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## Retail Product Portfolio Evaluation – Final Report

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## Executive Summary

This report presents findings from an evaluation of the Northwest Energy Efficiency Alliance's (NEEA) Retail Products Platform (RPP) initiative. The RPP initiative seeks to transform the markets for a portfolio of appliance and consumer electronics products by engaging with retailers and other market actors to improve the supply and assortment of efficient models. NEEA contracted with Apex Analytics and its partner, Opinion Dynamics Corporation (formerly Research Into Action, Inc., collectively the Apex team) to investigate the following key research objectives:

- Assess whether the market intervention strategies NEEA selected for each product were appropriate given available information about market and regulatory characteristics.
- Review and articulate the assumptions underlying NEEA's projections for baseline uptake of efficient products.
- Confirm NEEA's approach for longitudinal tracking of qualified products, including validating data cleaning and model matching approaches and identify opportunities for improvement.
- Investigate product-specific questions and resolve issues around regional demand.

To address these objectives, the Apex team worked closely with NEEA staff to understand intervention strategies and baseline approaches, and conducted a detailed market assessment for each product in the RPP portfolio.<sup>1</sup> These assessments primarily drew on analyses of retailer-reported sales data and secondary research, supplemented by interviews with market actors as needed.

## Key Findings

The Apex team's review of the products in the RPP portfolio identified five key findings.

- There were significant differences in energy consumption and efficient market share between different product configurations within multiple RPP product categories. As a result, the appropriate market intervention strategies varied by configuration. Analyzing the market share of efficient products across all the models in a product category can mask these differences and the need for distinct intervention strategies.
- Midstream incentives are likely to be most effective when efficient options are available across a wide range of product configurations, capacities, feature sets, and price points. For some products, efficient models were not widely available or were concentrated in certain parts of the market, leaving retailers little opportunity to assort and promote efficient products while still meeting consumer demand.
- The ability to differentiate between efficient and inefficient products is key to NEEA's selection of market intervention strategies and assessment of the success of those strategies. In the most extreme cases, addressing measurement and compliance issues that prevent available data from effectively differentiating between efficient and inefficient products may be a prerequisite to other interventions in the market.

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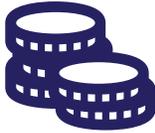
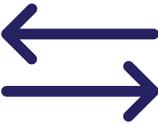
<sup>1</sup> These detailed characterizations are presented in Appendix A: Detailed Product Assessments.

- In projecting a theoretical baseline market share reflecting no involvement from NEEA or its partners, it is important to recognize that a low and stagnant market share may not lead to the market events that NEEA assumes will accelerate uptake of efficient products (e.g., revisions to ENERGY STAR specifications and federal standards). Under conditions of low and stagnant market share, it may be difficult for specification- and standard-setting bodies to justify a revision, particularly in a theoretical baseline case in which NEEA and its partners are not involved.
- In some cases, it was not clear to the Apex team whether NEEA’s assumptions about market event timing or effects reflected the initiative’s influence or represented a baseline case without NEEA’s influence. Articulating NEEA’s assumptions about market events both with and without initiative influence would resolve this confusion.

## Conclusions and Recommendations

Table 1 lists the conclusions and recommendations the Apex team draws from our review of NEEA’s RPP strategies and baseline assumptions.

**Table 1: Conclusions and Recommendations**

Icon	Conclusions	Recommendations
	Midstream incentives alone are likely to drive uptake of efficient products only under specific market conditions. As NEEA has recognized, other strategies are necessary for many products.	NEEA should continue to fully and carefully assess market conditions to determine whether midstream incentives or another strategy will best increase uptake of efficient products within each category.
	It is important to analyze market conditions and select intervention strategies by product configuration (i.e., not just by product category).	NEEA should continue to assess market conditions and select intervention strategies at the product configuration level.
	The assumptions on which a baseline curve is based must fit together in a coherent story.	NEEA should continue to articulate the thinking behind each of its baseline assumptions and ensure that assumptions are consistent with each other.
	It is important to clearly differentiate assumptions about uptake of efficient products with RPP intervention from assumptions about baseline uptake, in absence of intervention.	NEEA should articulate when events influencing the baseline will occur both with and without program intervention.
	Effective energy consumption measurement and specification compliance is critical to the success of all other intervention strategies.	NEEA should carefully analyze DOE and ENERGY STAR specifications, test procedures, and qualified products lists to identify any potential measurement and compliance issues during the initial year after adding a new product to the RPP portfolio.

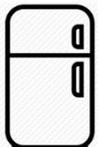
# 1. Introduction

This report presents findings from an evaluation of the Northwest Energy Efficiency Alliance’s (NEEA) Retail Products Portfolio initiative. NEEA contracted with Apex Analytics, LLC (Apex) and its partner, Opinion Dynamics Corporation (formerly Research Into Action, Inc., collectively, the Apex team) to document and assess NEEA’s RPP initiative.

## 1.1. Background

NEEA has been a leader in the development of midstream program approaches to drive uptake of efficient products in consumer electronics and appliance product categories. NEEA’s efforts in these areas, which began in 2009 with the Business and Consumer Electronics Television initiative, have evolved and expanded over time into the current RPP initiative. In 2018, the RPP initiative included eight products:<sup>2</sup>

**Table 2. NEEA RPP Initiative Products**

<p><b>Refrigerator</b></p> 	<p><b>Clothes washers</b></p> 	<p><b>Room air cleaners</b></p> 	<p><b>Soundbars</b></p> 
<p><b>Freezers</b></p> 	<p><b>Clothes dryers</b></p> 	<p><b>Room air conditioner</b></p> 	<p><b>Ultra-HD televisions</b></p> 

NEEA has developed a structured process for selecting products to include in the RPP initiative.<sup>3</sup> Over time, NEEA has chosen to remove incentives (e.g., soundbars, room air cleaners, and televisions), or increase the stringency of the requirements (e.g., clothes washers). These changes have been implemented based on market analysis and strategic product planning.

<sup>2</sup> A table detailing the efficiency specifications and incentives offered for each product is in Appendix B: RPP Product Qualification Levels and Incentives.

<sup>3</sup> NEEA, November 2016, “RPP Product Portfolio Selection Process - Final - 11.4.2016.docx,” as updated.

NEEA’s RPP initiative is part of the nationally-coordinated ENERGY STAR Retail Products Platform (ESRPP) program, which brings together program administrators across the United States to offer retailers midstream incentives for sales of products meeting the program’s efficiency criteria. These incentives are designed to motivate retailers to sell more efficient products, most likely by favoring them over inefficient alternatives in their assortment and promotion decisions.<sup>4</sup> Retailers participating in ESRPP provide full-category sales data for each of the product categories for which they receive incentives.

NEEA closely monitors the markets for the products in its RPP portfolio and pursues market intervention strategies beyond the midstream incentives that are the basis of the ESRPP effort. These interventions include advocacy for revisions to energy use measurement and compliance, advocacy for updates to ENERGY STAR specification revisions and mandatory efficiency standards, and efforts to increase availability of emerging technologies.

## 1.2. Research Objectives and Tasks

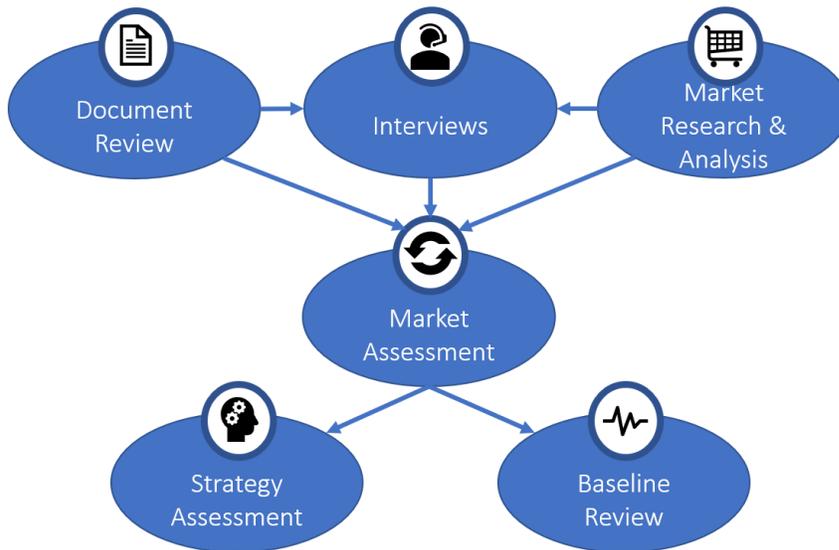
The central objectives of this evaluation were:

Strategy Assessment:	Baseline Assessment:	Data Validation:	Other Considerations:
Assess whether the market intervention strategies NEEA selected for each product were appropriate given available information about market and regulatory characteristics.	Review and articulate the assumptions underlying NEEA’s forecasted baseline market share of efficient products.	Review and articulate the assumptions underlying NEEA’s forecasted baseline market share of efficient products.	Investigate product-specific questions and resolve issues around total NEEA-region demand.

The Apex team addressed these objectives by conducting a detailed market assessment for each product. We then used the findings from that assessment to review NEEA’s selection of intervention strategies and the assumptions underlying NEEA’s baseline approach. The findings from these detailed market assessments are presented in Appendix A, as are the Apex team’s investigation into crosscutting issues related to data validation. Figure 1 summarizes the data sources and research activities the Apex team used to address the research objectives.

<sup>4</sup> A retailer’s product assortment is the set of individual models that retailer offers within a particular product category.

**Figure 1: Data Sources and Evaluation Activities**



The Apex team drew on three key sources for this research effort: document review, interviews, and market research and analyses of market and sales data. A summary of each of these activities is below.



