales data from participating retailers is a valuable commodity in evaluation and for external purposes. Additionally, this allows RPP PA's to adjust incentive levels for retailers, qualified products, or other program aspects in nearly real time if a measure is failing to perform as expected.

5.3.4 Long-term Potential of Market Transformation

NEEA defines market transformation as "the strategic process of intervening in a market to create lasting change in market behavior by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice."[51] Figure 4 shows this in graphical form, where costs decrease over time, while the adoption of efficient products increases and/or accelerates.

[50] *Ibid.,* p. 15.
[51] "NEEA's Definition of Market Transformation," *NEEA,* https://neea.org/docs/default-source/marketing-tookits/neea_definition_of_markettransformation.pdf?sfvrsn=2, (accessed Sep. 18, 2017).

Figure 4: Market Transformation Over Time



Source: https://www.energystar.gov/sites/default/files/asset/document/ESRPP%20Pitch%20Deck_Draft_5.26.17%20-%20508%20PASSED.PDF

ESRPP is still in its early stages, and we are yet to see any conclusive results. However, if significant, long-term market transformation does occur as a result of this program, then there will be improvements in the efficiency of products on the market for years to come, even after most of the costs and responsibilities of the PAs have been removed.[52] One PA who was in the process of joining ESRPP told us that after struggling to achieve success in increasing the sales of CEE tier 2 and 3 models, the RPP market-transformation model offered the greatest opportunity to move beyond the shrinking savings of ENERGY STAR as market penetration increases, and baselines tighten. "*Some of these products need manufacturing to catch up; there just aren't many CEE tier 2 and 3 models available for some products. Tier 1 is what most stores have…That's why we're going midstream to influence what is actually in-store rather than offering an incentive and praying customers can actually find it*," she said. She added that in many cases these struggles were mostly due to manufacturers who do not produce models meeting CEE tier 3 specifications. This leaves retailers with

"Ultimately, the greater transformational impact of changing the market is what you should focus on… Putting good options in front of people is much more impactful than anything else."

[52] For more on this see the CA logic model: Malinick and Ridge, "California 2016-2019 Retail Products Platform Program Pilot" *pp.* 6-7.

limited efficient option to stock. The California program describes the goal of long-term transformation, with regards to RPP, which should influence manufacturers as well:

> Long term market changes are expected to influence not only participating retailers but also non-participating retailers. Non-participating retailers will experience market-signals telling them to be selling more energy-efficiency products, and manufacturers will experience increased demand for efficient products…Long-term demand on manufacturers for more energy-efficient products, as well as policy-related effects on standards, should ultimately make the market transformation effects permanent.[53]

It is important to note that it may take 10-15 years for the full effects of any RPP efforts to play out and for these indicators to be fully measured.[54] Different outcomes of the ESRPP program will take place at different stages, and would likely include NEIs and other results outside of traditional savings. This means that it could take quite some time to evaluate the impacts of such a program, which adds a degree of risk and requires trust in the process, especially in the early years. We will discuss these risks further below. Still, our respondents were optimistic about the long-term outcomes of RPP. On the potential of market transformation one stated,

> *Moving towards a broader market transformation framework for claiming credit is the end goal…Ultimately, the greater transformational impact of changing the market is what you should focus on…This is lofty, but the end goal is to get everyone to convert to greater efficiency…Realizing what drives people and why they make the decisions they do is very important. Putting good options in front of people is much more impactful than anything else*.

Respondents also noted that, "*In year one, two, or three RPP might not be effective. It won't be cost-effective immediately, it will take several years...[With] The market transformation curve and high initial costs, there are not a lot of [early] savings, but by the end you get a lot of savings for basically no-investment*." Interviewees also noted that as efficient products become more prevalent in large retailers through RPP, the model should lead to accelerated standards changes. "*We saw this happen with the TV initiative for NEEA [which we found] sped up the market by about six months or so. When you started seeing retailers ask manufacturers to design TVs to a certain spec or beyond it, which there were a few instances of, it was because they knew they could get incentives. That was one of those areas where that was pretty cool. I think there's potential for that in RPP*," explained one evaluator and ESRPP designer. Several noted that this could be another opportunity for PAs sponsoring the ESRPP program to claim attribution, but also noted that determining the level to which those savings could be claimed will be difficult to determine.

5.4 Weaknesses and Challenges

5.4.1 Redefining the Products Program Landscape

Switching to RPP is a challenge due to uncertainty in moving to a new type of program after years of offering traditional downstream rebates. "*There is a well-worn path of 25 years of*

[53] *Ibid.*, *pp.* 8-9.
[54] *Ibid.*, *p.* 62.

downstream rebates. It makes sense – give people money and they buy something efficient – and it has been extremely successful, but it's starting to go away," said an EPA employee. Respondents identified three major challenges that they have had in moving away from downstream rebates to the ESRPP model: (1) figuring out the future of products for which they currently offer downstream rebates, and are included in the RPP portfolio, (2) learning to deal with outside organizations choosing what products are being sponsored in their local territory, and (3) finding a suitable evaluation framework, especially given the requirements of public service commissions, who are often rooted in downstream thinking.

As we have discussed previously in this section, there are differing opinions on the future of downstream rebates. With regards to RPP, some were hesitant to move products that are still achieving savings to a new model. Several interviewees stated that RPP could exist alongside downstream rebates with each offering separate products, but one suggested using an RPP approach and a downstream approach on the *same* products to try to leverage them even further. While this contact admitted that this "*blows the idea of RPP up" to an extent",* he also noted that there could be more room for RPP and downstream programs to interact than some others have thought. We also heard some who considered this *"double-dipping*" unfeasible because of the difficulty in attribution and the increased costs from paying multiple incentives on one product.

Dealing with outside influences and organizations was a concern in terms of losing the opportunity to continue to run successful downstream programs for the products achieving the highest savings. There was also concern that many utilities may have to begin sponsoring products where the savings are less in their own region than in others. One ESRPP sponsor highlighted this, saying,

> *The difficult thing with RPP is you can't always get what you want. There are seven different appliances, two probably that wouldn't matter much to [my state] if it weren't for the various other partners. I think you have to look at the program overall and determine if there's a benefit. For example, we probably wouldn't do much with window ACs, but then on the other side, there are probably some products that benefit us more than other areas…We want to incentivize things to help the program as a whole. We see the greater good in trying to incentivize window ACs, even if it's not a huge benefit to us.*

Another PA told us that they will be joining the ESRPP program but will only sponsor three measures (added flexibility in ESRPP now allows this). They stated that with the importance of justifying savings to their state public service commission in sponsoring ESRPP, they can only choose the measures that will offer the greatest savings.

While there is concern about incentivizing measures that are not the most effective locally, some utilities that are part of the ESRPP territory of a larger collaborative have also fought against losing the savings from their best measures in a downstream program. "*What has made [ESRPP] a little tricky has been 'turfiness' between the utilities and [the regional administrator] in not wanting to give up the best products,*" said one administrator, who acknowledged that this made the program more appealing for utilities working directly with ENERGY STAR. With the lack of results expected from the RPP model in the first few years, giving up a program or measure that is currently achieving savings through a downstream model is a difficult proposition. Evaluating the short and long-term effects of RPP is also a challenge; we discuss this challenge in section 5.4.4.

5.4.2 Loss of Customer-Utility Relationship

Four interviewees identified risks in losing the relationship between the customer and the utility, or the visibility of the utility, in an RPP model. They raised this concern for two reasons: (1) customers may lose sight of the utility's efforts, and the benefits of investment in energy-efficiency, and (2) some products may require effort on the part of the customer to achieve the greatest level of energy-efficiency (e.g., properly setting up an advanced power strip) or to be utilized as an effective demand-response tool (e.g., properly programming a smart thermostat). By taking the utility out of the equation, there is the possibility that customers will miss out on an educational process to help them best use their new devices. "*The nice thing about downstream is it's visible to customers. [Our] customers have expressed they would like to see more rebates, so this gives us more customer connection,*" said one utility representative. "*I think many [utilities] are hesitant to abandon [downstream rebates] because they want customers to know who helped them make this efficient decision, and who was there for them when they needed help,"* added another interview participant. Two participants suggested that RPP is most successful with in-store marketing campaigns, something that the ESRPP program allows. This may present an opportunity for the utility to both increase the program's success and to stay visible.

"[Utilities] want customers to know who helped them make this efficient decision, and who was there for them when they needed help."

An evaluator also noted that relying heavily on RPP for programs will not work for new technologies, which may be more efficient than what is currently on the market. With regards to heat pump dryers, she said, "*midstream products or interventions aren't going to work for products that the retailers don't feel confident about because their consumers don't feel confident about it*." RPP is not the way to raise awareness about the efficiency of new or existing technologies, "*in my view, midstream programs at their best are frankly taking a choice away from the consumer, so that they're not seeing the inefficient products. That often means that you're not messing with awareness directly at all*," said an ESRPP planner. "*Indirectly after many years [consumers] might just notice that ENERGY STAR is part of everything [and otherwise be unaware of efficiency*]."

5.4.3 Initial Impact

The RPP model is aimed at long-term market transformation; therefore, significant results are not expected in the first few years. In many cases, retailers signed on to the program after already making purchasing decisions for the upcoming year, so the impact the program could make in this time is limited.[55] As such, there will be few indicators early on in determining whether the program is progressing as planned, and it is very likely that there will be nothing to show for the money that has to be invested to get the program off the ground. One EPA employee bluntly said, "*If you want first year cost-effectiveness don't even try this.*" While everyone we spoke with acknowledged the risks, most explained that their trust in the RPP model made them feel comfortable in taking these risks. "*We haven't done an evaluation yet…We're slated to do our first evaluation in 2018 for program years 2016-17…obviously,*

[55] Malinick and Ridge, "California 2016-2019 Retail Products Platform Program Pilot," *p.* 8.

it's a little scary supporting something for two years before you really know what, if any, savings you're going to get out of it," said one Program Administrator. This PA added that having other organizations like NEEA and various CA stakeholders involved in early evaluation efforts has made him much more comfortable with the process. Another participant acknowledged that even with many stakeholders involved, it is unlikely that RPP sponsors will ever be able to compete with manufacturers for retailers' attention. "*There's so much more money going around [between manufacturers and retailers] that we're not going to have a huge effect. We're going to have a small effect, and hopefully it's enough to [make an impact]. That's a very open question, we don't know how to answer it yet*," said an ESRPP sponsor.

As expected, initial evaluations of RPP have seen little to no lift across most measures (see 5.5 for more). Since the expectations for market impacts in the first few years are small, there is no way to determine if the program is working as planned. Finally, there is the possibility that the market is changing without program impact, and RPP may only have a small effect on changes that were likely to happen regardless of its existence. One of several challenges in evaluating RPP is never knowing exactly what would have happened without RPP.

5.4.4 Difficulty in Evaluating

"*The success of the program will hinge on whether it can be evaluated to the relative acceptance of all the PAs or the sponsors of the program…it's frankly very hard,*" said an evaluator working on the ESRPP program. "*Even if on the face of it, there's some usefulness or at least the logic is sound, can we prove it, and feel confident that we've proved it correctly or enough? Or can we feel confident that it's good enough that we're comfortable with the uncertainty?*" asked an evaluator, adding,

> *If I have 10% of the units that are attributable to RPP, then you can easily take that and rework what the incentive would be. If I incented every single unit at $10 but 10% were attributable to RPP, then what does that make the actual per-unit incentives that I paid that are attributable? That's the question and you can compare that to the number from the downstream incentive that you're paying and that NTG. Think of it that way, you can kind of do a quick eyeball of "is this even cost-effective?" That hasn't been done yet and I think it really should. Even though people say how RPP is more likely to [reduce costs] because you're paying smaller incentives, you're still paying them on every unit, so the total attributable incentive paid, you don't know what that is yet.*[56]

[56] As noted in the C&S memo, having to pay incentives on every unit will hurt the low-cost potential of RPP and its NTG ratio, which will compare especially poorly with traditional programs if evaluated the same way. For more on this discussion see p. A-11 in this report.

There are still many questions on the best way to evaluate RPP, although some consensus is beginning to emerge.[57] Getting into the specific challenges and strategies of RPP evaluation is largely outside the scope of this report, but all the interviewees identified the need to overcome evaluation barriers and show the effects of the program as critical to its potential success. *"[Evaluation of RPP is] not rocket science but it's new and different and evaluators have to figure it out*," said an EPA employee. Evaluation challenges include the need to establish accurate baselines (something which could be muddied if the market transformation achieves the intended consequence of impacting non-participating retailers), determining what is actually attributable to the program, and to a local region, and dealing with or moving beyond traditional evaluation metrics. Free-ridership, spillover, and NTG, cannot be thought of in the traditional sense when it comes to evaluating RPP. "*What was valid in the EM&V method before is now taken away from you and you're now stuck with what people think is a horrible method, which is pre-post. With enough data and enough people, it's actually not that bad, but it's still not always accepted so how do you get around that?*" asked an evaluator.