**Document Review** The Apex team conducted a detailed review of the RPP initiative and associated documents, including NEEA-developed product strategies,<sup>5</sup> stakeholder comments submitted by NEEA to EPA, incremental cost analysis, market barriers reports, prior MPER and RPP evaluation documents, and various NEEA memos and supporting RPP documentation. The document review also helped inform deeper areas for exploration and questions to ask staff during our staff interviews and communications.



**Interviews** The Apex team conducted phone interviews and followed up by email with industry experts, including NEEA initiative staff, washer and dryer manufacturers, the Association of Home Appliance Manufacturers (AHAM) and Appliance Standards Awareness Project (ASAP) staff. The Apex team used phone interviews to gain additional insight into regulatory and EPA timelines and manufacturer outlook for efficient products; learn more about the RPP assumptions and strategies; and dig deeper into product specific market trends.

<sup>5</sup> Energy Solutions drafted strategy documents for each RPP product.



Apex analyzed primary and secondary sales, shipment, and other market data to gain insight into the RPP product markets, identify gaps in previous research, and help validate or offer recommended changes to NEEA’s current product strategies. The Apex team’s market research and analysis included the compilation and analysis of the following data sources:

- Web-scrape data,<sup>6</sup>
- California Energy Commission certified appliance and electronic databases,
- U.S. Department of Energy Compliance Certification Database,
- NEEA regional RPP portal sales data,
- Energy Solutions analysis and re-matched RPP sales data,
- Incremental cost and hedonic price modeling data, and
- Publicly available ENERGY STAR and market research documents.

### 1.3. Report Structure

This report summarizes and documents products and trends and assesses NEEA’s overarching product strategies, baseline approach, and other efforts to support RPP products. Similar to memos produced for each individual product, this report includes the following sections:

 <p><b>Market Assessment</b> Summarizes key considerations for market assessment research to inform product strategy selection and baseline assumptions and summarizes findings for each product.</p>	 <p><b>Product Strategy</b> Describes near-term market intervention strategies and reviews applicability of near-term strategies to assigned products.</p>
 <p><b>Product Baseline</b> Summarizes NEEA’s approach to predicting baseline market share and provides high-level assessment of baseline assumptions.</p>	 <p><b>Model Classification Validation</b> Reviews NEEA’s approach to data cleaning and model matching.</p>
 <p><b>NEEA-Region Sales Assessment</b> Reviews approaches to estimating full NEEA-region market size.</p>	 <p><b>Conclusions &amp; Recommendations</b> Draws conclusions and recommendations from the above research.</p>

<sup>6</sup> From retailer websites, collecting data on product pricing, features, and reviews. See Appendix A for more specific references.

## 2. Market Assessment

NEEA selects intervention strategies and estimates baseline market shares based on the market and regulatory conditions that each product faces. The Apex team conducted a market assessment for each product to gather data that would either confirm or suggest revisions to NEEA’s strategies and baseline assumptions. For each product, the Apex team assessed two key considerations: market segmentation and efficiency/ENERGY STAR trends. Table 3 summarizes some of the specific items within each consideration, as well as their implications for NEEA’s strategy selection and baseline estimates. The Apex team sought to address all listed considerations but was constrained in some cases by missing data (particularly related to non-qualified models).<sup>7</sup>

**Table 3: Market Assessment Considerations**

Consideration	Research Questions	Baseline/Strategy Implications
Market Segmentation	<ul style="list-style-type: none"> <li>• Can market be segmented by product type or configuration?</li> <li>• How does energy consumption vary by segment?</li> <li>• What is the market share of each segment?</li> <li>• Are new technologies entering the market that are likely to impact energy use?</li> <li>• What is the price differential between segments and between efficient and inefficient products within segments?</li> </ul>	<ul style="list-style-type: none"> <li>• Determines whether distinct strategies and baselines are needed for each segment</li> <li>• Identifies opportunities for emerging technology strategies</li> <li>• Identifies barriers to uptake of efficient products with implications for baseline</li> </ul>
Efficiency and ENERGY STAR Market Share Trends	<ul style="list-style-type: none"> <li>• What is ENERGY STAR market share and how has it changed over time?</li> <li>• Are any product types, sizes, or configurations more or less likely to be ENERGY STAR certified, and why?</li> <li>• What proportion of products exceed minimum ENERGY STAR requirements and by how much?</li> <li>• How do the efficiency metrics used to determine ENERGY STAR certification relate to unit energy consumption?</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies opportunities for measurement and compliance and/or specification revision strategies</li> <li>• Establishes revision timeline for baseline</li> </ul>

A key, overarching finding from these market assessments was the importance of differentiating between product types or configurations in assessing energy consumption characteristics and intervention opportunities. There were significant differences in energy consumption and efficient market share between configurations for multiple products. While NEEA has historically tracked market share and energy consumption by configuration, the RPP initiative has also begun to adopt different intervention strategies that respond to the conditions of each configuration. These distinctions were often not apparent from an analysis of efficient market share across the category as a whole.

The remainder of this section summarizes the key findings from the Apex team’s assessment of the market for each product. Additional details are included in the detailed product findings in Appendix A:

<sup>7</sup> Data were most limited for products not subject to federal standards, including soundbars and air cleaners, as manufacturers are not required to report energy consumption information to any central database.

Detailed Product Assessments. As discussed further in the Product Strategy section, below, NEEA has recognized many of these market conditions and developed intervention strategies to address them.

**Refrigerators:** The refrigerator market is divided between three primary configurations, based on the location of the freezer. Federal standards and ENERGY STAR specifications recognize differences in energy consumption by configuration, allowing units with bottom-mount freezers to use as much as 25% more energy than units with top-mounted freezers of the same size and with the same features. This has slowed refrigerator efficiency gains as the market share of units with bottom-mount freezers has grown. The ease with which manufacturers can meet ENERGY STAR specifications also appears to vary by configuration. ENERGY STAR specifications for some bottom-mounted freezers became *less* stringent with the most recent specification revision, and bottom-mount units have the highest market share among the three configurations.

The refrigerator market is also divided between higher-end models, which are more feature rich, and lower-end models, typically with top-mounted freezers, which are more commoditized and face greater price pressure. ENERGY STAR models are considerably more likely to be priced above \$600 than non-qualified models, but sales data indicate that there is demand for lower-priced, efficient units.

**Freezers:** Freezers, in general, are a more utilitarian product than refrigerators, although some of the most efficient upright models are high-end units designed to be incorporated into a kitchen, rather than used as secondary food storage in a low-traffic area of the home. Due to the utilitarian nature of most freezer models, manufacturers' motivation to develop new features and update freezer models is limited. Market data suggest there is a backlog of older freezer models, particularly chest freezers, in the market that retailers are selling through.

Like the refrigerator market, the freezer market is divided between configurations: chest and upright. ENERGY STAR and federal standards further differentiate between compact and standard-sized freezers, but our research found this distinction is not meaningful from the consumer's perspective, particularly among chest freezers. ENERGY STAR market share of chest freezers is low and stagnant, while ENERGY STAR market share of upright freezers is high, particularly among larger units. Chest freezers consume less energy than similarly-sized upright freezers, and both the federal standards and ENERGY STAR specifications provide greater energy consumption allowances for upright freezers than chest models. In addition, consumers tend to purchase smaller chest freezers. As a result, upright freezers' contribution to overall category energy consumption is significant, despite the high market share of efficient upright freezers.

**Clothes washers:** The clothes washer market is also divided by configuration, with front-loading and top-loading models. Front-loading models are more efficient than top-loading models and have historically been subject to considerable promotion from energy efficiency programs. The market share of efficient models within the front-loading segment, even at the highest efficiency tiers, is very high.

Nonetheless, front-load washers remain a minority of the washer market and their market share has largely remained flat for the past several years. Efficient market share is considerably lower for top-loading washers and few models meet advanced efficiency tiers. However, manufacturers have added features to top-load washers and developed increasingly efficient top-load washers, with one top-load model achieving similar efficiency levels to front-load washers. The shift (though only marginal at this point) to even less efficient agitator-type top load washers has further complicated the efficient washer market dynamics. Market data suggest that manufacturers design clothes washer models to just meet efficiency standards, whether ENERGY STAR, Consortium for Energy Efficiency (CEE) specifications, or federal minimum efficiency requirements. The greatest energy savings opportunities in the clothes washer market come from shifting consumers from top-load to front-load models when possible, as well as promoting increased efficiency in top-load washers.

**Dryers:** Clothes dryers have fewer differentiating features than washers. Retailers and manufacturers typically market dryers as part of a “laundry pair” with a matching washer. Dryers have received considerably less attention from efficiency programs and advocates than washers, with the first ENERGY STAR specification for dryers taking effect in 2015. Market share of basic-tier ENERGY STAR dryers has grown steadily since then but may be slowing. NEEA has been working with other organizations to encourage uptake of heat pump dryers,<sup>8</sup> which are considerably more efficient than dryers using electric resistance heat and meet the ENERGY STAR Most Efficient designation. Uptake of heat pump dryers remains slow as manufacturers express concerns that the longer drying times will turn away consumers and as consumers report performance and reliability problems with early models.

Washers and dryers are interrelated in both their energy consumption and the way the products come to the market. While dryers consume more energy than washers, the greatest opportunity for laundry energy savings comes from reducing the remaining moisture content of clothes when the wash cycle is complete. Consumers purchase a majority of washers and dryers as a pair, and retailers and manufacturers consider laundry appliances as pairs in their decision-making around the products. Retailers are unlikely to promote or assort a dryer unless the matching washer also fits into their promotion or assortment plans.

**Soundbars:** Soundbars are a relatively new product category, developed over the past two decades to compensate for the low audio quality of flat-screen televisions, which do not have room for powerful sound systems. Soundbars fall under the ENERGY STAR Audio/Video specification, which covers a broad range of products. The ENERGY STAR specification’s broad requirements do not effectively reflect soundbar efficiency, as most qualified soundbars meet the requirement based only on their sleep mode energy consumption, a usage mode that accounts for less than half of total soundbar energy

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<sup>8</sup> NEEA’s super-efficient dryer initiative has been advocating for increased market presence for heat pump dryers. For more information, please see <https://neea.org/news/neea-launches-super-efficient-dryer-initiative>

consumption.<sup>9</sup> Manufacturers, and many consumers, do not see energy efficiency as a high-priority feature for soundbars. In some cases, manufacturers opt not to submit soundbar models that meet ENERGY STAR requirements for certification.

The conditions described above limit the data available on soundbar efficiency. With no federal standard, manufacturers are not required to report energy consumption data for non-qualified models. ENERGY STAR certification becomes less effective in differentiating efficient and inefficient products when manufacturers decline to submit qualified models for certification. Even the data manufacturers submit on ENERGY STAR soundbars may lack key energy consumption information, like amplifier efficiency levels, if the models are not required to meet specifications in those areas. As discussed further below, NEEA has been working with ENERGY STAR to address these shortcomings.

**Room Air Cleaners:** Both air cleaner sales and the capacities of air cleaners sold through RPP retailers have increased significantly over the past few years. Larger-capacity air cleaners tend to have higher efficiencies (defined as Clean Air Delivery Rate (CADR) per Watt) than smaller units. Nonetheless, the shift to larger-capacity air cleaners has led to an increase in average air cleaner energy consumption as the increased efficiency of higher-capacity units does not fully compensate for the increase in energy use due to their larger capacity. The market share of ENERGY STAR air cleaners is high among NEEA retailers but has decreased slightly over the past few years. Like soundbars, there is limited data on non-qualified air cleaners.

**Televisions:** Manufacturers redesign their television models every year, allowing new technologies to move through the television market more quickly than is typical for most other RPP products. This rapid technological adoption led to dramatic decreases in television energy consumption as liquid crystal displays (LCD) came to dominate the market and light emitting diode (LED) backlighting became dominant in LCD displays. Television energy consumption began to increase as the market adopted ultra-high definition (UHD) capabilities, which are now becoming standard for large televisions. The energy consumption premium associated with UHD has decreased since UHD models first entered the market, but ENERGY STAR specifications have not adapted to this change. In addition, some manufacturers appear to have taken advantage of differences between the test clip used to measure energy consumption and typical viewing conditions to report television energy use values that are considerably lower than the product consumes in typical conditions. NEEA advocated to address this

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<sup>9</sup>A recent study estimates that sleep mode usage accounts for approximately 40% of soundbar energy consumptions. Urban et al., "Energy Consumption of Consumer Electronics in U.S. Homes in 2017: Final Report to the Consumer Technology Association."

issue during the most recent specification revision and continues to engage with international technical committees to revise the test clip.<sup>10</sup>

**Room Air Conditioners:** The room air conditioner market is highly seasonal and weather dependent. Air conditioner sales are also highly concentrated among a small number of models, with the top five models representing more than half of total unit sales in each year of RPP data. With the adoption of the V4.0 ENERGY STAR specification in 2015,<sup>11</sup> a significant gap in efficient market share has emerged between air conditioners with cooling capacities greater than 8,000 Btu/h and units with cooling capacities less than 8,000 Btu/h. Ninety-five percent of ENERGY STAR V4.0 room air conditioners sold in 2015 had cooling capacities greater than 8,000 Btu/h. The limited market share of ENERGY STAR room air conditioners with lower cooling capacities, combined with growth in the market share of smaller room air conditioners, has led to declines in efficient market share of room air conditioners over the past few years. A few room air conditioner models use a technology that has allowed them to significantly exceed the ENERGY STAR specification. NEEA is targeting advancement of this technology.<sup>12</sup>

### 3. Product Strategy

#### 3.1. Definitions and NEEA assumptions

NEEA has defined six intervention strategies for products in the RPP portfolio, each of which seeks to influence the market in a distinct way. These strategies range from efforts to influence retailers and manufacturers through midstream incentives and promotion of emerging technologies to efforts to influence revisions to federal standards and voluntary efficiency specifications. Table 4 lists the strategies NEEA has identified.

**Table 4: RPP Market Intervention Strategies**

Strategy	Definition	Desired Outcomes
<b>Midstream Incentives</b>	NEEA provides incentives to retailers for sales of products meeting initiative-defined efficiency criteria	Retailers favor efficient products in assortment and promotion decisions, increasing efficient market share
<b>Emerging Technology</b>	NEEA works with manufacturers, retailers, and other industry stakeholders to promote the development and availability of efficient products	Efficient technologies become more widely available and are incorporated into a wider range of products

<sup>10</sup> See NEEA’s stakeholder submitted comments to the EPA, Leritz, N, April 2017, ENERGY STAR Specification for Televisions, Draft 2 Version 8.0, available online at [https://www.energystar.gov/sites/default/files/NEEA%20Comments\\_2.pdf](https://www.energystar.gov/sites/default/files/NEEA%20Comments_2.pdf)

<sup>11</sup> We should note that the current room AC ENERGY STAR specification is actually V4.1, which revised the V4.0 spec in 2016 by adding testing instruction and certifying products with efficient variable output. The EPA did not make any substantive changes to the qualification criteria.

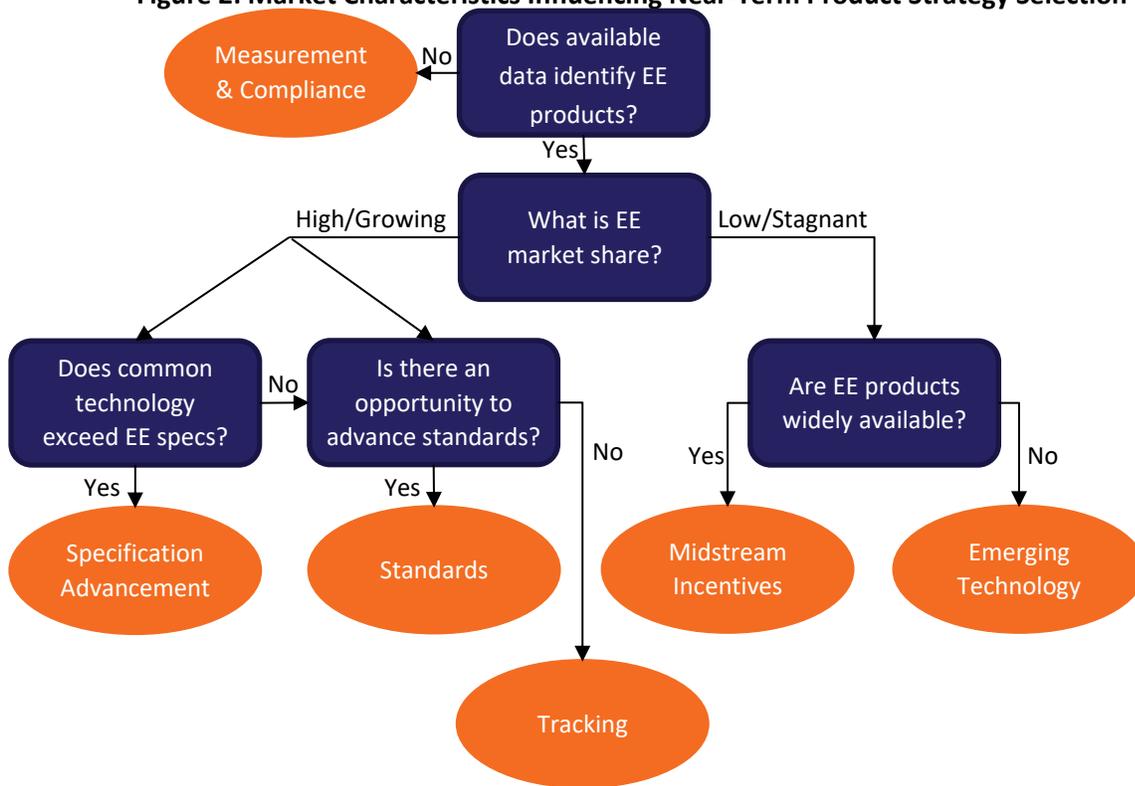
<sup>12</sup> NEEA’s room AC strategy, and the current V4.1 ENERGY STAR specification, are both focused exclusively on window room AC units and does not include portable room AC units.

Strategy	Definition	Desired Outcomes
<b>Measurement and Compliance</b>	NEEA engages with DOE, EPA, and others to advocate for test procedures and reporting requirements that accurately reflect real-world energy use and differentiate efficient products	Test procedures and the standards and specifications that rely on them accurately differentiate efficient products
<b>Specification Advancement</b>	NEEA engages with EPA and others to advocate for more stringent voluntary efficiency specifications	Product specifications recognize the most efficient products and motivate manufacturers to increase efficiency
<b>Standards</b>	NEEA engages in DOE and other minimum efficiency standard revision processes to advocate for more stringent standards	Stringent standards eliminate the least efficient products from the market, increasing share of efficient options

In addition to the five strategies listed in Table 4, NEEA employs a sixth, more passive, tracking strategy for products where more direct market intervention opportunities are not warranted or feasible. When tracking a product, NEEA monitors the market for shifts in market share of efficient products or adoption of new features or technologies with implications for energy consumption. Monitoring the market in this way allows NEEA to be prepared to shift to more active intervention strategies when market conditions create opportunities to bring about energy savings.

NEEA selects near-term intervention strategies for each product based on the adequacy of available energy consumption data, the availability and market share of efficient products, and the potential for standard and specification revisions. Figure 2 provides an example of how these characteristics can drive near-term strategy selection for a given product or subcategory. It is important to note, however, that the answers to the questions the figure poses may not be clear-cut or binary. In addition, NEEA responds to opportunities to influence the market through standard and specification revisions or support for emerging technologies as they arise. As a result, NEEA may pursue multiple near-term strategies for a given product or may deviate from the guide that Figure 2 provides.