"The success of the program will hinge on whether it can be evaluated to the relative acceptance of all the PAs or the sponsors of the program."

Much of RPP's success may depend on the regulatory approach. A California utility employee acknowledged that California faces an uphill battle in establishing RPP because of the inherent free-ridership that is taken into account. She went on to tell us that California committing to at least four years of RPP to determine its effectiveness was a great benefit of potential success. She also noted that the "*relaxed regulatory approach we see in Northwestern states is a key to the success of RPP [in that region]*." An ESRPP stakeholder in the Pacific Northwest echoed that using market-baselines in evaluation and staying away from free-ridership is very beneficial in approaching RPP.

"Even though people say how RPP is more likely to [reduce costs] because you're paying smaller incentives, you're still paying them on every unit, so the total attributable incentive paid [is not yet known]"

As noted above, and in early evaluations, a key component to the ESRPP platform is the availability of sales data of both qualified and non-qualified models from participating retailers, including sales data from the year prior to participation. This allows evaluators to estimate baselines that consider RPP's effect on retailer decisions made at the national level.[58] Establishing accurate baselines is a challenge, although having different partners working on ESRPP and collaborating could help to create solutions to accurately establish these baselines.[59] With the many parts involved in

[57] For more see: "Retail Products Portfolio Market Test Assessment," *NEEA*, and Malinick and Ridge, "California 2016-2019 Retail Products Platform Program Pilot" *EMI Consulting.*
[58] "Retail Products Portfolio Market Test Assessment," *NEEA, pp.* 23-4.
[59] In the "Retail Products Portfolio Market Test Assessment" prepared for NEEA, the evaluators recommend sharing information about baseline approaches at the ESRPP EM&V Task Group to facilitate this process. See: *Ibid., p.* 31

evaluating RPP, early recommendations emphasize the importance to focus on a theory driven evaluation, along with other methods.[60] "*A vital [part of moving] into midstream or upstream is doing really good, solid, in-depth interviews that are not quantitative but rather asking [retailers and manufacturers] about how they're using the program, using the incentive money, etc. etc*.," said one evaluator involved in ESRPP design and planning. *"[This] can get you an idea of if there is a component of free-ridership at the retailer or manufacturer level*."

5.5 Early Results

The most comprehensive early evaluation of an ESRPP program is the NEEA Market Test Assessment, which is completed for late 2015 and 2016.[61] PG&E and SMUD's 2015 pilot has also been the subject of an evaluation.[62] Due to the early timing of evaluation in each of these reports (compared to the lengthy timeframe at which changes through RPP are expected to occur), neither were expected to find significant shifts in the market. The evaluations are centered more around the theory and measuring changes outside of market lift. The NEEA report found the program to be successfully expanding its scale and beginning to succeed in working out early difficulties with the data coming from the retailers. The problems with the data centered on difficulties in product-matching, the qualified products list, and products being ENERGY STAR qualified at different times.[63] Using a t-test, the evaluation did find shares of efficient freezers and dryers differed significantly from 2015 to 2016. Regression analysis and exponential smoothing techniques showed that the 6% market lift in efficient dryers was statistically significant, albeit with a large confidence interval.[64]

The report also identified the importance of economies of scale and the large influence on retailers as key components to the success of ESRPP. The authors also cited the need to justify savings, finding the ability of program sponsors outside the Northwest to estimate savings and validate them to regulators to be the "*greatest risk to the initiative's continued growth.*"[65] The 2015 PG&E and SMUD evaluation also cited scale as a critical component of RPP, claiming the "*twenty-six participating stores [from that pilot] are not going to transform any market.*"[66] As of now, it seems that the collaborative effort, and number of program sponsors and retailers signed on to ESRPP, are the program's greatest strength. They should help to overcome barriers found in the PG&E/SMUD pilot and other potential barriers identified if the program's influence was too small.

In their first ESRPP progress report, ENERGY STAR stated that ESRPP has "*successfully increased the number of retailer participants, increased the percent of households covered*

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[60] Malinick and Ridge, "California 2016-2019 Retail Products Platform Program Pilot," *EMI Consulting, pp.* 15-25, and Malinick, Ridge, and Colvin, "Pacific Gas and Electric Company Retail Plug Load Portfolio (RPP) Trial: Evaluation Report," *PG&E, p.* 7.
[61] "Retail Products Portfolio Market Test Assessment," *NEEA.*
[62] "Pacific Gas and Electric Company Retail Plug Load Portfolio (RPP) Trial: Evaluation Report," *PG&E*.
[63] "Retail Products Portfolio Market Test Assessment," *NEEA, pp.* 11-5.
[64] *Ibid., p.* 28.
[65] *Ibid.*, *p.* 31.
[66] Malinick, Ridge, and Colvin, "Pacific Gas and Electric Company Retail Plug Load Portfolio (RPP) Trial: Evaluation Report," *PG&E, p.* 2.

by an ESRPP territory [to roughly one-third of the US population], and proven that utilities can work together with each other and retailers to deliver a nationally coordinated program."[67] This sets the framework to potentially "*drive the sales of qualified products and transform the market for ENERGY STAR certified appliance and consumer electronics [at a low cost].*"[68] Still, the actual savings numbers of the program remain to be seen, and that will be the true test in determining the effectiveness of the RPP model. Results will rely heavily on the consensuses reached in establishing baselines and other evaluation techniques.

[67] "The ENERGY STAR RETAIL PRODUCTS PLATFORM 2016 Progress Report," *ENERGY STAR*.
[68] *Ibid.*

A Appendix A What's Next for Products and Lighting Task 1 Documentation of Codes and Standards

We include the already approved Task 1 memo as Appendix A for reviewer's reference.

Executive Summary

The goal of the RLPNC 16-10: What's Next for Products and Lighting Study is 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 plan cycle that will achieve cost-effective savings. This memo, the first step in that process, outlines existing codes and standards, as well as other metrics, to measure and identify potential savings opportunities.

OBJECTIVES

The objectives of this task are as follows:

- To document current and future codes and standards of household appliances and products
- To identify more stringent product standards which could be used in defining incentive levels for products programs (i.e., ENERGY STAR and Consortium for Energy Efficiency (CEE) specifications)
- To use these guidelines, as well as documentation of existing state standards, to identify the best opportunities for product/program savings in Massachusetts
- To explore other opportunities for residential savings (e.g., demand-side management and plug-load programs)
- To explain the next steps we will take in this process of identifying the most effective ways to capture future savings

METHODOLOGY

We first created a preliminary list documenting the existing and future Department of Energy (DOE) federal requirements, as well as ENERGY STAR and CEE specifications, of over 40 household products and appliances. In addition to documenting existing guidelines, this process involved reviewing the outlook for efficient models, including studying ENERGY STAR and CEE scoping reports, reviewing existing studies of future savings opportunities, and documenting the efficiency of newly released models. To further identify the savings potential of products, we also documented ENERGY STAR market share at the national level, projected per-unit annual kWh savings of efficient model types, and whether a product is

currently part of a Massachusetts program. Massachusetts-specific penetration rates will also be examined following the data collection from the RES-1 baseline research. It is important to note that national numbers may not be wholly representative of Massachusetts, and that true savings potential cannot be accurately determined without current free-ridership rates. With guidance from the PAs, we narrowed the list of products covered in this memo to exclude central HVAC equipment as well as ductless mini-split systems (although room air conditioners are included).[69]

We also sought to provide information on cutting-edge demand-side management (DSM) and plug-load management programs, as well as an overview of emerging technologies like residential connected lighting controls and home battery storage systems. We achieved this end by investigating these technologies and existing programs that were identified by CEE and/or the American Council for an Energy-Efficient Economy (ACEEE) as having achieved success.

The current memo offers *preliminary* guidance on the savings potential of about 30 household products, as well as an overview of some successful utility-run programs. The goal is to create a guideline that NMR, as well as the PAs and EEAC Consultants, can use moving forward in this process. We will be using our findings to help guide upcoming in-depth interviews, and possible planning summits, to better identify the best ways to capture energy savings opportunities. As this memo does not consider cost-effectiveness, the savings identified refer only to the *technical* savings of a measure.

DEFINING TERMINOLOGY

- *Savings*: As noted above, "savings" is used throughout this memo to describe the technical savings of a measure. We do not examine the cost-effectiveness of each measure, nor do we look at free-ridership.
- *Market Share:* Market share refers to the extent to which a product or type of product has infiltrated the market place, or the percentage of units shipped for a given product that have the ENERGY STAR label. ENERGY STAR market share discussed in this memo refer to the product's share on the national level unless otherwise noted. While ENERGY STAR generally refers to this as "Market Penetration" we have utilized the term "Market Share" to be consistent with Massachusetts definitions. This data comes from *ENERGY STAR's* 2015 Unit Shipment and Market Penetration report, and therefore the "penetration" data are all calculated based on the percentage of units shipped for a given product that have the ENERGY STAR label.[70]

[69] Central HVAC equipment does not qualify for the MA products program which is why it is not included. Room air conditioners do qualify and are therefore included. Ductless mini split systems are covered in other studies which focus exclusively on their potential.

[70] "ENERGY STAR Unit Shipment and Market Penetration Report Calendar Year 2015 Summary" *ENERGY STAR,* https://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2015_USD_Summary_Report.pdf?2632-3515 (Accessed May 16, 2017).

- *Current/Future Standards:* Standards refer to Federal (DOE) requirements for any appliance/product listed.[71]
- *Current/Future Specifications (Tiers):)*: The requirements for a product or appliance to meet the specifications for ENERGY STAR, and/or any CEE tiers, all of which exceed the efficiency requirements of the DOE standard for a given product, and serve as a baseline we used to identify savings potential of most products throughout this memo.
- *Demand Response Programs:* Utility programs aimed at reducing peak demand in the residential sector during high usage periods (most often throughout the day and early evening during the summer). These programs could be aimed at controlling a customer's HVAC systems directly, or incentivizing behavioral changes.
- *Two-way communication programs:* Refers to programs where customers install a "bridge" device atop their (usually smart) meter, which communicates energy use and patterns with the utility in real time.
- *Home Energy Management System (HEMS):* Systems that allow customers to manage their home energy consumption, in areas such as lighting, appliance, electronics, and smart thermostats/HVAC by using "smart" technologies to curb inefficient habits. Customers often have access to a portal allowing them to understand their habits and improve their efficiency. Although HEMS are mostly discussed in the demand-response section of this memo, these systems and specific measures (e.g. smart power strips and energy portals) have the potential to achieve savings at peak and off-peak times.
- *Connected Lighting:* "Smart" lighting control technologies (e.g. occupancy sensors, dimmers, timers) which present the opportunity to capture residential lighting savings even after a household has switched to all LEDs.
- *Residential Battery:* In this memo we address only residential storage batteries that are installed in the home, and not in an electric vehicle.

CAVEATS/DISCLAIMERS

Of note to all current reporting is that the current research focuses on technical savings potential, not Massachusetts-specific savings. As such the current research is meant to be a first-step in the process of identifying appliances and measures that could be both beneficial and cost-effective for future products programs in Massachusetts, but true estimates of potential and cost-effectiveness will rely on current free-ridership rates, penetration, saturation, etc.

[71] "Electronic Code of Federal Regulations", US Government Publishing Office, https://www.ecfr.gov/cgi-bin/text-idx?SID=2942a69a6328c23266612378a0725e60&mc=true&node=se10.3.430132&rgn=div8 (Current as of May 12, 2017).

KEY FINDINGS

Key findings from this task include the following:

- ***ENERGY STAR and CEE specifications on products that are not currently offered as part of Massachusetts products programs may offer both opportunities and possible parameters of future products programs.***
- ***Based on existing standards, ENERGY STAR saturation, and current Massachusetts program offerings, clothes washers and dryers, refrigerators and freezers, room air conditioners, and pool pumps offer the greatest technical opportunities for savings, although their achievable and economic savings in Massachusetts will depend on current free-ridership and saturation rates. The cost-effectiveness of these products in Massachusetts is still to be determined. We intend for these measures to be a focus of interviews in the Task 2 Market Scan.***
- ***Based on projected residential energy consumption trends, plug load management may be a significant source of future residential savings. The best savings opportunities for many household electronics (e.g., TVs and DVD players) could be through mid-stream plug load programs, which have proven to be effective in increasing market shares of larger ENERGY STAR appliances like refrigerators, washers, and dryers.***
- ***New technologies and innovative program designs have helped DSM programs save 200 billion kWh nationwide in 2015. Based on regional EE funding figures, it appears that the Northeast is behind the rest of the country in terms of investments into these programs.***
- ***Programs in residential connected lighting and residential battery storage are in their infancy. Both areas offer enticing savings opportunities, but the best way to implement programs and utilize these technologies are still being discovered.***

A.1 INTRODUCTION

The Massachusetts PAs have cited increasingly stringent federal codes and standards as the single biggest hurdle they are facing with the retail products program. With federal standards often set at a level that allows little or no room for claiming cost-effective savings from even the most efficient models of products, running an effective products program has become extremely challenging. For this research task, NMR documented and summarized the latest codes and standards changes, as well as the relevant ENERGY STAR specifications and CEE stretch specifications, in an effort to identify measures for more in-depth cost-effectiveness screening and potential program inclusion.