**Figure 2: Market Characteristics Influencing Near-Term Product Strategy Selection**



As Figure 2 suggests, the market share of efficient products is a key consideration in selecting the most appropriate intervention strategy for a given product. The availability of data that effectively identifies efficient products is critical to determining the market share of efficient products. As a result, measurement and compliance strategies can be critical to creating the conditions for NEEA to intervene in a market in other ways.

The market characteristics reflected in Figure 2 help to indicate which strategies NEEA should pursue in the near-term. NEEA also considers strategies to pursue in the longer-term. As strategies affect the market, they bring about a shift in market conditions that can make a new strategy appropriate. For example, a successful emerging technology strategy may increase availability of the efficient technology to the point that a midstream incentives strategy is most effective. That midstream incentives strategy, in turn, might increase the market share of efficient products to the point that a specification revision becomes necessary. Market share of products meeting the new specification would likely be lower than under the previous specification, potentially returning the initiative to an emerging technology or midstream incentive strategy. This cycle could continue until there is no further opportunity to advance specifications, at which point NEEA would shift to tracking.

Two strategies fall outside of the cycle described above:

- **Measurement and compliance:** As noted above, all other intervention strategies depend on NEEA’s ability to effectively measure and compare the efficiency of different models within a product category. Occasionally, the test procedure or metric driving qualification may not be sufficient to discern the efficient product or could be subject to gaming by manufacturers. As a result, addressing measurement and compliance issues may be a prerequisite to additional interventions in the market. Specification updates that incorporate the new measurement and compliance practices are often concurrent with or shortly follow changes to measurement and compliance practices.
- **Standards:** Revision to mandatory efficiency standards, particularly federal standards, is a long process that involves multiple stakeholders and is responsive to the larger political environment. As a result, NEEA’s ability to pursue a standards revision strategy depends on a range of external factors that determine when a revision process will occur. EPA also typically revises ENERGY STAR specifications to take effect at the same time as a new federal efficiency standard revision.

The Apex team assessed whether market data supported NEEA’s selection of near-term product strategies for the products included in RPP in 2018. The next section provides a brief summary of our findings.

## 3.2. Product Strategy Assessment

The following sections summarize the findings from a review of the strategies NEEA identified for each product. The summary below includes only products for which NEEA identified the strategy as a primary strategy, a short-term opportunity, or for which the Apex team identified an opportunity. NEEA identified additional secondary or longer-term opportunities for many products. Additional detail is available in the product summary memos.<sup>13</sup>

### Midstream Incentives

Midstream incentives seek to motivate retailers to favor efficient products over inefficient alternatives in their assortment and promotion decisions and thus increase the market share of those products. Retailers’ central concern in making those decisions is meeting customer demand for price points,

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<sup>13</sup> Apex prepared summary memos that review and document the strategies for each product, the regulatory history, and the near-term opportunities identified by NEEA. These documents accompany this summary document and are available at [NEEA.org](http://NEEA.org).

configurations, and features. As a result, for midstream incentives to be effective, efficient options must be available that provide the features and configurations retailers seek at a competitive price point.<sup>14</sup>

NEEA identified midstream incentives as a primary, near-term strategy for seven products (Table 5). The Apex team found that three of those products met the conditions described above for when midstream incentives are likely to be most effective (i.e., refrigerators, basic upright freezers, and room air conditioners). We also identified one additional product as a candidate for midstream incentives (top-load clothes washers).<sup>15</sup> The Apex team found that midstream incentives alone may have limited potential to influence retailer assortment and promotion decisions (advanced upright freezers,<sup>16</sup> chest freezers and dryers). Efficient models were either not widely available or were concentrated in certain parts of the market for these products, leaving retailers little opportunity to assort and promote efficient products while still meeting consumer demand for lower-priced models.

**Table 5. Midstream Incentive Strategy Assessment**

Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
Bottom- and Side-Mount Refrigerators	ENERGY STAR Most Efficient	✓	✓	<ul style="list-style-type: none"> <li>Multiple brands offer ENERGY STAR Most Efficient options in bottom-freezer and top-freezer configurations, but market share remains low, suggesting there is opportunity to influence retailers.</li> </ul>
Upright Freezers (basic)	ENERGY STAR	✓	✓	<ul style="list-style-type: none"> <li>ENERGY STAR models are widely available and incremental cost of efficient products is low, suggesting changes in assortment and promotion could increase market share.</li> </ul>
Upright Freezers (advanced)	ENERGY STAR + 5%	✓		<ul style="list-style-type: none"> <li>Qualified products are limited to high-end models and sell in low volume through RPP retailers, suggesting limited opportunity to influence retailer decisions.</li> </ul>
Chest Freezers	ENERGY STAR	✓		<ul style="list-style-type: none"> <li>With few or no efficient options available, midstream incentives are unlikely to influence retailer assortment and promotion decisions.</li> </ul>
Top-Load Clothes Washer	ENERGY STAR	✓*	✓	<ul style="list-style-type: none"> <li>Efficient top-load washers are widely available, including at lower price points, but market share remains stagnant.</li> </ul>
Dryer	ENERGY STAR Most Efficient	✓		<ul style="list-style-type: none"> <li>With few models available in the market, midstream incentives are unlikely to influence retailer assortment and promotion decisions.</li> <li>Midstream incentives do not address consumer concerns about product performance and reliability.**</li> </ul>

<sup>14</sup> While downstream incentives are designed to reduce differences in costs to end-users between efficient and standard options, RPP’s midstream incentives are not designed to lower costs to the end-user. Instead, RPP’s midstream incentives seek to motivate retailers to act to increase sales of efficient products over standard alternatives (most likely by favoring efficient products in assortment or promotion) by making efficient products more profitable to the retailer.

<sup>15</sup> NEEA is aware of this opportunity and began offering incentives for top-load clothes washers in 2019.

<sup>16</sup> NEEA offers tiered incentives for some products, providing a higher incentive for the most efficient, advanced tier, products and a lower incentive for basic tier efficient products.

Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
Room Air Conditioner	ENERGY STAR	✓	✓	<ul style="list-style-type: none"> <li>ENERGY STAR models are widely available and market share has been declining, especially after spec revision V4, suggesting incentives could increase market share.</li> </ul>

\* Midstream incentives introduced in 2019.

\*\* NEEA’s strategy for dryers goes beyond the RPP strategies listed here. Through the Super-Efficient Dryer initiative, NEEA had also offered upstream incentives on heat pump dryers through 2018 and coordinates a qualified products list that regional utilities use to offer downstream incentives on heat pump dryers.

Paying midstream incentives gives NEEA access to full-category sales data for the products receiving incentives, and those data can be critical in supporting other strategies. Full category sales data can increase NEEA’s understanding of the market trends within a product category and help NEEA better customize interventions to address those trends. For example, sales data analysis helped NEEA identify the potential to target top-load clothes washers. As a result, there may be value for NEEA in offering midstream incentives for some products on which the incentives are unlikely to immediately shift retailer decisions.

### Specification Advancement

Specification advancement strategies help to ensure that voluntary efficiency specifications, like ENERGY STAR, effectively differentiate efficient products from less efficient alternatives. A specification advancement strategy may be appropriate in either of two situations:

- When the market share of products meeting the specification is high enough that the specification no longer effectively differentiates efficient models from inefficient ones.
- When there is a specific deficiency in the existing specification that prevents it from effectively differentiating products. In this case specification advancement and measurement and compliance strategies work in conjunction.

NEEA identified specification advancement as a primary strategy for three products – soundbars, air cleaners, and UHD televisions – and the Apex team’s review supported the strategy for all three.

Additionally, Apex identified a specification advancement opportunity for top-mount refrigerators (Table 6). In each case, there was a specific issue preventing the specification from effectively differentiating efficient products.

**Table 6. Specification Advancement Strategy Assessment**

Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
Top-Mount Refrigerators	ENERGY STAR Most Efficient		✓	<ul style="list-style-type: none"> <li>Under current criteria, all ENERGY STAR top-mount refrigerators qualify for Most Efficient designation</li> </ul>
Soundbars	All	✓	✓	<ul style="list-style-type: none"> <li>High ENERGY STAR market share and measurement and compliance issues will require spec advancement</li> </ul>
Air Cleaners	All	✓	✓	<ul style="list-style-type: none"> <li>Market share of efficient products is high, suggesting opportunity to increase stringency of specifications</li> </ul>

Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
UHD Televisions	All	✓	✓	<ul style="list-style-type: none"> <li>Measurement and compliance issues will require spec advancement and revisions to test procedure</li> </ul>

### Standards Revision

As noted above, the potential for NEEA to engage in a standards revision strategy depends on a variety of external factors that determine the timing of revision processes. Standards revision activity is not occurring as expected at the federal level in the current political environment, and NEEA did not identify standards revision as a primary, short-term strategy for any of the products included in the 2018 RPP portfolio. The Apex team also did not identify any standards revision opportunities in our review.

### Emerging Technology

NEEA sees promotion of emerging technologies as necessary to achieve significant increases in efficient market share in product categories where the share of efficient products is low and has remained stagnant. An emerging technology strategy also depends on the presence of a promising emerging technology in the market. As a primary, short-term, RPP strategy, NEEA typically promotes emerging technologies that are commercially available but may be confined to one segment of the market and have not seen wide uptake.<sup>17</sup> NEEA identified emerging technology strategies for five products, and the Apex team found support for that strategy in each case (Table 7).

**Table 7. Emerging Technology Strategy Assessment**

Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
Refrigerator (all configurations)	All	✓	✓	<ul style="list-style-type: none"> <li>Stagnant efficient market share suggests new technology may be necessary for significant efficiency advances.</li> <li>Emerging efficient technologies are available, and market shows demand.</li> </ul>
Freezer (all configurations)	All	✓	✓	<ul style="list-style-type: none"> <li>Highly efficient models are available but limited to high-end models; wider adoption of these technologies is needed to bring about significant shifts in efficient market share.</li> <li>Due to shared technology, refrigerator advances should apply.</li> </ul>
Top-Load Clothes Washer	All	✓	✓	<ul style="list-style-type: none"> <li>Stagnant efficient market share suggests new technologies needed for significant gains.</li> <li>Significantly more efficient products exist, but have little uptake.</li> </ul>
Dryer	ENERGY STAR Most Efficient	✓	✓	<ul style="list-style-type: none"> <li>Heat pump technology is established in other markets, but few models are available in the US and sales are low.</li> </ul>

<sup>17</sup> NEEA also engages with manufacturers and other industry actors to support emerging technologies that are not yet commercially available, like ultrasonic dryers and the use of alternate refrigerants in refrigerators and freezers. These efforts are typically longer-term strategies.

Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
Room Air Conditioner	All	✓	✓	<ul style="list-style-type: none"> <li>Advanced dual inverter compressor technology exists, offers significant savings, but few models are available, and sales are low.</li> </ul>

### Measurement and Compliance

A measurement and compliance strategy is appropriate when the standardized procedures used to measure a product’s energy consumption or efficiency do not reflect typical usage in homes, or when the reported data omits information important to determining energy use and tracking energy consumption trends. In the most critical cases, these measurement and compliance gaps can make it impossible to effectively distinguish between efficient and inefficient products. NEEA has taken a measurement and compliance strategy for five RPP products, and the Apex team found support for that strategy in each case (Table 8).

**Table 8. Measurement and Compliance Strategy Assessment**

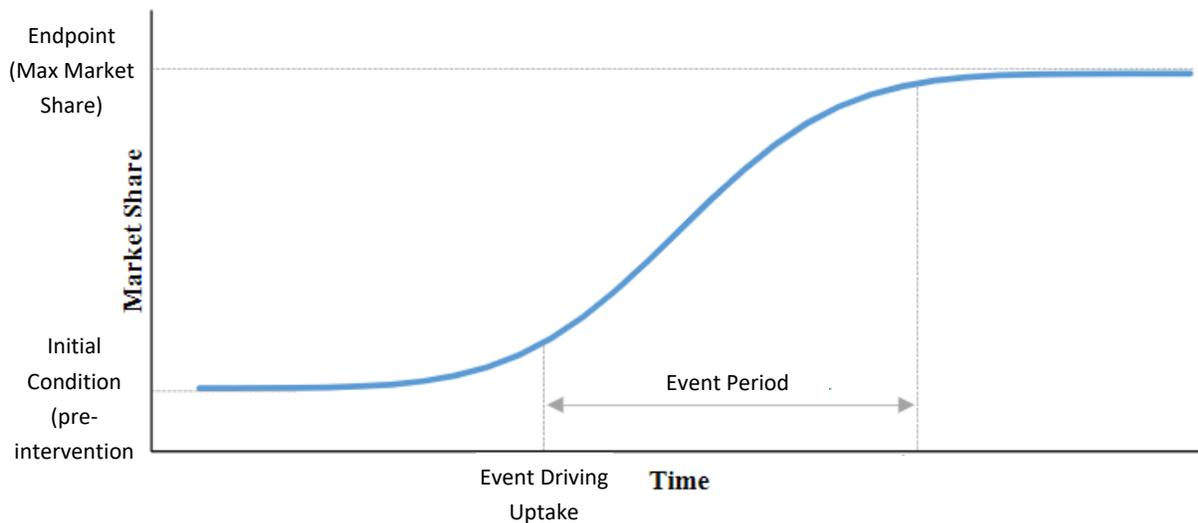
Product	Efficiency Tier	NEEA Targeted Strategy	Apex Assessment	Notes / Rationale
Front-Load Clothes Washer	All	✓	✓	<ul style="list-style-type: none"> <li>Growth in market share of qualified products has not resulted in increases in sales-weighted average efficiency (integrated modified energy factor (IMEF)) or decreases in sales-weighted energy consumption</li> <li>Efficiency metrics favor larger models</li> <li>Test procedures may not reflect real-world use</li> </ul>
Clothes Dryers (All Configurations)	All	✓	✓	<ul style="list-style-type: none"> <li>Test procedures do not reflect real-world use (test cycles, size and composition of test load differs from typical laundry load)</li> </ul>
Soundbars	All	✓	✓	<ul style="list-style-type: none"> <li>Key energy consumption metrics not tracked for many products because they are not required by specification</li> <li>Test clip and amplifier input power used in test procedure do not reflect actual use</li> <li>Products designed to be used together are tested and reported separately, and components designed to operate wirelessly are tested in wired mode</li> <li>ENERGY STAR does not track soundbars as a distinct product type</li> </ul>
Air Cleaners	All	✓	✓	<ul style="list-style-type: none"> <li>Current specification does not account for relationship between size and efficiency, favoring larger models</li> <li>While much product labeling is based on smoke filtration, efficiency assessment is based on dust filtration</li> <li>Characteristics with implications for energy use, like motor type, are not tracked</li> </ul>
Televisions	All	✓	✓	<ul style="list-style-type: none"> <li>Energy use allowance adder for UHD capabilities does not reflect actual difference in energy consumption between HD and UHD</li> <li>Test clip differs from typical viewing conditions and does not include high definition and high dynamic range content</li> <li>Persistence of energy saving features and impact of new features on standby power are not properly characterized</li> </ul>

## 4. Product Baseline

### 4.1. Definitions and NEEA Assumptions

NEEA’s product baselines represent the market share of qualified products<sup>18</sup> that would exist at a given time in absence of NEEA or its partners’ intervention in the market. NEEA develops baseline curves, or forecasts, to anticipate where each qualified product market share will naturally be over the long-term.<sup>19</sup> NEEA defines baseline curves according to the theory of Diffusion of Innovations which suggests that market share of a new product or technology typically follows a consistent, s-shaped curve.<sup>20</sup> NEEA uses available market data to define this curve based on assumptions about four key elements that determine the curve’s location and inflection points.<sup>21</sup> Figure 3 illustrates a typical baseline curve and highlights the key elements that NEEA uses to define baseline curves for each product.

**Figure 3: Elements Defining a Product Baseline Curve**



As Figure 3 suggests, in defining baselines, NEEA examines the initial condition (pre-intervention) market share, considers events that might accelerate uptake of efficient products, assesses the timing of that accelerated uptake, and estimates the maximum market share, or endpoint, that efficient products are likely to achieve. Table 9 summarizes the factors NEEA considers in assessing each of these elements.

<sup>18</sup> NEEA RPP program qualified products may be basic ENERGY STAR, ESME, or higher efficiency tiers as defined by the initiative.

<sup>19</sup> NEEA typically forecasts 15 to 20 years into the future.

<sup>20</sup> Rogers, Everett. 1962. *Diffusion of Innovations, First Edition*. New York: The Free Press.

<sup>21</sup> For more information about the diffusion model, please see Van Clock, J, Moran, D, Steinhoff, C, 2018. Building a Foundation on Moving Ground: Five Easy Steps to a Market Transformation Baseline, ACEEE

**Table 9. NEEA Baseline Assumption Summary**

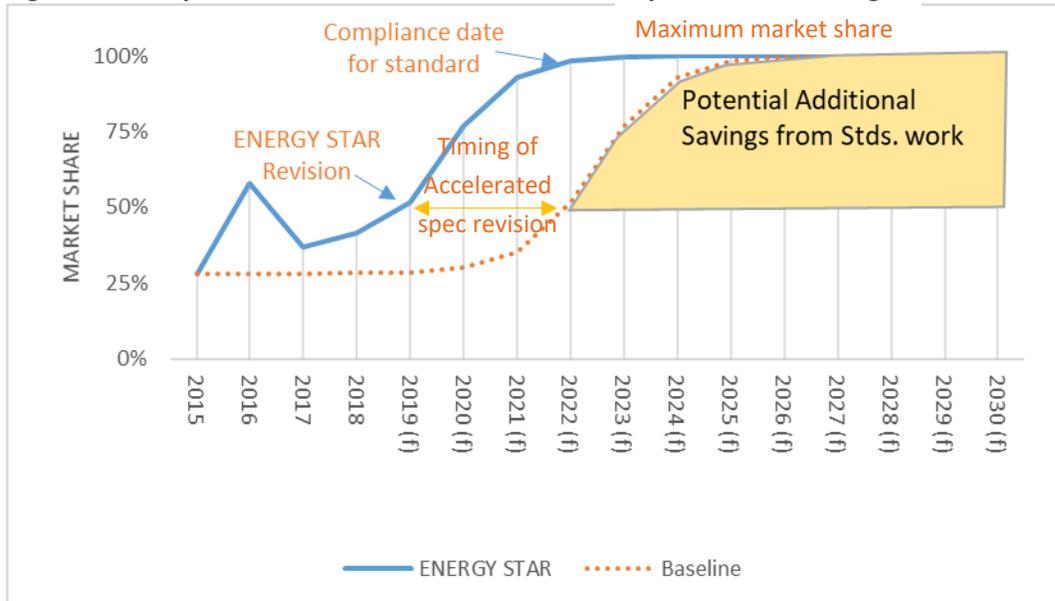
Baseline element	Description	NEEA Assumptions
<b>Initial Conditions</b>	The initial starting point and trajectory for the baseline forecast.	<ul style="list-style-type: none"> <li>Based on historical market share data one year prior to start of RPP incentives.</li> <li>Assume this forecasted market share trend line will continue until a market event drives change.</li> </ul>
<b>Market Event</b>	An event that drives increased uptake of efficient products, including: <ul style="list-style-type: none"> <li>ENERGY STAR specification revision</li> <li>DOE standard update</li> <li>Adoption of new/emerging technology</li> </ul>	In determining how market events would affect uptake of efficient products in the baseline condition, relative to actual or projected events occurring with NEEA's intervention, NEEA considers: <ul style="list-style-type: none"> <li>Whether, and by how much, NEEA and its partners affected, or might affect, when the event occurred,</li> <li>Whether, and by how much, NEEA and its partners affected or expects to affect the extent to which the event will impact market share, for example by increasing the stringency of a specification or standard,</li> <li>How the event may be related to other market events, for example, ENERGY STAR specification revisions typically follow DOE standard updates and emerging technologies may accelerate specification revisions.</li> </ul>
<b>Event Period</b>	The length of time required for an event to fully impact the market	NEEA assumes standard and specification revisions typically occur over relatively predictable timelines: <ul style="list-style-type: none"> <li>Federal standard revisions take approximately three years to finalize and become effective three years after they are final.</li> <li>ENERGY STAR specification revisions typically occur over a one-to-two-year timeframe.</li> </ul> NEEA also assumes timing of uptake of emerging technologies is less predictable and depends on factors like the speed of product turnover in the market.
<b>End Point</b>	The maximum potential market share of qualified products; may be less than 100% if technical limitations make it not feasible for some portion of the market to adopt efficient products.	NEEA uses sales data to estimate the percentage of the market where specific configurations did not include sales for the efficiency tier. NEEA considers: <ul style="list-style-type: none"> <li>Whether the technology is available for all configurations,</li> <li>Whether there are other (cost) barriers preventing adoption,</li> <li>Whether technical barriers exist for some configurations,</li> <li>If the program specification will be incorporated as a standard NEEA assumes 100% of the market (all models and configurations within that product class) will have to meet the standard.</li> </ul>