In addition, the market for many product types is saturated with ENERGY STAR models. As a result, while savings between standard and ENERGY STAR models are still achievable, incentives put toward these efficient models may be going to consumers who would have

purchased the ENERGY STAR model in absence of those incentives. This memo seeks to document relevant codes and standards to provide insight into where potential gross savings may be most readily available. It also reviews plug-load management and selected residential demand-response programs to offer insights to the MA PAs and EEAC on how these programs can be most effective. We also outline the next steps we will undertake, as this research is intended to be an iterative process that culminates in actionable recommendations for changes to the products program. We anticipate completing each task of this study – and will identify key takeaways and make final recommendations – following the completion of the planning summit and manufacturer interviews.

A.1.1 Defining Savings Opportunities

Figure 5 displays the ENERGY STAR and higher CEE tiers in existence for various products and appliances, along with the market share of *non*-ENERGY STAR products.[72] It also indicates whether Massachusetts is currently sponsoring the product as part of a program at each level. Generally, greater savings opportunities can be found by moving toward the top and the right of this figure (i.e., toward the products with CEE-recognized tiers and high market share of non-ENERGY STAR products).[73] For example, the figure reveals that refrigerators may have greater savings potential (multiple CEE tiers, a market share of over 50% for non-ENERGY STAR products, and not currently part of a Massachusetts program) than dehumidifiers (no CEE specifications, a market of mostly ENERGY STAR models, and current Massachusetts sponsorship). Figure 5 is a simple model we used as a general guideline to identify gross savings. It is important to note that it does not account for other factors involved in identifying potential savings, such as applicability factors (e.g. number of homes using the product), product lifespan, net savings, or the per-unit energy savings of efficient models. It also does not consider the cost-effectiveness of the measures for the Massachusetts program.

Throughout this memo, we group these products into either *high gross savings potential* or *moderate-to-low gross savings potential*, and Figure 5 generally defines these groups. The high savings potential group tends to comprise the products in the top-middle and top-right of the figure. While many home electronics have no CEE specifications and moderate-to-high ENERGY STAR market shares (e.g., TVs, set-top boxes, DVD players), these products are excluded from the low savings potential group. Rather, they are discussed in A.3, which looks at Plug Load Management, as this may be a way to capture the savings of several of these products. While NMR initially explored the savings potential of HVAC equipment (e.g., gas

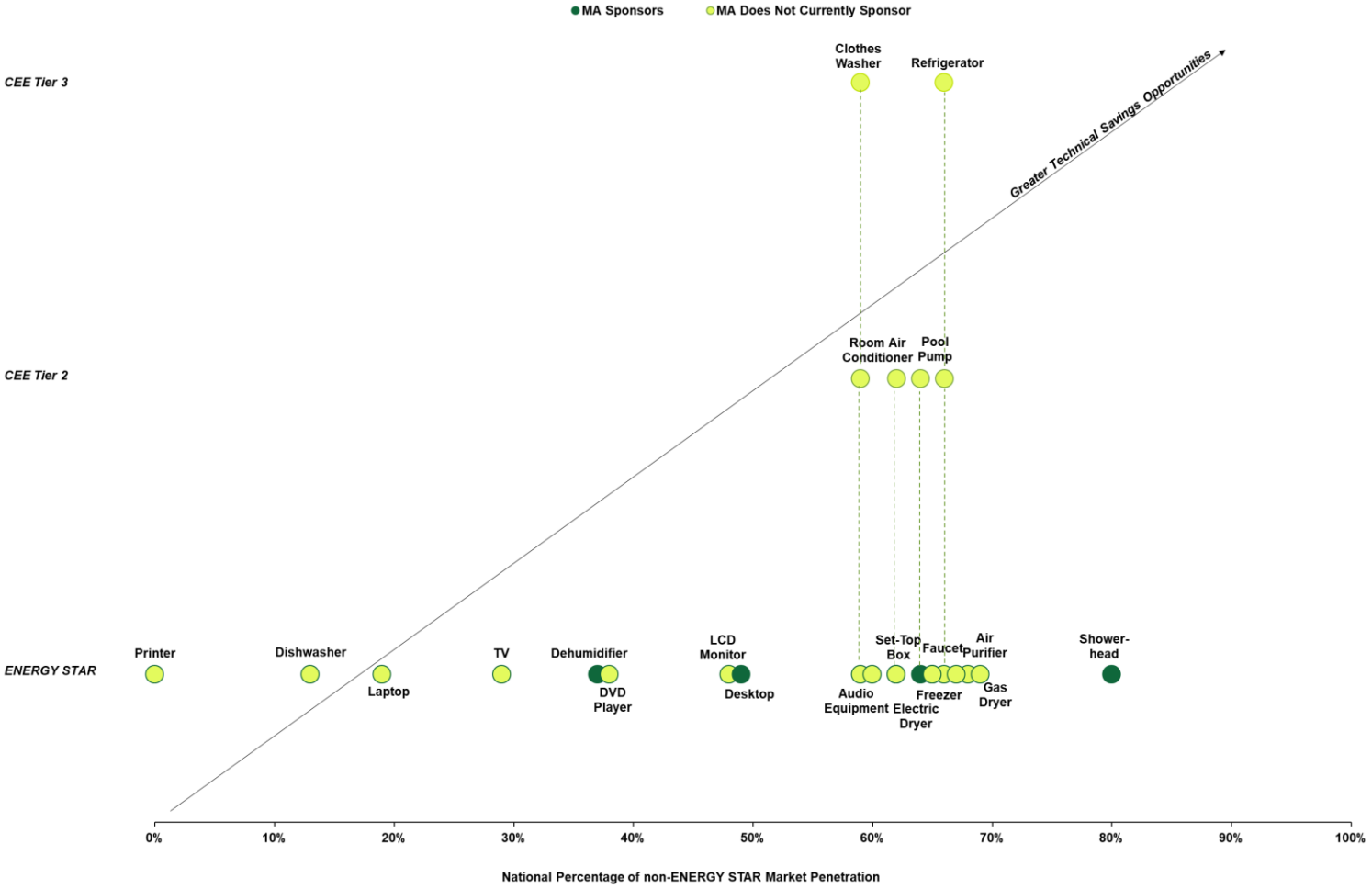
[72] NMR will have additional market share information when the Massachusetts baseline study is completed. The greater the non-ENERGY STAR proportions the higher the likelihood of a higher net-to-gross than those with smaller non-ENERGY STAR proportions, i.e., net savings. The current market share values serve as placeholders, and come from: "ENERGY STAR Unit Shipment and Market Penetration Report Calendar Year 2015 Summary" *ENERGY STAR.*

[73] While higher CEE tiers can be a useful program guideline, the challenges associated implementing a program that only incents the higher tiers should be noted. Unlike ENERGY STAR, there are not visible identifiers on these products making it difficult for both the consumer and the store managers to figure out which products actually qualify. The problem is exacerbated by model numbers that are often very similar, only differing by one letter. Massachusetts dealt with this challenge in running rebates on Most Efficient refrigerators.

boilers, air source heat pumps, and gas furnaces) in order to cast as wide a net of savings potential as possible, these are mostly excluded from the memo due to incentives already offered in Massachusetts as well as to focus on measures that could be included in a products program.[74] In Figure 5, faucets and showerheads are subject to WaterSense specifications and market share levels, rather than ENERGY STAR. The ENERGY STAR and WaterSense market share numbers are based on national figures from 2015 and should be used as only a general guideline when considering the current market in Massachusetts. Massachusetts-specific penetration numbers will be updated following the results of the current residential baseline study.

[74] Large HVAC systems do not qualify for the MA products program, but room air conditioners do.

Figure 5: Gross Savings Potential of Selected Appliances/Products[75]



[75] ENERGY STAR numbers are based on 2016 shipment data: https://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2016_USD_Summary_Report.pdf?425f-5e3e; CEE tiers current as of December 31st, 2017.

A.2 APPLIANCES/PRODUCTS

This section outlines the current and future federal (DOE) standards, higher ENERGY STAR and CEE specifications, and savings potential of selected household products.

A.2.1 High Gross Savings Potential

Table 8 details the current and future DOE standards of the products we identified as having the greatest potential for energy savings. Additionally, it provides indicators that helped guide us in this categorization. These include higher product specifications in existence (i.e., ENERGY STAR and CEE tiers), the 2015 ENERGY STAR market share of each given product, current Massachusetts program status, and the annual per-household savings over baseline of a model with specifications equal to the highest available criteria (i.e., ENERGY STAR or the highest available CEE tier).[76]

[76] All calculations made using baseline assumptions from DOE/ENERGY STAR calculators: "Energy and Cost Savings Calculator for Energy-Efficient Products", *US Department of Energy*, https://energy.gov/eere/femp/energy-and-cost-savings-calculators-energy-efficient-products (Accessed May 16, 2017).

Table 8: High Savings Potential Products

Product	MA Products Program Status	Current Standard	Tiers Above Federal (% above):	2015 ENERGY STAR Market Share	Next Federal Standard in Effect	New Standard	Highest Tier Annual Savings[1]
Clothes Washer-Top Load	Early replacement only (HES)	IMF >1.29, IWF<8.4	ENERGY STAR (60%), CEE Tier 2 (112%), CEE Tier 3(126%)	56%[2]	1/1/2018	EF > 1.57, IWF < 6.5	397 kWh
Clothes Washer-Front Load	No; previously offered but dropped due to market saturation	IMF >1.84, IWF<4.7	ENERGY STAR (29%), CEE Tier 2 (49%), CEE Tier 3 (58%)	56%[2]	1/1/2018	EF > 1.84, IWF < 4.7	246 kWh
Clothes Dryer - Gas	No	CEF > 3.3	ENERGY STAR (6%)	17%	2022	N/A	N/A
Clothes Dryer - Electric	Yes; no program for heat pump dryers which are currently too expensive	CEF > 3.73	ENERGY STAR (5%)	15%	2022	N/A	160 kWh
Refrigerator and Refrigerator /Freezer	Recycling only; previously offered but dropped due to high free-ridership	Varies widely by size and specs	ENERGY STAR (10%), CEE Tier 2 (15%), CEE Tier 3 (20%)	46%	2022	N/A	69 kWh
Freezer - Stand Alone	Recycling only; previously offered but dropped due to high free-ridership	Varies widely by size and specs	ENERGY STAR (10%)	30%	2022	N/A	N/A
Room Air Conditioner	Yes	CEER >9.0 -11.0 (varies by size)	ENERGY STAR (10%), CEE Tier 2 (15%)	54%	2022	N/A	86 kWh
Pool Pumps	Yes	None	ENERGY STAR (Varies by size)	42%	2021	Varies by size	2,061 kWh

[1]Savings are compared to baseline model at current federal standards
[2]ENERGY STAR report does not separate market share of front-load and top-load washers

Although largely outside the scope of this memo, it is worth mentioning that projected continual increases in temperatures will likely lead to increased use of products such as air conditioners and pool pumps, making efficient units more valuable in the future. Per the time-of-use assumptions in DOE's calculators, air conditioner use is roughly 15% higher in New York City than Boston. Projections suggest that by 2040 or earlier, Boston's temperatures will match those currently occurring in New York City.[77] This suggests that savings for products like air conditioners or pool pumps could increase substantially in the future.