The market events listed in Table 9 closely parallel NEEA's intervention strategies. NEEA's market interventions seek to influence the timing of these events, the extent to which they increase efficient market share, or both.<sup>22</sup> Figure 4, below, provides an example of how NEEA's strategies can influence market events. The dotted line in the figure is NEEA's assumed baseline curve. It reflects an assumption that NEEA will advance ENERGY STAR specifications by three years, resulting in a projected increase in uptake beginning in 2019, rather than 2022, when NEEA anticipates the specification revision would

<sup>22</sup> Two strategies do not directly parallel the market events listed in Table 9: midstream incentives and measurement and compliance. Midstream incentives increase market share of efficient products above its baseline trajectory, and higher market share is likely to accelerate specification revisions. Effective measurement and compliance is necessary for specification and standard revisions.

have occurred without intervention. The curve also reflects NEEA’s potential influence in making federal standards more stringent, assuming that the maximum market share of qualified products would be lower than 100% if the standard did not adopt the specification the program promoted.

**Figure 4. Example of NEEA Product Baseline for Multiple Product Strategies**



Source: NEEA baseline.xlsx

## 4.2. Baseline Assessment

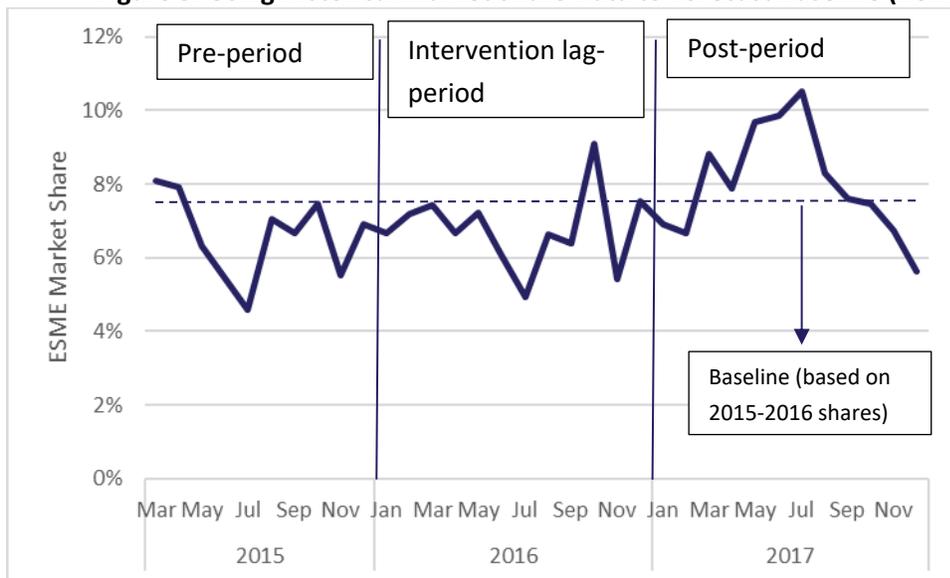
The following sections summarize the findings from a review of the assumptions NEEA has made for their forecasted RPP product baselines. NEEA develops unique baseline predictions for each product configuration and efficiency bin. Across the eight RPP products, this results in 18 individual baseline estimates. Overall, the Apex team found that NEEA did a commendable job documenting the wealth of information that informs these baseline estimates.

The Apex team’s assessment and recommendations for NEEA’s primary baseline elements are summarized below.

**Initial Conditions:** The review found NEEA’s approach to forecasting initial market share was largely appropriate, although there are opportunities for improvement.

NEEA relies on historical precedent, specifically retailer-reported sales data for the 12 months prior to the start of RPP intervention,<sup>23</sup> to forecast initial market conditions. Real-world market cycles provide an opportunity for NEEA to draw on a longer period to estimate initial baseline conditions for most products. The national ESRPP interviews with retailers indicate that products typically appear in stores between five weeks and 12 months after retail merchants purchase them and remain in stores for 6 to 18 months, although this may be longer for large appliances.<sup>24</sup> This suggests that RPP’s market interventions are unlikely to have a large impact on retailers’ assortment of most products in the first year. NEEA could draw on this lag period after RPP’s intervention begins, but before its effects are likely to appear in stores, to further inform its initial baseline estimates. Figure 5, below, provides an example of how NEEA could draw on both the pre-intervention period and the lag period after the intervention begins to establish a baseline for comparison against actual sales once the intervention’s influence reaches stores.

**Figure 5. Using Historical Market Share Data to Forecast Baseline (Refrigerator example)**



Source: Re-matched NEEA region RPP portal sales data provided by Energy Solutions, Refrigerator2019-02-17-NEEA.csv

This approach has the benefit of allowing NEEA to better distinguish market share trends from seasonality effects in the data. Yet, it would require NEEA to carefully assess and articulate when it anticipates RPP interventions will begin to have a significant impact on sales. As a default, the Apex team recommends NEEA adopt a 24-month moving average forecast, which places greater emphasis on

<sup>23</sup> Retailers are required to report these data to receive midstream incentives as part of their ESRPP participation agreement.

<sup>24</sup> EPA, July 2018, ESRPP Interview Findings Year 1 Participant, and ESRPP Interview Findings Year 2 Participant

more recent periods but still reflects both the pre-period and intervention lag-periods.<sup>25</sup> Within a 24-month moving average, NEEA should also consider seasonality effects.<sup>26</sup>

**Market Events:** The most common market events that NEEA anticipated were revisions to voluntary efficiency specifications, like ENERGY STAR, and mandatory efficiency standards, like DOE standards. NEEA makes a variety of general assumptions about how these events influence uptake of efficient products. The Apex team largely agreed with these assumptions based on our review of the market for each product, as summarized in Table 10.

**Table 10: General Assumptions about Specification and Standard Impacts on Product Baselines**

NEEA Assumption	Event Types		Apex team Assessment
	Voluntary Specifications	Mandatory Standards	
Revisions occur on a regular timeline	✓	✓	Largely true but current national political environment makes standard revisions unlikely until at least 2021
Revisions are naturally occurring: NEEA is unlikely to influence timing		✓	Agree
Current ENERGY STAR specification will serve as a basis for revised standard		✓	While not true in all cases, this is a reasonable, conservative, assumption

While the Apex team largely found NEEA’s assumptions around specific market events to be sound, we identified two opportunities for improvement in the way NEEA incorporated events into product baselines more generally:

- Ensure assumptions about events are consistent with assumptions about other baseline elements.** Market events are responsive to market conditions, and, if the baseline assumes that a market event will occur, it is important that baseline conditions are consistent with that event. For example, an assumption that the initial baseline market condition would be a continued low and stagnant ENERGY STAR market share may be inconsistent with the assumption that a specification or standard revision process would begin in the short- or medium-term. Under conditions of a low and stagnant market share, and in a baseline case where NEEA and its partners do not advocate for revisions, it may be difficult for EPA or DOE to justify revisions to specifications or standards.<sup>27</sup>

<sup>25</sup> Apex recommends this approach in general but NEEA should adjust this for cases where it doesn’t make sense.

<sup>26</sup> For example, television sales mostly occur in Q4 and room AC sales occur mostly in summer months.

<sup>27</sup> There may be cases in which NEEA would reasonably expect standard or specification revisions to occur in low or stagnant market share conditions. In these cases, it would be important for NEEA to articulate the reasoning for these expectations.

- **Clearly document NEEA’s assumptions both about the timing and stringency of the event in the baseline case and how NEEA anticipates RPP will influence them.** In some cases, it was not clear to the Apex team whether NEEA’s assumptions about market event timing or effects reflected the initiative’s influence or represented a baseline case without NEEA influence. Articulating the assumptions in both cases would help resolve this confusion. For example, if NEEA anticipates its intervention will accelerate a specification revision, it is important to state assumptions about when the revision will occur with NEEA’s influence and when NEEA anticipates it would have occurred independently. As with all baseline assumptions, NEEA could update these assumptions as it gains knowledge of the market.

**Event Period:** The baseline event period begins when an event starts to influence the market and ends when the market share growth slows, or another event occurs. The event period is most clearly defined for standard and specification revisions. NEEA assumes that federal standards adoption takes six years to complete after the process is initiated. Interviewed Appliance Standards Awareness Project (ASAP) staff confirmed that six years would be the norm and a conservative assumption for this baseline element. The rule-making process for an update to appliance standards typically takes approximately three years, followed by a three-year lead time before the revised standard takes effect, for a total of a six-year cycle. The timing for specification revisions depends on the stakeholders involved and the issues under consideration. In general, we found the cycle time between initiation and effective date to average one-and one-half (clothes washer V8, air cleaner V1) to three years (refrigerator and freezer V5) for specification revisions.

Another timing-related consideration is that some events may drive others to occur. As an example, a new federal standard would likely lead to a new ENERGY STAR specification. The Apex team confirmed that NEEA’s assumptions about co-dependency are reasonable through ASAP staff interviews and our review of historical relationships between these events.

**Maximum Saturation:** NEEA uses sales data to determine the maximum qualified market saturation of efficient products. If there is a product configuration in which efficient products are not available, NEEA will exclude the proportion of the market that configuration represents from the maximum saturation. As an example, if there were no bottom-mount refrigerators with automatic defrost and through-the-door ice sold within the ESME tier, then NEEA would exclude the percentage of sales from the maximum market share. The Apex team found this to be an incomplete means to assessing potential maximum market share. NEEA’s exclusion of a certain percentage of the product market due to lack of models in each product class should also be based on 1) whether other configurations added qualifying models over time, and 2) if products are available outside of RPP sales, relying on the ENERGY STAR qualifying product list (QPL) as a reference. NEEA should consider the possibility that manufacturers may also introduce qualifying models for configurations currently excluded. Conducting outreach to established manufacturer contacts could help NEEA identify whether they are planning on incorporating this technology in the near future.

## 5. Data Validation

The following section summarizes the Apex team’s findings from validating Energy Solutions data cleaning and model classification approach, as part of our model validation objective.

ICF manages the RPP portal with the goal of tracking qualified and non-qualified sales and administering incentives based on qualification status. The RPP portal qualifies models based on their presence on the ENERGY STAR qualified products list (QPL) at the time of sale and does not track historical qualification based on changing specifications. The data available through the RPP portal alone are insufficient for NEEA to forecast the baseline market shares of qualified products and develop unit energy consumption estimates by product class and efficiency level.<sup>28</sup> As a result, NEEA contracts with Energy Solutions to address these limitations of the portal by independently reclassifying the models listed in the RPP portal to current and past ENERGY STAR QPLs and generating energy usage estimates for RPP products at the level of detail NEEA needs to create its savings estimates.

Energy Solutions relies on a different – and more dynamic – process to establish a product’s RPP qualification and efficiency tier than the RPP portal. Energy Solutions uses a product’s qualifying criteria (which may be unit energy consumption (UEC) or another metric such as CEER for room AC) to classify model efficiency levels. As a result, Energy Solutions may qualify models into higher efficiency tiers even if the models are not on the ENERGY STAR QPL, and therefore do not qualify for program incentives.<sup>29</sup> For federally regulated products, which have common energy attributes specified for both inefficient and efficient models, Energy Solutions is able to reclassify the ENERGY STAR qualification and assign the model to the appropriate efficiency tier. This process is applicable for refrigerators, freezers, washers, dryers, and room ACs. Yet, for other RPP products that are not held to federal standards, Energy Solutions can only classify models as qualifying if they appear on the ENERGY STAR QPL. For example, air cleaners and sound bars are not subject to federal efficiency standards, and energy consumption data for non-ENERGY STAR models are not widely available. Therefore, Energy Solutions had to rely on the ENERGY STAR QPL.

The Apex team assessed Energy Solutions’ current data cleaning and model matching approach to validate the reclassifications and identify opportunities for improvement. Energy Solutions provided documentation related to their processes and reclassified RPP sales data for refrigerators, freezers, clothes washers, dryers, soundbars, room air cleaners, and room AC products. Appendix A: Detailed

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<sup>28</sup> In order to estimate energy savings from RPP, NEEA determines a baseline curve tracking the market share of each program specification for each product. To track actual sales over time relative to these baseline curves, NEEA will need to determine which products meet program specifications (and potentially ENERGY STAR specifications) that may no longer be in effect at the time the product was sold.

<sup>29</sup> For the purposes of this report, we define this reclassification as “re-matching.”

Product Assessments provides a separate, more detailed analysis, reviewing and validating Energy Solutions’ model matching and summarizing the impacts on market shares for each RPP product.

In summary, this review found Energy Solutions’ model reclassification process to be robust and reliable. There were minimal instances where the reclassified data was incorrectly specified. The reclassification process adds valuable insight into trends in RPP-qualifying product market shares, which allow NEEA to more accurately track historical market share trends and, ultimately, savings. The following are key opportunities to improve the process:

- Validating the reclassified models’ basic attributes to ensure they match the original RPP portal attributes. As an example, we found re-matched clothes dryers that received a different fuel source classification than identified by the RPP portal data. This caused a movement to higher tiers due to differing standards for gas versus electric dryers. This issue was only identified for clothes dryers.
- Increasing documentation to help NEEA understand the impacts, on an ongoing basis, of the re-matching process and to provide insight to NEEA for the underlying drivers behind significant movement in classification.

Another goal was to understand, during validation, the extent of reclassification and key drivers. A high-level summary of the percentage of each product’s RPP efficiency tiers that Energy Solutions reclassified is shown in Table 11 below. Energy Solutions had reclassified a significant portion of models for several of the products (soundbars, room air cleaners). Other products saw only one-to-two percent of sales reclassified (freezers, dryers). We also found the annual percentage of reclassified products had declined over time. This decline is mostly attributable to Energy Solutions’ more dynamic matching process, which retroactively updates product classifications to reflect specification changes and classifies ENERGY STAR tiers that are not RPP program qualified, and, less significantly, reflects improvements to the RPP portal system. We also found, universally across the RPP products, that over 99% of products that were reclassified went to higher tiers.<sup>30</sup> The movement to higher-qualified tiers can be attributed to the dynamic Energy Solutions model matching process, which revises the qualification based on revised specifications and continually updated qualification lists.<sup>31</sup>

**Table 11. Apex team Summary of Energy Solutions Reclassified Differences from RPP Portal**

RPP Product	Average Percent of Sales Reclassified to Higher Tier	Reclassification Drivers
Refrigerators	12% in 2015 declining to 2% in 2018	Prioritization of CEC-defined annual energy use values over ENERGY STAR defined values.

<sup>30</sup> This is an important distinction, since models that are re-matched to lower tiers implies NEEA is paying incentives on products that is should not be.

<sup>31</sup> For example, a product sold in 2016 under the ES V6 spec would be classified as ES V6 in the RPP portal. If that product also qualified for an ES V7 spec that took effect a year later, the portal would update it as of the effective date of the new specification, whereas Energy Solutions would retroactively update all sales of that model in their dataset.

RPP Product	Average Percent of Sales Reclassified to Higher Tier	Reclassification Drivers
Freezers	Consistently < 2% annually	Reclassified into the non-qualified tier because the CEC- and DOE-assigned bin was different than the RPP-reported bin.
Clothes washers	Upwards of 50% to higher tiers in 2015-2016 declining to 15% in 2017-2018	Models flagged as non-qualified in RPP portal yet qualified as basic in the Energy Solutions dataset because NEEA did not start paying incentives until 2017.
Dryers	2-3% in 2016 to < 1% in 2018	Prioritization of CEC-defined fuel reclassification (from electric to gas dryer).
Room air cleaner	70% of non-qualified from 2015-2018	Updated reclassification reflects new products listed on the ENERGY STAR QPL being used to refresh historical qualification
Soundbars	40-50% of non-qualified to ES qualified	Updated reclassification reflects new products listed on the ENERGY STAR QPL being used to refresh historical qualification
Room AC	40-50% of non-qualified to ES qualified	V3 were non-qualified, so were not assigned V3 status in the portal.

## 6. NEEA-regional Sales Assessment

The following section summarizes the findings from a NEEA-regional sales assessment.

The NEEA-regional sales assessment was a key component of the product-specific research objectives. The sales data NEEA receives from retailers participating in RPP covers only a portion of the overall sales occurring in the four-state NEEA region. Sales not included in the RPP data include online sales, sales from non-participating retailers, and sales outside of traditional retail channels (e.g., production builders working with regional distribution centers). NEEA seeks to understand the total, regional market for products included in RPP in order to:

- Estimate total regional market size for each product to estimate additional potential impacts of the market transformational model;
- Develop a snapshot of the proportion of the regional market that RPP represents; and
- Understand whether significant differences exist between the product mixes (for washers, this would mean differences in proportion of top- versus front-load units).

NEEA purchased regional shipment data from the Association of Home Appliance Manufacturers (AHAM) for the years 2016 to 2018 to gain insight on the total regional market. AHAM data were available for five of the eight RPP products (refrigerators, freezers, clothes washers, dryers, and room air

conditioners). As part of this evaluation effort, NEEA sought to understand whether AHAM data provided an accurate estimate of the regional market.

AHAM staff interviewed for this project reported that their shipment data represents 97% to 98% of the overall US shipments of major appliances and includes both foreign and domestic manufacturing (i.e., any unit that is shipped within the US), and includes online sales. Based on this insight, the Apex team concluded that, in general, AHAM shipment data did reflect a reasonable estimate for overall regional sales.

Yet, NEEA and the Apex team identified discrepancies between AHAM data and RPP retailer-reported sales data for specific products that needed to be investigated more closely. These discrepancies included large differences between total AHAM shipments and RPP sales for many of the RPP products, and relative differences in market share by specific configuration for some products. For example, AHAM shipment data showed different saturations of front- versus top-load washers relative to RPP sales saturations. Interviews with AHAM staff and analysis of sales data trends from our market assessments suggested two key causes of these discrepancies:

- **Differences in the type of data reported:** AHAM reports data on shipments from manufacturers to distribution centers, while the RPP program receives data on retail sales. Because the two data sources report on different levels of the supply chain, some differences are to be expected. The timing of retail sales lags that of shipments to distribution, and not all shipments go through retail channels.
- **Sales through non-retail channels:** As noted above, RPP sales data are limited to the participating retailers. A significant portion of shipments for some products go through non-retail distribution channels. For example, high-volume appliance purchases by large production builders could explain the different sales patterns for some products. The appliances production builders purchase directly from manufacturers or distributors are included in AHAM shipment data but would not appear in retail sales data. These purchases are likely to favor lower-cost models, which would explain relative differences in market saturations between AHAM data and RPP sales data for some products.