A.2.1.1 Clothes Washers

[77] "Effects of Global Warming in Massachusetts", *Union of Concerned Scientists,* http://www.ucsusa.org/globalwarming/scienceandimpacts/impacts/effects-global-warming-massachusetts.html#.WRtUVWgrLIW

While future DOE standards have not yet been announced for many products, the new standards on clothes washers (both front-load and top-load) are set to go into effect in 2018. This future standard will not place greater restrictions on front-load washers and requires only a slight increase in the efficiency of top-load washers. Following the implementation of these standards, the next federal regulation will likely go into effect in 2024. Currently, there are ENERGY STAR, CEE Tier 2, and CEE Tier 3 specifications placed on clothes washers. Given the existence of these higher specifications and the lengthy period before stricter standards may go into place, clothes washers represent good potential for savings. While all front-loading clothes washers qualify for ENERGY STAR, ENERGY STAR saturation is moderate (56%) for all clothes washers, which include top-loading units. Massachusetts program involvement is currently limited, offering an incentive only for early replacement. DOE savings calculators estimate that a CEE Tier 3 front load clothes washer saves 246 kWh per year, while a tier 3 top-load washer saves a projected 397 kWh annually over a baseline model. Further, the abundance of CEE Tier 2 and 3 washers on the market – 39 models currently meet Tier 3 specifications and another 37 have achieved Tier 2 status – also points to the products' potential.[78] However, it can be difficult to only provide incentives to the higher CEE tier models, based on the lack of a visible identifier on such products (as opposed to the ENERGY STAR label). This can present a challenge for both the consumer and the store manager in figuring out which products qualify. For this reason, using a midstream approach to increase the market share of CEE tier 2 and 3 products, may be the best way to reach consumers.

A.2.1.2 Dryers

Recent improved testing and technologies suggest that substantial savings may also exist for dryers, a product whose efficiency potential was until recently thought to be limited.[79] Dryer efficiency can first be increased before clothes even enter the unit. Longer spin cycles in washing machines can remove significantly more moisture than most models currently do. Replacing both units could lead to more efficiency in washing and drying by starting the drying process in the washer. In dryers, automatic termination and moisture sensors can limit unnecessary runtime. These savings are not captured by current testing procedures used by the DOE and ENERGY STAR, which only test mid-cycle efficiency[80]. Additionally, ultra-low cycle speeds have proven to greatly increase dryer efficiency (though consumers may be unhappy with the increased cycle-lengths), which means that dryers with an ultra-low-speed

[78] "ENERGY STAR Product Finder", *ENERGY STAR*, https://www.energystar.gov/productfinder/ (Accessed May 16, 2017) and "CEE Program Resources: Residential", *CEE,* https://www.cee1.org/content/cee-program-resources (Accessed June 15, 2017).

[79] "ENERGY STAR Market & Industry Scoping Report: Residential Clothes Dryers", *ENERGY STAR,* https://www.energystar.gov/sites/default/files/asset/document/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf (Nov. 2011), 4-8.

[80] This may be an example of savings that could be claimed outside a traditional products program by advocating for a better test procedure through a standards support program. NEEP and CEE have both noted that test procedures for dryers do not simulate real world conditions due to both test cycle conditions and the cloth used in the standard sample load. NMR will explore this topic during market scan interviews. For more see: Brian McCowan, Kerri-Ann Richards, and Michael Wacker, "Residential Electric Clothes Dryer Baseline Study", *NEEP,* www.neep.org/file/2766/download?token=wn4kylsO (March 2015), 17-18.

options could also increase efficiency.[81] Therefore, significant opportunities may lie in dryer efficiency outside improvements to the Combined Energy Factor (CEF) which the DOE uses to test dryers. ENERGY STAR currently requires dryers to have a CEF of at least 3.93 with a maximum cycle time of 80 minutes, which equates to annual household savings of roughly 160 kWh/year per the DOE appliance calculator. This falls well short of the most efficient models on the market, several of which have CEFs of up to 5.7 and represent over twice the savings.[82] Dryers account for an estimated 6% of residential energy use, and the next federal standard is currently expected to go into effect in 2022. Market share of ENERGY STAR dryers is relatively low (15% of electric dryers), and although there are no higher CEE dryers, some electric units that utilize these new technologies such as automatic termination, moisture sensors, and ultra-low-speed settings, are awarded the ENERGY STAR Emerging Technology Award. California has used this classification (i.e. award winners) as an incentive level in product programs.[83]

Finally, the increasing availability of heat pump (or ventless) dryers may also present an opportunity for savings. In November 2011, ENERGY STAR reported that there were no ventless dryers on the US market, despite their popularity abroad. This report additionally stated that heat pump dryers would cost roughly $400 more than an average vented unit, which would require a household to complete 500-700 cycles per year to make a heat pump dryer financially viable, far more than the roughly 250 loads that the DOE projects the annual US household to complete annually. [84,85] This may mean that heat pump dryers could be an effective measure in multifamily buildings if a single dryer is used by multiple tenants, boosting the total annual loads completed by the unit. However, the viability of these units in single-family homes may be increasing, as well. Over the last several years, ventless dryers have become more available in the US, and although many remain over $400 more expensive than the cheapest options in traditional dryers, prices are becoming competitive with many units.[86] A recent study in Florida as part of the ACEEE's 2016 Summer Study on Energy Efficiency in Buildings wrote, "with a current retail cost of $948 there is only a small premium on the heat pump clothes dryers, making them cost-effective when chosen at time of replacement."[87] Several organizations are working to see increased prevalence of such

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[81] "Emerging Technology Dryer Testing", *NEEA and Ecova,* http://neea.org/docs/default-source/reports/emerging-technology-dryer-testing.pdf?sfvrsn=7, (Nov. 7, 2013), 9.
[82] "ENERGY STAR Product Finder"
[83] Erik Jacobson, "Request For Authority for Retail Products Platform (RPP) Pilot within PG&E's Residential Energy Efficiency Plug-Load and Appliances Sub-Program", *PG&E* to *Public Utilities Commission of the State of California,* https://www.pge.com/tariffs/tm2/pdf/GAS_3668-G.pdf (Dec. 24, 2015), 11. List of ENERGY STAR Emerging Technology Award Winning Dryers available at: https://www.energystar.gov/about/awards/energy-star-emerging-technology-award/2014-emerging-technology-award-advanced-clothes-dryers
[84] "Energy and Cost Savings Calculators", *US Department of Energy*.
[85] ENERGY STAR Market & Industry Scoping Report: Residential Clothes Dryers", 10-11.
[86] Per Lowe's websites, heat pump dryers range from $899 to $1,529, while traditional dryers range from $299 to $1,899 (ENERGY STAR units start at $549): https://www.lowes.com/pl/Dryers-Washers-dryers-Appliances/4294857980?sortMethod=sortBy_priceLowToHigh&refinement=4294764693 (Accessed Jun. 5, 2017).
[87] Eric Martin, Karen Sutherland and Danny Parker, "Measures Performance of Heat Pump Clothes Dryers", *ACEEE* and *Florida Solar Energy Center*, http://www.fsec.ucf.edu/en/publications/pdf/fsec-rr-645-16.pdf (Aug. 2016).

units in the US. The Northwest Energy Efficiency Alliance (NEEA) has been working with manufacturers and retailers to "increase product availability and drive demand for heat pump clothes dryers."[88] NEEA was a founding member of the Super-Efficient Dryer Initiative (SEDI) which is also working to increase the heat pump dryer use. Additionally, ENERGY STAR now includes *ventless* as an option for dryers. If these organizations are successful at increasing availability and decreasing prices of ventless dryers, these units could create a popular and effective savings opportunity in the future, although the current high cost associated with the units means they are unlikely to pass cost-effectiveness testing in the near future.

A.2.1.3 Refrigerators and Freezers

CEE publishes Tier 2 and Tier 3 specifications for Refrigerators and Freezers, which require 15% and 20% efficiency over federal standards, respectively (while ENERGY STAR requires 10% efficiency over the DOE standard). The current standards on refrigerators and freezers went into effect in 2014 and vary widely based on the unit specifications, including size, freezer location (if attached to a refrigerator), ice-making capabilities, and door size and orientation. The 2014 standard reduces allowable consumption by an average of about 25% over the previous standard, and refrigerators today use "just one-quarter of the energy of refrigerators in 1972, even as refrigerators today offer 30% more storage volume."[89] The 2015 estimate for ENERGY STAR market share of refrigerators was 46%, and 30% for standalone freezers. This market share has increased in states with targeted mid-stream programs; although other factors at play may also explain some of these increases (see A.3 for more). The existence of CEE Tier 2 and 3 specifications along with limited program sponsorship suggest likely savings potential for refrigerators and freezers in Massachusetts. Since these units are commonly purchased through retailers, the best approach may be through a mid-stream program aimed at increasing the market share of the most efficient models.

A.2.1.4 Room Air Conditioners

Both ENERGY STAR and CEE Tier 2 specifications exist for room air conditioners. The requirements vary by size, but units under 8,000 BTUs are required to have a SEERSEER rating of at least 11.0. ENERGY STAR models currently make up 54% of the market. The next standard is due to be announced in 2019 and go into effect in 2022. As Table 9 shows, room/window units make up a disproportionate share of air conditioning in the Northeast – and especially in New England – when compared to the rest of the country, based on the United States Energy Information Administration's (EIA) 2015 Residential Energy Consumption Report.[90] Sixty-four percent of New England homes use room air conditioning, while 57% had at least two units, and 25% had three or more room air-conditioners.[91] Based

[88] "Super Efficient Dryers", *NEEA*, http://neea.org/initiatives/residential/super-efficient-dryers, (Accessed Jun. 29, 2017).
[89] "Refrigerators and Freezers", *Appliance Standards Awareness Project*, https://appliance-standards.org/product/refrigerators-and-freezers (Accessed May 16, 2017)
[90] "2015 Residential Energy Consumption Survey", *United States Energy Information Administration (EIA),* https://www.eia.gov/consumption/residential/data/2015/#ac (Accessed May 23, 2017).
[91] "2015 Residential Energy Consumption Survey", *United States Energy Information Administration (EIA),* https://www.eia.gov/consumption/residential/data/2015/#ac (Accessed May 23, 2017).

on the prevalence of these units, along with the availability of CEE specifications, room air conditioners may present a good savings opportunity. In addition to potential increased efficiency, newer models offer "smart" technology, allowing the units to be controlled remotely or on a schedule. Some utilities offer programs for such units, which we discuss further in the Demand-Response section below.

Table 9: Room and Window AC Distribution by US Region

Homes that Currently Use AC	Northeast	*New England*	Midwest	South	West
Central AC equipment	40%	*36%*	73%	81%	75%
Window/wall AC units	60%	*64%*	27%	19%	25%

Source: https://www.eia.gov/consumption/residential/data/2015/#ac

A.2.1.5 Pool Pumps

Pool pumps, a newer CEE initiative, also offer savings potential. The first ever federal standards are set to go into effect in 2021, although ENERGY STAR models have achieved a market share of 42% as the savings potential of efficient pool pumps has been recently recognized. This first federal standard will vary widely by pool and pump size, but self-priming pumps follow the rule:

*Efficiency Factor = -2.30 * ln(rated-hydraulic horsepower) + 6.59*

ENERGY STAR specifications require multi-speed capabilities including a low speed and high speed, while CEE Tier 2 specifications require variable-speed devices with at least three settings, including an ultra-low/efficient speed. Per the Massachusetts TRM, a variable-speed unit currently offers annual savings of 11,062 kWh over a baseline single-speed pool pump.[92] These savings are by far the greatest of any product addressed in this memo and highlight the need for a federal standard to improve the efficiency of baseline models.[93] While there may be a limited amount of pool pumps to replace in Massachusetts, the savings opportunities offered by CEE Tier 2 variable-speed units could be sizable.

A.2.2 Moderate-to-Low Savings Potential

The products highlighted in this section are likely to offer fewer opportunities for savings than those listed above. This categorization relates to several factors, including lack of CEE specifications, high ENERGY STAR market share, and the long expected useful lives of some of these products (such as showerheads and aerators). Products with moderate-to-low savings potential are displayed in Table 10.

[92] "Massachusetts Technical Resource Manual", *Massachusetts Electric and Gas Energy Efficiency Program Administrators,* http://ma-eeac.org/wordpress/wp-content/uploads/2016-2018-Plan-1.pdf (Oct. 2015).
[93] Pool pumps may also provide an opportunity for savings through a standards support program, although when first federal standard goes into effect in 2021 it may reduce these opportunities.

Table 10: Moderate-to-Low Savings Potential Products

Product	MA Products Program Status	Current Standard	Tiers Above Federal (% above)	2015 ENERGY STAR Market Share	Next Federal Standard in Effect	New Standard	Highest Tier Annual Savings[1]
Dishwasher - Standard	No; previously offered but dropped due to market saturation and lack of cost-effectiveness	>307 kWh/year, > 5.0 gallons/cycle	ENERGY STAR (14%)	84%[2]	2024	N/A	37 kWh
Dishwasher - Compact	No	>222 kWh/year, >3 .5 gallons/cycle	ENERGY STAR (9%)	84%[2]	2024	N/A	19 kWh
Dehumidifier	Yes	> 1.35-2.5 Liter/kWh (varies by size)	ENERGY STAR (12-33%)	84%	6/13/2019	> 1.6-2.8 liter/kWh	214 kWh
Air Purifier	Yes	None	ENERGY STAR	29%	None Scheduled	N/A	283 kWh
Faucets	No-- aerators only in direct install	None[3]	WaterSense (Lavatory: 32%), CEC (Kitchen: 22%)	N/A	None Scheduled	N/A	73 kWh
Shower head	Yes	None[3]	WaterSense (20%), CEC (28%)	N/A	None Scheduled	N/A	475 kWh

[1]Savings are compared to baseline model at current federal standards.
[2]ENERGY STAR report does not separate market share of compact and standard dishwashers.
[3]Faucets and Showerheads are subject to a federal guideline rather than a standard.

A.2.2.1 Dishwashers

Dishwashers have relatively high ENERGY STAR market share and no CEE specifications. In the ENERGY STAR product finder, no standard or compact models are listed with greater efficiency than the current ENERGY STAR specification. [94] As Table 10 indicates, Massachusetts dropped its dishwasher program due to high market saturation, and with a lack of highly efficient models being manufactured, savings appear to be very limited. [95] Current federal standards went into effect in 2015 and the next standard will likely be implemented in 2024, so if more efficient models are introduced to the market in the near future, it is possible that the savings outlook could improve, but as of now potential efficiency gains seem relatively limited.

[94] "ENERGY STAR Product Finder"
[95] NMR will ask about potential work between California and manufacturers during the market scan, but currently the CEC does not enforce a higher standard on dishwashers. SoCal Water$mart offers incentives that focus on the Integrated Water Factor rather than the energy consumption of a unit.

A.2.2.2 Dehumidifiers and Air Purifiers

Another product for which CEE does not identify any specifications above the ENERGY STAR criteria is dehumidifiers. This leaves little room to improve upon the current Massachusetts program offered for ENERGY STAR units. Unlike dishwashers, there are several dehumidifier models on the market above the ENERGY STAR specification of 2.0 liter/kWh for a 40 pint/day dehumidifier. The T next federal standard, which goes into effect in June of 2019, would cut projected savings of an ENERGY STAR dehumidifier by roughly 20% compared to the new baseline model based solely on DOE savings calculators.[96] However the 2019 standard will also update test procedures, changing the ambient temperature during testing from 80 degrees Fahrenheit to 65 degrees Fahrenheit to better simulate the basement conditions where dehumidifiers often operate. This new testing method should allow future models to be built to more effectively save energy, as they will be required to show efficiency under the conditions at which they are actually operated. This would suggest that newer models, built up to DOE and ENERGY STAR specifications using the new test-procedures should achieve greater efficiency than older dehumidifiers. [97]

Similarly, air purifiers have no CEE specifications and are currently offered in the Massachusetts program with incentives for ENERGY STAR units. Like dehumidifiers, there are modest savings for ENERGY STAR units, but little opportunity to increase efficiency beyond that. There are currently no federal standards regulating air purifiers, meaning that ENERGY STAR savings could decrease if these were introduced, although currently there are no indications that standards will be implemented.

A.2.2.3 Showerheads and Faucets

Showerheads and faucets have similar regulations; they are both subject to federal guidelines (not standards), allowing states to make the final ruling on regulations and have efficient models defined by WaterSense rather than ENERGY STAR. Massachusetts has been a leader in pushing for greater use of efficient showerheads. The Mass Save program's rebates on efficient showerheads and thermostatic shutoff valves help capture significant savings in an area that many states have not addressed.[98] Most models in the program have a flow rate of 1.5 gallons per minute (GPM). This is slightly higher than the 1.3 GPM rate of the most efficient models on the market. Meanwhile, faucet aerators are part of a direct-install program, but more efficient faucets are not sponsored in Massachusetts. The current state guideline limits faucets to a maximum flow rate of 2.0 GPM. Many faucets are available with flow rates of 1.5 GPM, the WaterSense specification, and even 1.0 GPM rates. These models offer savings of 300-500 kWh/year when replacing a 2.0 GPM faucet, according to the WaterSense

[96] "Energy and Cost Savings Calculators", *US Department of Energy*.
[97] "Dehumidifiers", *Appliance Standards Awareness Project,* https://appliance-standards.org/product/dehumidifiers (Accessed May 16, 2017).
[98] "WaterSense Calculator", *United States Environmental Protection Agency,* https://www.epa.gov/watersense/watersense-calculator (Accessed May 16, 2017).

savings calculator.[99][100] These savings are substantial considering the low cost of many of these new faucets. Massachusetts currently modifies existing faucets with aerators and replaces showerheads through the HES program.

A.2.2.4 Additional Products

Additional products that we researched include humidifiers, toaster ovens, vacuum cleaners, coffee makers, induction stove tops, and battery chargers. Although efficient models of all these products do exist, none have federal standards or ENERGY STAR or CEE specifications. This, coupled with the lack of programs in other states incentivizing these products, makes identifying the efficient models and specifications to use in a products program difficult. ENERGY STAR has released scoping reports on efficient humidifiers, toaster ovens, vacuums, and coffee makers, so there may be future opportunities, but as it stands these products do not currently present strong opportunities for cost-effective savings. This does point to the potential for informing the new standards when and if set, though none are currently scheduled.

A.3 Plug Load and Demand-Side Management (DSM) Savings Opportunities

A.3.1 Plug-Load Programs

Table 11 shows the current and future federal standards (or lack of standards) for various household electronics. Additionally, it provides higher tier specifications and, where available, the average efficiency gains that these higher models achieve. Table 11 also presents the projected annual per-unit savings (per ENERGY STAR calculators) to provide some guidance on the savings potential of these products, which have less information available than those in the previous sections (i.e., federal standards to provide baseline assumptions).

The most effective way to target savings for many electronics may be through mid-stream plug load programs, aimed at increasing the market share of ENERGY STAR, higher CEE tier(s), and the most efficient models of a given product. This section outlines some aspects of successful mid-stream plug load programs.

[99] WaterSense Calculator," *United States Environmental Protection Agency,* https://www.epa.gov/watersense/watersense-calculator (Accessed May 16, 2017).
[100] NMR will explore opportunities for capturing these savings through a mid-stream program for renovators during the market scan interviews.

Table 11: Savings Potential of Household Electronics

Product	MA Products Program Status	Current Standard	Tiers Above Federal (% above)	2015 ENERGY STAR Market Share	Next Federal Standard in Effect	New Standard	Highest Tier Annual Savings[1]
TV	No; previously offered but dropped due to market saturation	None	ENERGY STAR (Varies widely based on size and resolution, sets limits for consumption while on, idle or in standby mode)	89%	None Scheduled	N/A	36 kWh (Plasma screen); 87 kWh (LCD Screen)
Computer - Desktop	No; previously offered but dropped due to market saturation	None	ENERGY STAR (Varies widely by model, size and specs)	39%	None Scheduled	N/A	11 kWh
Computer - Laptop	No	None	ENERGY STAR (Varies widely by model, size and specs)	95%	None Scheduled	N/A	22 kWh
Computer Monitor	No; previously offered but dropped due to market saturation	None	ENERGY STAR (Varies widely by model, size and specs)	93%	None Scheduled	N/A	6 kWh
DVD Player	No	None	ENERGY STAR (Varies: ~40% more efficient than model with same specs)	57%	None Scheduled	N/A	6 kWh
Blu Ray Player	No	None	ENERGY STAR (Varies: ~40% more efficient than model with same specs)	61%	None Scheduled	N/A	4 kWh
Set Top Boxes	No	None	ENERGY STAR (Varies ~32% more efficient than model with same use/specs)	45%	None Scheduled	N/A	N/A
Audio Equipment	No	None	ENERGY STAR (Varies ~50% more efficient than model with same use/specs)	33%	None Scheduled	N/A	N/A

[1]Savings calculated over DOE baseline assumptions from https://www.energystar.gov/ia/.../bpsavings_calc/Calc_TV_product_10-21-08.xls and http://www.energystar.gov/sites/default/files/asset/document/Office%20Equipment%20Calculator.xlsx

An ACEEE futures study identifies plug load management as the top measure for energy savings through 2030.[101] The California Energy Commission claims that "plug loads account

[101] Dan York, Steven Nadel, Ethan Rogers, Rachel Cluett, Sameer Kwatra, Harvey Sachs, Jennifer Amann, and Meegan Kelly, "New Horizons for Energy Efficiency: Major Opportunities to Reach Higher Electricity Savings by 2030", *ACEEE,* http://aceee.org/sites/default/files/publications/researchreports/u1507.pdf, (Sep. 2015), vii.

for virtually all of the 2013-2016 residential energy consumption growth."[102] A recent Navigant report states:

> *The results show that these new appliance plug measures [computers, power strips . . . TVs, clothes washers, dishwashers] have a significant impact on energy savings potential and make up nearly a quarter of the [market] potential savings in 2020.*[103]

EIA predicts that TV/set-top boxes will show some of the greatest growth in residential energy consumption through 2040 (Figure 6). EIA predicts that TV/set-top boxes will show some of the greatest growth in residential energy consumption through 2040 (Figure 6). The "other" category, also known as miscellaneous electric loads (MELs), accounts for the greatest projected growth of any residential consumption category. This is a difficult area to find savings opportunities, due not only to the small per-unit savings of many of these products, but also because the definition of such products is intentionally left vague so as to cast a wide net that captures any energy-drawing device that adds to residential plug load consumption. In their Residential Energy Consumption Survey (RECS), EIA admits, "it is impossible to account for all MELs…using large-scale survey methods."[104] A Navigant study projecting future MEL energy consumption, written for the EIA, initially considered 173 MELs, before identifying 15 on which the residential section of the report is focused. These were; dehumidifiers, set-top boxes, modems and routers, external power supplies, non-computer rechargeable electronics (e.g. mobile phones, digital cameras, handheld vacuums), ceiling fans, televisions, DVD players, laptop PCs, desktop PCs, monitors, audio equipment, pools/pool pumps, and home security systems.[105] Other products falling into this category include coffee makers, rechargeable toothbrushes, rechargeable power tools, video game consoles, microwaves, cook stoves, circulation pumps, and more.[106] This memo addresses the savings potential of several of these products (see Table 11 for more), but in many cases there are no standards in place and limited efforts to improve efficiency.

Smart power strips and connected homes, as well as midstream programs to increase efficient market-shares where practical, may help capture savings in this area. However, the forecasted increases in "other" consumption is likely a reflection of the challenges in designing programs to target such products.[107]

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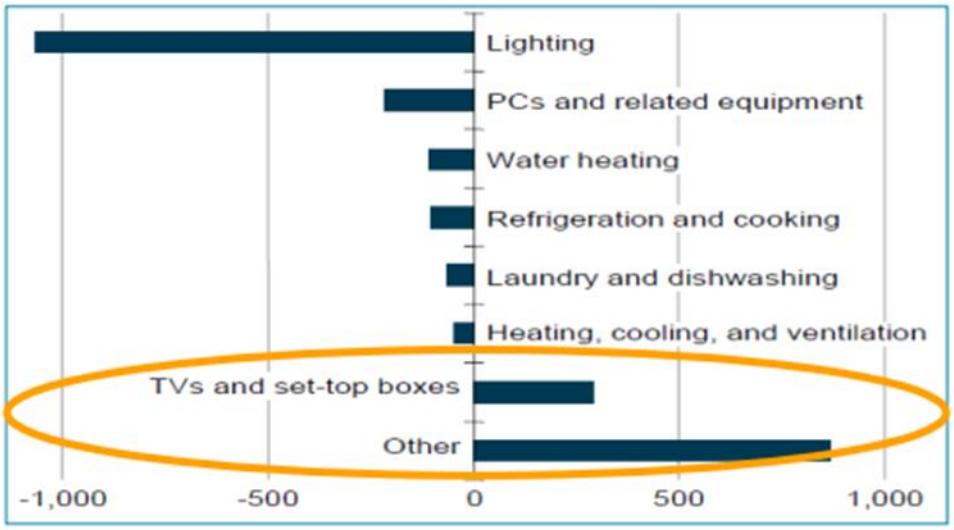
[102] Scott Fable "2016 Residential Plug-Load and Appliance Energy Efficiency Programs", *Pacific Gas and Electric Company (PG&E),* http://ccag.ca.gov/wp-content/uploads/2016/03/PGE_Plug-load_EE_Programs_Overview_2016_0217.pdf (Feb. 17, 2016).
[103] Erik Jacobson, "Request For Authority for Retail Products Platform (RPP) Pilot" 6.
[104] "Analysis and Representation of Miscellaneous Electric Loads and NEMS", *EIA,* https://www.eia.gov/analysis/studies/demand/miscelectric/ (May 10, 2017).
[105] "Analysis and Representation of Miscellaneous Electric Loads in NEMS", *Navigant* prepared for *EIA,* https://www.eia.gov/analysis/studies/demand/miscelectric/pdf/miscelectric.pdf (May 23, 2013).
[106] See: Suzanne Foster Porter, Chris Calwell, Jeffrey Swofford, Philip Walters, David Denkenberger, and Erica Lighthigher, "Capturing Plug Load Energy Savings with a Wide Net: Horizontal Policy Lessons Learned and Future Opportunities", *ACEEE*, http://aceee.org/files/proceedings/2012/data/papers/0193-000302.pdf (2012) and Pat Phelan, "Building Technologies Office: R&D Opportunities to Reduce Energy Consumption in Miscellaneous Electric Loads (MELs)" *US Department of Energy,* https://energy.gov/sites/prod/files/2016/06/f32/BTO%20MELs%20Workshop%20Introduction%20%28June%203%202016%29%20FINAL.pdf (Jun. 3, 2016).
[107] NMR will ask about how PAs are targeting "other" products during the market scan interviews.

As Table 11 indicates, set-top boxes have relatively low ENERGY STAR market share, as does audio equipment, which is a focus of Pacific Gas & Electric's (PG&E) Plug Load Program, more information on which is provided below.

Figure 6: Forecasted Change in Electric Consumption, 2012-2040 (kWh/household)[108]



Source: U.S. Energy Information Administration Annual Energy Outlook 2014

Massachusetts is already ahead of many other states in targeting plug load by running a smart power strip program, but additional savings are available by influencing the market. Not only is this area an appealing target for energy savings, it also presents an opportunity for retailers to increase profits. PG&E notes that "gross profit expressed in percentage terms as gross margins for appliance and consumer electronics stores are also among the lowest in the retail industry."[109] These factors, along with the high proportion of these products sold through retail channels make these plug load programs an appealing option to capture savings. Two programs which have been successful in this area are the PG&E Plug Load Appliance Program and the NYSERDA New York Products Program.

PG&E's Plug Load and Appliances Program have been able to increase market shares for various ENERGY STAR products, including electronics appliances and water-saving measures, to 68-86%.[110] The NYSERDA Products Program accounted for greater market shares of ENERGY STAR models, including a 52% increase in refrigerators, a 55% increase in clothes washers, a 48% increase in dishwashers, and a 37% increase in room air

[108] Although this figure separates PCs from other residential consumption, most definitions of "other" or miscellaneous residential products that we reviewed include PCs.
[109] Erik Jacobson, "Request For Authority for Retail Products Platform (RPP) Pilot" 6.
[110] Dan York, Max Neubauer, Seth Nowak, and Maggie Molina, "Expanding the Energy Efficiency Pie: Serving More Customers, Saving More Energy Through High Program Participation", http://aceee.org/sites/default/files/publications/researchreports/u1501.pdf, (Jan. 2015), 8-9.

conditioners.[111] Although these figures indicate that these program have been very successful, the number of units sold that are attributable to such efforts may be less substantial. That is, while market shares may show considerable increases from a gross perspective, the net savings that can be directly tied to program intervention are more modest, often in the 5-10% range.[112] It is important to remember the difference between the market lift measured in RPP programs and NTG ratios of traditional products programs. As elucidated in the following passage:

> *Hypothetically, RPP may increase sales of qualified units within a given product category from 100,000 units to 110,000 units in a given year, achieving a market lift of 10% attributable to the program. A downstream program targeting the same category could achieve a net-to-gross ratio of 85% by providing incentives on 5,000 units, with 4,250 of those units influenced by the program. Within this hypothetical example, to accurately compare the impacts of the two programs, we would need to consider the market lift the RPP program generated (10% hypothetically) in relation to the market lift the downstream program generated (4.25% hypothetically), rather than the downstream program's net-to-gross ratio.*[113]

NMR will focus on learning more about the actual net effects of such programs, and the best methods and practices for successful program intervention when conducting market scan interviews.

Both the PG&E and NYSERDA programs work in similar ways, with efforts to increase the prevalence of ENERGY STAR and higher CEE tier products through midstream incentives, better partnerships, targeted advertising, and working to educate both salespeople and the public to focus more on efficiency.

The NYSERDA products program (which includes lighting) identified three main goals:

1. Increase the supply of products through partnerships with retailers, manufacturers, and distributors.
2. Create demand for ENERGY STAR-certified and "Most Efficient" products, and higher efficiency tier CEE-rated products through increased consumer awareness and understanding of the ENERGY STAR certification.
3. Support other NYSERDA residential-sector programs through increased coordination and leveraging opportunities.[114]

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[111] Dan York, Max Neubauer, Seth Nowak, and Maggie Molina, "Expanding the Energy Efficiency Pie: Serving More Customers, Saving More Energy Through High Program Participation", http://aceee.org/sites/default/files/publications/researchreports/u1501.pdf, (Jan. 2015), 9.

[112] For example, see: Scott Dimetrosky, Noah Lieb, Jacob Rowberry, Jane Peters, and Robert Scholl. "New York Products Program: Market Characterization, Assessment, Process, and Market-Based Impact Evaluation." *Apex Analytics LLC and Research Into Action, Inc.* prepared for *NYSERDA* (Apr. 2014).

[113] Alex Dunn, Joe Van Clock, Sara Conzemius and Scott Dimetrosky, "Paradigm Shift Needed! Without it, Midstream Lift Yields NTG Woes for Plug Load Programs" http://aceee.org/files/proceedings/2016/data/papers/7_1120.pdf ACEEE, (2016).

[114] Jane S. Peters and Robert Scholl, "New York Products Program: Final Revised Logic Model Report", *Research Into Action* to *The New York State Energy Research and Development Authority*, (Nov. 2013), 3-1.

To achieve this, the program focused on mid-stream incentives, providing sales training to retailers, as well as offering point-of-purchase (POP) advertising and other promotions. The products program identified the channels through which specific products are purchased and aimed marketing efforts at these channels. Long-term goals focus on creating a market in which educated customers and retailers buy and sell ENERGY STAR and higher tier CEE products without any incentives, thus keeping the benefits while eliminating the need to fund the program. While NYSERDA intends to drop the program design moving forward, the effort did successfully identify the most viable channels for program intervention, and similar designs have the potential to be impactful in the future. The program is being dropped mostly because ENERGY STAR products are now widely available, even without program intervention. According to a 2012 evaluation of the NYSERDA program, market shares of ENERGY STAR products was no longer higher in NYSERDA territory than in non-program areas, something that had not been the case in earlier evaluations.[115]

Newer programs may work by identifying areas where the ENERGY STAR market is small for a given product, or by incentivizing retailers to sell products that meet ENERGY STAR most efficient criteria, or higher CEE specifications. This is the goal of two new programs, the PG&E Plug Load & Appliances Program, and the ENERGY STAR Retail Products Platform (ESRPP). It is worth noting that although NYSERDA is dropping their RPP program, New York retailers and Consolidated Edison are among the initial participants in the ESRPP program.[116]

PG&E launched a pilot for their Plug Load and Appliances program in 2013, partnering with several large retail chains to provide incentives for over 40 products in six product areas. Additionally, POP marketing efforts are a key strategy in this program. Products were selected based on the market shares of non-ENERGY STAR models, as well as by selecting products not incentivized in downstream programs. According to the program proposal, “The RPP model focuses on a portfolio of consumer energy efficient products with relatively small incentives paid to the retailer for each unit sold.”[117]

While both of these programs involved extensive planning to select products and marketing strategies, the overall strategy of incentivizing retailers to carry and sell more efficient models of products is fairly straightforward.[118] Given the success these programs have had in increasing ENERGY STAR market shares, it is an appealing option to capture savings in a wide range of products where downstream incentives may be an inefficient way to try to influence customer purchasing behavior.

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[115] . “New York Products Program: Market Characterization, Assessment, Process, and Market-Based Impact Evaluation.”
[116] See also: Michael Lukasiewicz and Peter Banwell, “Retail Products Platform – Piloting an Innovative Midstream Energy Efficiency Program Design”, *ACEEE,* http://aceee.org/files/proceedings/2016/data/papers/2_592.pdf (2016).
[117] Jacobson, “Request For Authority for Retail Products Platform (RPP) Pilot”, 3.
[118] See logic models: “New York Products Program: Final Revised Logic Model Report”, 4-2 and, “Request For Authority for Retail Products Platform (RPP) Pilot”, Appendix A.

ENERGY STAR has also recognized this type of midstream approach and in 2016 launched the ESRPP. This program is described as a "collaborative midstream initiative of ENERGY STAR, energy efficiency program sponsors, retailer partners, and other key stakeholders . . . [aiming] to offer a gateway for energy efficiency programs to capture energy savings in the growing 'miscellaneous/plug load' product categories at a significantly lower cost than current programs incur."[119] Eleven states (CA, CO, ID, MN, MT, OR, NJ, NY, VT, WA, and WI) and four retailers (Best Buy, Home Depot, Kmart, and Sears) participated in the first year. The program initially included ENERGY STAR dryers, air cleaners, freezers, sound bars, room air conditioners, and in 2017 added clothes washers and refrigerators. Retailers are offered incentives for selling these ENERGY STAR products, resulting in a lower cost to PAs than traditional rebates in a products program (retailers receive a roughly $25 incentive for selling an ENERGY STAR washing machine, compared to a traditional $50-100 rebate offered to the consumer). Through these rebates and targeted in-store advertising, the program reported that 160,000 ENERGY STAR-certified appliances and consumer electronics were sold at 700 participating retailers in the program's first year, although this may overestimate what is actually attributable to the program.[120]

A.3.2 Demand Response-Programs

Demand-response programs seek to save costs and improve efficiency by reducing peak demand loads. With increases in smart metering and other responsive technologies, PAs can design innovative programs to incentivize efficient customer behavior.

A 2014 report by EIA found that residential demand response programs reduced just over 3,000 megawatts from peak demand. This reduction came from roughly 8.5 million residential customers who each saved an average of about 100 kWh during peak times, and in return received an average of $40.[121] These programs are most commonly found in Western and Southern states. A 2017 CEE study found that demand response programs in the Northeastern US make up the smallest percentage of energy efficiency program expenditure of any region.[122]While Massachusetts has begun to implement demand-response programs, there are opportunities to increase the scope of current efforts and to expand on demand-response offerings. These programs can target peak reduction in a variety of ways. Programs can put controls on HVAC systems and the smart thermostats controlling them, as well as pool pumps or room air conditioners to limit peak activity. More advanced programs offer feedback to customers as well as programming options to save energy by utilizing two-way communication (leveraging their Advanced Metering Infrastructure or customers WiFi

[119] "The ENERGY STAR Retail Products Program" *ENERGY STAR*, https://www.energystar.gov/ESRPP (Accessed May 31, 2017).
[120] "The ENERGY STAR Retail Products Platform 2016 Progress Report" *ENERGY STAR,* https://www.energystar.gov/sites/default/files/asset/document/ESRPP%202016%20Annual%20Update_5.26.17.pdf (Accessed May 31, 2017).
[121] "Demand response saves electricity during times of high demand", *EIA,* https://www.eia.gov/todayinenergy/detail.php?id=24872 (Feb. 8, 2016).
[122] "2016 State of the Efficiency Program Industry", *CEE,* https://library.cee1.org/system/files/library/13159/2016_CEE_Annual_Industry_Report.pdf (Mar. 31, 2017), 34.

capabilities) and Home Energy Management System (HEMS) options. The programs discussed in this section were all recognized by CEE.[123]

Demand-response programs aimed at HVAC systems, pool pumps, and smart thermostats are straightforward. When a customer enrolls in the program, they commit to reduce their demand during peak times on high demand days, which are usually limited to a few events per year. This may entail allowing the utility company to take control of a newly installed or existing smart thermostat on these days and either raising the temperature slightly (usually between 0.5 and 4 degrees Fahrenheit) or shutting the entire system off for a few minutes. These programs also often take control of pool pumps. Other programs alert customers when these days are in effect but rely on the customer to reduce their own consumption, offering incentives only if a certain target is achieved. While most of these programs are tied to central AC systems and are most popular in states with warmer climates, ConEdison offers a program in New York to install smart room air conditioners with Wi-Fi capability.[124] Most of these programs offer incentives of about a $5 credit on summer monthly energy bills (sometimes this is a one-time lump payment), which encourages more efficient behavior without paying the cost that may be required to incentivize a customer to install a more efficient unit. National Grid is currently running a demand response program in Massachusetts. The Connected Solutions program, which offers customers incentives of $5 per month to allow their smart-thermostats to be adjusted 2-3 degrees during Peak Energy Events, follows a similar structure to many of these central HVAC demand-response programs.

Two-way communication programs offer both utilities and customers greater opportunities to learn about where energy is being consumed and allows dynamic changes to be made, like using adjustable time-of-use rates.[125] This helps customers reduce their own energy use and provides utilities with data on the best places to find savings. An example of such a program is DTE Energy's Insight Program, which provides participants with a free smart phone app and a "bridge" device that links meter data to the app, allowing customers to see their usage patterns and daily energy consumption by device. This app also identifies what wasteful devices may be plugged in. Some program participants saw this reduce their monthly energy use by roughly one-third without purchasing any more efficient measures, although acquiring and maintaining customers has proved challenging.[126] These programs may have moderate upfront costs, but little after that and the technology for two-way communication systems is improving rapidly. [127][128]

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[123] "CEE Program Resources – Residential", *Consortium for Energy Efficiency (CEE),* http://www.cee1.org/content/cee-program-resources (Accessed May 16, 2017).
[124] "Smart AC Program", https://conedsmartac.com/signup *Consolidated Edison*, (Accessed May 16, 2017).
[125] "Demand Response", *US Department of Energy,* https://energy.gov/oe/services/technology-development/smart-grid/demand-response (Accessed May 23, 2017)
[126] Frank Witsil, "DTE app gives customers insight into power usage", *Detroit Free Press,* http://www.freep.com/story/money/business/michigan/2015/10/24/dte-energy-app-insight/73932382/ (Oct. 24, 2015)
[127] For example, see, https://www.whiskerlabs.com/solutions.html#connected-savings
[128] "Advanced Metering Infrastructure (AMI)", *FERC,* https://www.ferc.gov/CalendarFiles/20070423091846-EPRI%20-%20Advanced%20Metering.pdf (Accessed May 17, 2017).

HEMS programs tend to roll several of these demand-response aspects together.[129] For example, Gulf Power's Energy Select program features an interactive energy management system that consists of four elements: (1) price-responsive programmable thermostats and timers for water heaters and pool pumps, (2) rates featuring four time-dependent prices for electricity, (3) a communications gateway, and (4) an online programming portal. Program participants have paid less per month compared to other Gulf Power customers 87% of the time.[130] Additional demand-response programs involve time-of-use rates. For example, Xcel Energy runs a program in four states that allows customers to attach appliances to a second meter with a lower rate per kWh, with the stipulation that these devices cannot be run during peak hours.[131] HEMS can also be used for more than just demand-response (see A.3.3).

At least one utility is using demand-response to target efficiency in multifamily buildings. Baltimore Gas & Electric (BG&E) offers the PeakRewards Multifamily Program, which allows customers in a building to coordinate when they are willing to have the temperature in their unit elevated slightly. This takes advantage of the different schedules residents may have, and allows building-wide peak demand to decrease, while (ideally) not forcing customers to change their temperature settings during the hours that they are home. The program markets itself by claiming this allows tenants to live in eco-friendly settings, without needing to make significant changes to their routines.[132]

A.3.3 Emerging Technologies: Connected Lighting, Lighting Controls, Connected Home, and Battery Storage Programs

Battery storage systems and connected lighting programs represent two other potential areas for claiming residential energy savings. Existing programs are relatively sparse, and thus available information on the true savings potential is limited, but these technologies are rapidly expanding and some opportunities are already evident.

Connected lighting and lighting controls programs offer savings opportunities in residential lighting, which will remain available after incandescent and halogen bulbs are phased out of the market. While the future of connected lighting programs likely lie in smart technologies, savings opportunities may exist after LED installation through installation of new controls. To increase efficiency in residential lighting, connected lighting programs use the following technologies:

- Occupancy/Vacancy Sensors

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[129] Kamil Bojanczyk, "Redefining Home Energy Management Systems", *Green Tech Media,* https://www.ferc.gov/CalendarFiles/20070423091846-EPRI%20-%20Advanced%20Metering.pdf (Sep. 11, 2013).
[130] "Gulf Power Raises the Bar for Automated Residential Price-Based Demand Response Programs", *Comverge* to *Gulf Power*, http://www.comverge.com/comverge/media/pdf/Case%20Studies/Gulf-Power-Case-Study.pdf (Accessed May 16, 2017).
[131] "Limited Off-Peak Service Program", *Xcel Energy,* https://www.xcelenergy.com/Programs_and_Rebates/Residential_Programs_and_Rebates/Equipment_and_Appliances/Limited_Off-Peak_Service (Accessed May 23, 2017).
[132] "PeakRewards Multifamily Program", *Baltimore Gas and Electric,* https://bgesavings.com/programs/multifamily, (Accessed Jun. 19, 2017).

  - Occupancy sensors detect when someone is in the room and turn lights on, then turn them off after a set period where no movement is detected.
  - Vacancy sensors turn lights off in the same way but occupants turn lights on manually, allowing the sensors to save energy by not "waiting" to detect movement and be activated.

- Photosensors
  - Photosensors turn lights on/off depending on outdoor light, used almost exclusively in residential settings to turn outdoor lights on at dusk and off at dawn.

- Dimmers
  - Dimmers offer savings that are difficult to quantify due to challenges in establishing customer behavior. These controls may have more potential in the future once dimmer technology works better with LEDs. Additionally, dimming may be a common feature to create savings in connected homes.

- Timers
  - Countdown timers allow users to turn on lights at certain times.
  - Astronomical clocks are a replacement for sensors, using geographical location to activate at dusk and turn off at dawn. [133]

A 2014 CEE study concluded that, based mainly on the size of the residential lighting market, "lighting controls have a real opportunity to make a noticeable impact on residential energy use. However, understanding the nature of that impact and the best way to integrate new technologies and implement supporting programs [requires] further analyses."[134] This report suggests that initial costs, as well as lack of consumer education, are barriers to consumer adoption. The researchers suggest that increasing the market share of smart controls is the best way to increase the use of connected lighting. Based on interviews with manufacturers, the report concludes that downstream programs are the most effective way to increase market adoption. [135] While programs are rare, they are developing. TakeCHARGE Newfoundland offers $3 rebates on lighting timers, motion sensors, and dimmer switches to Newfoundland Power and Newfoundland Labrador Hydro customers.[136] A small study into connected homes in Vermont found some promising trends in connected lighting savings, with smart bulbs accounting for a 27% reduction in energy use.[137] The study, which only

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[133] "Residential Lighting Controls Market Characterization", *CEE* and *Navigant Consulting*, https://library.cee1.org/system/files/library/11458/CEE_LightingMarketCharacterization.pdf (2014).
[134] "Residential Lighting Controls Market Characterization", *CEE* and *Navigant Consulting*, https://library.cee1.org/system/files/library/11458/CEE_LightingMarketCharacterization.pdf (2014).
[135] "Residential Lighting Controls Market Characterization", *CEE* and *Navigant Consulting*, https://library.cee1.org/system/files/library/11458/CEE_LightingMarketCharacterization.pdf (2014).
[136] "TakeCHARGE Instant Rebates", *TakeCHARGE Newfoundland*, https://takechargenl.ca/residential/rebate-programs/instant-rebates/ (Accessed May 23, 2017).
[137] Lara Bonn and Jasmine Rivest, "Smart Lighting & Smart Hub DIY Install: Does it Yield", *Efficiency Vermont*, https://www.efficiencyvermont.com/Media/Default/docs/white-papers/efficiency-vermont-hems-pilot-white-paper.pdf (Aug. 2016), 5-6.

included 15 homes, also found participants often utilized the dimming capabilities of their smart-LED bulbs (38% of the time). Currently in Massachusetts, National Grid is engaged in a Home Energy Management System and Smart Lighting Pilot Study with Lockheed Martin to study lighting controls. This study seeks to understand the energy-savings potential for lighting controls. The results of this pilot study may help the PAs to further understand the potential in this area.

In addition to demand-response, HEMS programs also seek to capture **connected home** savings outside of lighting. A 2015 study completed by the Northeast Energy Efficiency Partnership (NEEP), reviewed existing technologies and studies related to HEMS. These programs are split into "information-based", providing customers information about their habits and allowing them to adjust, and "control based", where smart technology controls devices to automatically optimize efficient practices. Information based systems include energy portals, in-home displays, and web service platforms, while control based systems encompass smart measures like lights, power strips, and thermostats. Many of these systems can be used simultaneously. With the wide range of products that fall under this HEMS umbrella, and the growth of new technologies being added to the space, defining programs to best capture savings may be a difficult task, but it also one with great potential. A PG&E pilot with the smart home company Bidgely yielded up to 7.7% savings for the 850 participating customers – a promising result, although the large scale and long-term savings could differ substantially.[138] NEEP documented the measured savings of several of these HEMS programs.[139]

The **residential battery storage** market is rapidly expanding and is projected to be worth $5.4 billion by 2025 (not accounting for EV storage, which could add to this significantly).[140] In-home batteries are an enticing option for residential solar customers, allowing captured energy to be used when the sun is not shining, but even homes with no solar capacity batteries offer a new way for utilities to capture DSM savings. Several utilities have recently launched pilots, seeking to use batteries to reduce capacity and transmission costs, and to provide energy arbitrage opportunities.[141] Notably, Green Mountain Power has launched a program providing customers with the option to lease a Tesla PowerWall Battery for $37.50 a month, or to purchase the battery and receive a $31.76 monthly credit.[142] Additional residential battery programs have been or will soon be launched in New York, Kentucky, Arizona, California, and Hawaii. As with connected lighting, these programs remain new and

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[138] Neil Strother, "PG&E-Bidgely Pilot Yields Energy Savings, Now It Needs to Scale", *Navigant Blog,* https://www.navigantresearch.com/blog/pge-bidgely-pilot-yields-energy-savings-now-it-needs-to-scale (Apr. 20, 2015).

[139] "Opportunities for Home Energy Management Systems (HEMS) in Advancing Residential Energy Efficiency Programs", *NEEP,* http://www.neep.org/sites/default/files/resources/2015%20HEMS%20Research%20Report.pdf (Aug. 2015).

[140] Alex Eller, "Automakers Expanding from Garage to the Home with Energy Storage" Navigant Blog, https://www.navigantresearch.com/tag/residential-energy-storage, (Sep 1, 2016).

[141] Brett Simon, "The Growing Opportunity for Residential Storage in the US" *Greentech Media,* http://www.greentechmedia.com/articles/read/The-Growing-Opportunity-for-Residential-Energy-Storage-in-the-US (Jun 09, 2016).

[142] "Green Mountain Power Begins Installs of Tesla Powerwall Home Battery for Customers," *Green Mountain Power*, http://news.greenmountainpower.com/press-releases/green-mountain-power-begins-installs-of-the-tesla--11g096650-001?feed=d51ec270-a483-4f6c-a55e-8e5fbe2238c2, (May 4, 2016).

their effectiveness and most effective program designs remain to be seen, but residential battery programs offer a tangible way to manage demand using a rapidly developing technology.

A.4 KEY FINDINGS

This section summarizes the key findings and takeaways of Task 1 of the current research.

There may be opportunities in Massachusetts to expand energy savings through products programs. Several common products exist that are part of programs in other states, and have ENERGY STAR and CEE specifications (often multiple tiers). This information can be used as a guideline to identify products that could be effectively added to future products programs, and also present good candidates to focus on in follow-up Market Scan (Task 2) interviews. The existence of such specifications does not mean a particular product will be valid or cost-effective in Massachusetts (some have been utilized and dropped as a result of not providing cost-effective savings). In such cases an alternative delivery path, such as an upstream or midstream approach may be the best route to pursue; a topic which will be a focus of both market scan and manufacturer interviews.

Clothes washers and dryers, refrigerators and freezers, room air conditioners, and pool pumps offer the greatest opportunities for increased savings. These products all have CEE specification, and washers and refrigerators have multiple CEE tiers requiring greater efficiency than the ENERGY STAR specification. Improved testing procedures as well as new dry-cycle technologies suggest that substantial increases in dryer efficiency are coming. Room air conditioners are common throughout New England, and many products programs throughout the US already focus on incentivizing the most efficient models. As with air conditioners, pool pumps may see increased usage with projected rising temperatures, and a variable-speed unit already offers substantial energy savings over less efficient pumps, though these need to be screened for cost-effectiveness to understand their true potential.

Plug load and other mid-stream programs offer opportunities to capture savings from a wide range of products. EIA projects that the greatest increases in residential energy consumption through 2040 will come from TVs and set-top boxes, as well as other appliances, including many small household electronics. Offering small incentives on these products would likely be more effective when targeting retailers as opposed to providing rebates to individual consumers. Using a mid-stream approach similar to those in New York and California could widely expand customer participation. In addition to these incentives, these programs seek to improve partnerships with retailers, target advertising, and educate both consumers and salespeople to increase the sales of efficient products. Such programs have successfully increased the ENERGY STAR market share of not only these household electronics, but also larger appliances like refrigerators, clothes washers, and dryers, however some of these savings may overestimate the program's influence by conflating gross and net savings.

Innovative designs and new technologies have increased demand-response program options in the past few years, an area where Massachusetts could look to expand efforts. Demand-response programs can reduce system stress on the highest summer

usage days by alerting participants that they need to reduce their usage or by directly controlling customers' HVAC systems, pool pumps, and smart thermostats. These programs have been successful in reducing peak loads, but with advanced technologies, these benefits do not have to be limited to peak hours. Through two two-way communication and home energy management systems, customers can receive feedback to better understand their energy use habits and where they are wasting energy. This information allows customers to behave more efficiently on a daily basis. Examples of successful and innovative demand-response programs are widely available due to their popularity and prevalence, and they offer relatively low-cost opportunities to increase energy efficiency.

Emerging technologies and programs in connected lighting and residential battery storage could lead to substantial future energy savings. While the phase-out of incandescent and halogen bulbs is eliminating most savings from lighting programs as currently structured, smart controls could present future opportunities to increase efficiency in this major market. Along with new lighting controls, storage batteries are another technology that could soon become a mainstay in many homes. Batteries offer opportunities for houses with solar panels to store that energy and can also be used as a DSM tool for homes with no solar capacity. Reports have suggested that the market for both connected lighting and residential batteries will grow rapidly over the next decade, and administrators are just beginning to roll out programs in both areas.

A.5 NEXT STEPS

The purpose of the current research task was to outline products that have the potential to be impactful and cost-effective for the Massachusetts products program moving forward. It thus serves as a starting point for the future research tasks of the evaluation which are geared toward understanding how other programs are currently utilizing these and other measures to achieve successful products programs, and how these strategies could be best implemented in Massachusetts. In the next step of the evaluation, NMR will conduct a market scan to gather market intelligence from experts and thought leaders who have examined or are in the process of examining new residential energy and demand savings measures, including gas and electric appliances and products, residential energy storage and backup systems (including programs incorporating electric vehicles[143]), connected home products, and innovative demand-response solutions. NMR will also seek to address whether other PAs have found effective solutions to capture savings in multifamily housing units. Although as of 2013, "Boston and Austin were the only two cities where program dollars that go to multifamily accounted for more than 10% of the overall spend,"[144] there is a desire in MA to bridge the gap between overall penetration rates in multifamily new construction and those

[143] PG&E and BMW have announced a pilot focusing on using EV's for battery storage. The California based-company Nuvve, is working with Nissan on similar programs, which have been launched in Europe, but so far not in the United States. In addition to traditional EV programs, BMW and UC San Diego are researching repurposing used EV batteries to be connected to solar panels and used for storage outside the vehicles. http://www.energy.ca.gov/research/energystorage/tour/ev_batteries/

[144] Katherine Tweed, "Can Multi-Family Energy Efficiency Get Some Love?" *Greentech Media*, https://www.greentechmedia.com/articles/read/can-multi-family-energy-efficiency-get-some-love (Mar. 11, 2013).

rates in the general market. Interviewees will include other Program Administrators from across the nation, ENERGY STAR consultants, members of Regional Energy Efficiency Organizations, and potentially some respondents from the Natural Resources Defense Council (NRDC).

NMR has developed a preliminary list of market experts with whom we anticipate completing interviews, included below. The team anticipates the MA PAs and EEAC will provide feedback and guidance on this list in order for it to match their expectations for the market scan. Once the list is finalized, we anticipate completing 12-16 interviews with respondents whose insights the PAs and EEAC deem most valuable, which may represent a subset of the overall respondent list. The team will also conduct follow-up research based on the key takeaways of these conversations, identifying reports, products, or other information that is valuable based on the interviewees' insights. This information will then be provided in the memo or an appendix, as appropriate.

These conversations will include discussions on the following:

- Products that have shown substantial savings in their own programs
- Products that have shown or have promise in demand-response solutions
- Products interviewees intend to continue to focus on or place greater emphasis on in future planning
- How interviewees think programs can best influence consumer choice and purchasing behavior
- Program designs that will be particularly effective for products moving forward (e.g., opportunities/experience with RPP).

Prior to the interviews, NMR will conduct background research on the program designs relevant to specific PAs and implementers so that interview questions will focus on their particular programs. The team will deliver a draft report of key findings and takeaways from these interviews and will then design an online workshop/forum to discuss these findings with the MA PAs and EEAC as well as MA program implementers and solicit their feedback on the viability of implementing the proposed products, designs, and measures into their program planning. This feedback and insight will then be factored into the final memo.

B Appendix B Additional Information

B.1 Advanced Power Strips

Both advanced power strip manufacturers identified a lack of understanding of the product from both consumers and those trying to plan, justify, or measure savings as barriers for their success. While one tier 1 manufacturer felt confident that the annual savings were about 75 kWh/strip when used in a home entertainment setting, there was more debate over the savings achievable for tier 2 strips. One manufacturer told us that the TRM in many states assigns an unrealistically high value to the savings potential of tier two strips. “It might sound odd for a manufacturer to say ‘Hey, your savings estimates are way too high,’ but I’m interested in finding a well-established savings estimate from the field. If that happens, utilities will use these strips long into the future. If this evaluation comes back and knocks the savings back to something much lower, PAs may lose faith in the measure,” he said. The other manufacturer offered a solution to this suggesting that the best way to run a program for advanced power strips or other new technologies is by rewarding innovation so that the incentives for the manufacturer are tied to actual measured savings. “Field tests have proven that tier 2 (and tier 1) strips don’t all produce the same savings, so now the market is looking to fix this. Some states actually incentivize innovation. Incentives are based on actual savings, so manufacturers will perform more effectively,” he explained. Rewarding innovation and measured savings may be a solution to help the technology going forward, but this approach would still require well-established verification.

Both noted the need for good evaluation to see the actual effect of the APS, as consumer behavior is the key element in strips maximizing their potential. “To see persistence, this should be done in the long-term. What we need is a utility sponsor to deploy these measures into the field and do a survey at 12 months and at 24 months. That’s what gives us the confidence in the measure,” said one manufacturer.

B.2 Challenges and Strategies for Addressing the Smart Home Market

Several respondents focused on the role of PAs in addressing the connected home market, as well as the barriers to successfully integrating connected homes into the efficiency or demand-response markets. Most were in agreement that the utility needs to play a role to best capitalize on the opportunities in the "connect home market". “*Very few companies care about the home as a connected system, the utility is one of the only ones. There should be a lot of interest in using [in-home audit] structure(s) to create a dialogue about energy and energy usage between the utility and the customer,*” said one evaluator.

Others echoed the sentiment that education and proper installation is key to successfully engaging connected home devices. Although all agreed that this engagement is crucial, participants differed in their assessments of how successful utilities have been thus far in attempts to reach the connected home market. As noted by one evaluator, “*Right now, it’s*

the home security companies that are really trying to make moves in a big connected home play, or the big telecom companies. And I don't know that utilities or programs have taken that responsibility as seriously as they should have, because that's what customers want." Another respondent indicated industry engagement has been much more significant, stating, "*I think it's a little ironic that you have energy-efficiency on the front lines arguing for open standards for smart products, because whether it's to save energy, reduce demand, or save money through TOU rates, if these products are hard to connect or too much of a hassle, or they have ten different manufactured products and they don't have an aggregator and customers don't want to deal with ten different websites to manage it, then we won't see the benefits of those smart products*." He also discussed the need for smart products to be able to "talk" to each other to have a financial benefit for storage or efficiency, and noted that if this is not achieved, "*the term stranded assets comes to mind*." With smart home technology still in its infancy and most agreeing that there are risks in backing a technology too early, respondents agreed utilities need to be ready to address this, but may not be there just yet. "*We definitely need to work with connected homes, I just don't know how we will interface with them. It's definitely hard to know how quickly these things will move*," summarized one respondent.

Several respondents also raised security concerns as a potential barrier for moving into the connected home market. "*I think there are some real security issues around it that makes me wonder how quickly it will happen. I don't want people to be able to hack into my lights and freak me out, it's kind of scary*," said one PA. This could further delay market adoption and potentially create regulatory challenges in establishing efficiency or demand-response technologies targeted at connected homes.

B.3 HERs Scores and Additional Behavioral Opportunities

One PA, who runs a HERs program, discussed greater opportunities for utilities to approach customers to make behavioral changes as customer expectations are changing with the expanded role of technology in their daily life:

> *We're trying to leverage big data to gain insights into where we can start trying to segment messages to customers and things like that. We are working on additional layering, defaulting customers in to high usage alert emails, things like that. Customer expectations are also on the rise. For example, a cell phone company will send you an alert when you get to 75% of your data. You didn't ask for that alert, or sign up for it explicitly, but you're also happy to get that notification because it can impact your bill. So, the high usage alerts we send are pretty similar now. I think a few years ago, there would have been trepidation about defaulting a customer into an additional product without explicitly asking for their consent, but as long as we're doing it by email where there's no legal implications of things like that or other issues that we deal with, we find that it's an additional touch point.*

This PA reiterated the idea of "multiple touch points" several times, an idea that could apply to attempting to reach customers to make behavioral changes, or to try to influence behavioral changes *and* encourage them to purchase more efficient products. He was also optimistic about the increasing opportunities to use behavioral approaches as a demand-response tool. His utility recently created a mobile phone app for customers to receive real-

time notifications when high-usage events were starting and ending, and allowed them to track savings from the event. These opportunities for behavioral changes were also discussed at length by many with the connected home model in mind.

B.4 SPECIFIC PRODUCTS IDENTIFIED FOR DEMAND-RESPONSE

Others identified specific products that could be used in demand response. "*Something that won't affect customer comfort is best, like a dehumidifier. You can have them off for a few hours and will have no noticeable effects. Also, HVAC, heat pump water heaters, dryers (delaying start times to operate outside peak hours), and refrigerators or freezers that can work on efficient draw or can delay ice making, are all products with demand-response potential. Room air is also an opportunity as you can cycle this on or off*," one respondent summarized. Refrigerators, dehumidifiers, dryers, and HVAC technologies were all mentioned by multiple respondents. One advanced power strip manufacturer noted that his company also made a dryer kill switch that he believed would be a successful demand-response tool, but had been met with resistance from utilities who did not want to interrupt customer dry-cycles. ENERGY STAR currently has optional testing procedures and specifications for washers, dryers, refrigerators, and water heaters.

Smart thermostats were also frequently mentioned as a potential demand-response option. One PA, already running a successful demand-response program, stated that the two-way connected thermostats presented a great demand-response opportunity and that "*we're now reaching out to new customers with our new device as well as upgrading our current participating customers that have our 'one-way smart thermostat of ten years ago,' device*." This PA went on to describe the opportunities that these devices present as something that could create both efficiency and demand-response benefits, "*there's a big opportunity there with smart thermostats because we can claim additional demand-response benefits but also for the first time we're claiming energy-efficiency benefits from our demand-response device, so that's helping the energy-efficiency and demand-response side*." Not only has this benefited the utility in terms of benefits that can be claimed, but by *combining* demand-response and energy-efficiency program aspects, the utility is now able to install devices suited for both elements more easily.

> *The demand-response program is partnered with energy-efficiency side of the house when it comes to the quick home energy checkups we do. We now do the installation of the demand-response measure at the time of the [home energy audit program] so that's sort of an expansion of how you go about installing those. [The way our utility has] operated is always the customer calling for one specific program at a time, but this merger/partnership with the [home energy audit program] and our [demand-response program] allows the customer to get two programs within one appointment. So, that's leveraging operational efficiency between the programs*.

Another PA also expressed the desire to use smart-thermostats to achieve both demand-response and energy-efficiency solutions: *"The thing we're trying to figure out is how you roll out products to customers that can do both energy efficiency and demand-response and how do we make these products talk to our pricing signals to do the work for the customers. So how do you have the smart device switch things on and off at specific hours? It's something we don't have a handle on. I think right now there are seven ENERGY STAR smart*

thermostats and only a couple of them are capable of auto demand-response." Although smart thermostats undoubtedly present demand-response opportunities, one evaluator warned against relying too heavily on their use. "*When you want demand-response, you have to identify where that demand-response is needed. It seems like Murphy's Law says demand-response in not in a place where you can walk in and just throw a bunch of Nest thermostats and expect this to solve everything, because customer demographics or building set-up doesn't lend itself to said technology,*" he explained.