The Apex team developed bottom-up and top-down sales estimates to further validate the total AHAM shipment estimates. The bottom-up analysis used a combination of new construction housing starts and number of existing homes, along with assumptions of annual sales for each category.<sup>32</sup> We found that a bottom-up approach provides a range of estimates which are highly sensitive to turnover rate assumptions. In the clothes washer analysis (**Table 12**), the median point estimate based on RTF-

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<sup>32</sup> The Apex team based the housing stock estimate on a sum of the total new construction housing starts and the existing building stock number of housing units. We assumed that the same proportion of new construction projects would include an RPP appliance as saturations in existing homes. We also assumed the existing building stock experiences an annual turnover rate based on an assumed lifetime of the RPP appliance (demand is based on the inverse of the lifetime).

reported measure life was 25% higher than AHAM shipments. However, the inclusion of multiple inputs and underlying assumptions in this bottom-up model makes interpretation challenging; we cannot definitively say whether the uncertainty associated with the annual turnover rate or saturation of new construction homes is leading to the disconnect between estimated and AHAM unit totals.

**Table 12. Bottom-Up Estimate for Total Housing-Based Washer 2017 Annual Unit Sales**

Variable	Assumed Value			Source
<b>Bottom-up estimate</b>				
New Construction Housing Starts	84,962			National Association of Home Builders <sup>1</sup>
% of New Construction with Washers	34%			Assume zero MF, half of SF receive washer, RBSA II
<b>New Construction Units</b>	<b>28,887</b>			Calculation
Existing Housing Stock	6,103,820			U.S. Census, ACS <sup>2</sup>
% of Existing Stock with Washers	85%			RBSA
Assumed Life	8	14.2	20.4	RTF 14.2-year basis <sup>3</sup>
Turnover Rate (1/Life)	13%	7%	5%	Calculation
<b>Turnover Units</b>	<b>719,273</b>	<b>436,691</b>	<b>325,875</b>	Calculation
<b>Total 2017 Bottom-up Estimated Units</b>	<b>748,160</b>	<b>465,578</b>	<b>354,762</b>	Calculation
<b>AHAM shipments</b>				
<b>Total AHAM 2017 Units</b>	<b>373, 528</b>			Reported
<b>Total RPP 2017 Units</b>	<b>274,896</b>			Reported

<sup>1</sup> <https://www.nahb.org/en/research/housing-economics/construction-statistics/national/starts-and-permits.aspx>.

<sup>2</sup> [https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP\\_2017\\_PEPANNHU&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2017_PEPANNHU&prodType=table).

<sup>3</sup> <https://rtf.nwcouncil.org/measure/clothes-washers-0>.

The Apex team also developed a more simplified top-down estimate. The top-down analysis used total national annual sales (or shipments, depending on data availability) and allocated the national sales to the NEEA region based on NEEA’s proportion of households.<sup>33</sup> An example of our top-down model, based on clothes washers, is shown in Table 13 below. We found that the top-down model provided a closer estimate for total regional demand than the bottom-up model.

<sup>33</sup> This simplified estimate assumes equivalent NEEA-region and national household saturations. Regional (e.g., RBSA) and national saturation (RECS) data exist but may not add precision to the estimate since saturations are based on existing household stock and do not necessarily reflect sales or demand.

**Table 13. Top-down Estimate for Total Housing-Based Washer 2017 Annual Unit Sales**

Variable	Assumed Value	Source
<b>Top-down estimate</b>		
<b>Total 2017 US Shipments</b>	<b>10,091,900</b>	Statista (FTC data)
<b>NEEA region percent of households</b>	<b>4.4%</b>	US Census, factfinder
<b>NEEA region percent of households with washers</b>	<b>85%</b>	RBSA II
<b>Top-down estimate</b>	<b>377,437</b>	Calculation
<b>Total AHAM 2017 Units</b>	<b>373, 528</b>	Reported
<b>Total RPP 2017 Units</b>	<b>274,896</b>	Reported

Through the regional demand assessment, we believe the AHAM shipment data provided NEEA with reliable regional demand estimates. However, AHAM will no longer be providing region-specific shipment data. The loss of regional AHAM data will aggravate the uncertainty around estimating regional sales. However, NEEA can use this opportunity to develop a total NEEA-regional sales estimate similar to those demonstrated above. This sales estimate could also leverage historical relationships between RPP sales and AHAM shipments to account for configuration saturations, and some of the attributes provided here as part of these models. NEEA may also consider incorporating other parameters, including correlation with the economy (countercyclical vs cyclical vs non-cyclical) and correlation with sales of other appliances (attachment rates for washers/dryers and televisions/soundbars).

## 7. Conclusions and Recommendations

NEEA’s active involvement with the RPP initiative is focused on tailoring strategic opportunities and leveraging market insights to help transform the RPP product markets. NEEA has thought deeply about the RPP initiative and the underlying products and taken a proactive approach to managing the products and their impacts. Concurrently, NEEA has documented the supporting logic and market characteristics driving their strategies.

This active involvement in selecting and pursuing intervention strategies for products in RPP is both valuable and necessary to increase uptake of efficient products. NEEA recognizes that midstream incentives provide access to valuable data for understanding the interventions necessary in a market but may not increase market share of efficient products for all products at all stages of their lifecycle. For many products, deeper and more complex market engagements are necessary, including participation in

standard and specification revision processes to counter industry voices that may not support the level of stringency necessary to drive the market toward greater efficiency.<sup>34</sup>

The RPP initiative operates in a multifaceted web of market and sales data, behavioral dynamics from three market actors – upstream manufacturers, midstream retailers, and downstream consumers – and market dynamics. This is a considerably more complex environment than a simple midstream incentive offering might imply and requires active management. The Apex team draws the following conclusions and recommendations from our review of NEEA’s RPP strategies and baseline assumptions:

**Conclusion 1: Midstream incentives alone are likely to drive uptake of efficient products only under specific market conditions; as NEEA has recognized, other strategies are necessary for many products.**

Midstream incentives seek to motivate retailers to favor efficient products over inefficient alternatives in their assortment and promotion decisions. Retailers’ primary consideration in those decisions is meeting consumer demand for price points, configurations, and features. As a result, midstream incentives will be most effective when efficient products are available at the price points, in the configurations, and with the features that retailers anticipate consumers will want. If efficient products are not widely available or are concentrated at certain price points or in certain configurations, other strategies will be necessary to increase availability of efficient products to the point that midstream incentives can have their intended effect. It is also important to recognize that influencing retailers is not the only benefit the RPP initiative receives from midstream incentives; they also receive access to full-category sales data, which can be a critical input to other intervention strategies.

**Recommendation:** NEEA should continue to fully and carefully assess market conditions to determine whether midstream incentives or other strategies will best increase uptake of efficient products within each category. NEEA should also assess the value of the sales data it receives from offering midstream incentives and monitor to ensure that the value continues to justify the cost of incentives. When offering incentives, NEEA should articulate whether it anticipates the incentives will significantly influence retailers, or if the incentives are a means to obtain market data.

**Conclusion 2: It is important to analyze market conditions and select intervention strategies by product configuration.**

Metrics like efficient market share can be misleading at a product category-wide level when there are significant differences in efficiency between product configurations. For example, the efficient market share of upright freezers is relatively high, and growing, while the efficient market share of chest freezers remains low and stagnant. These two configurations face different market conditions and require different intervention strategies, which is not clear from category-wide market shares, which show a moderate, and slightly increasing share of efficient units.

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<sup>34</sup> See the television product memo for a deeper discussion of ENERGY STAR specification comments and revisions to demonstrate a perfect example of this in action.

**Recommendation:** NEEA should continue to assess market conditions and select intervention strategies at the product configuration level. Initial market analysis may be necessary to determine what configuration or feature differences are most meaningful.

**Conclusion 3: The assumptions on which a baseline curve is based must fit together in a coherent story.**

NEEA has developed and continues to refine a process to document the assumptions that go into its baseline estimates. In making baseline assumptions, it is important for NEEA and its future evaluators to consider how the individual assumptions that make up the baseline fit together. For example, an assumption that an ENERGY STAR specification revision will occur at a particular time may not be consistent with an assumption that efficient market share would remain low and stagnant until that time, as a low and stagnant market share would provide little justification to revise the specification. In this example, NEEA may have other reasons for assuming a specification revision would occur at the specified time, and should document those reasons.

**Recommendation:** NEEA should continue to articulate the thinking behind each of its baseline assumptions and ensure that assumptions are consistent with each other.

**Conclusion 4: It is important to clearly differentiate assumptions about uptake of efficient products with RPP intervention from assumptions about baseline uptake, in the absence of intervention.**

Baseline market share is, by definition, the market share of efficient products in the absence of any intervention by NEEA or its partner organizations. As a result, a forward-looking baseline estimate should reflect the market without intervention and should not vary depending on the intervention strategies NEEA pursues. Predicted uptake with program intervention, in contrast, could vary by intervention strategy, and it is important for NEEA to clearly articulate the differences in its assumptions. For example, if NEEA is pursuing a strategy to bring about an ENERGY STAR specification revision, it is important for baseline assumptions to articulate the anticipated timing and stringency of the specification both with and without NEEA's intervention.

**Recommendation:** NEEA should articulate more detailed assumptions about timing and/or specific assumptions regarding specification revisions and their impacts on influencing the baseline both with and without program intervention in baseline assumptions.

**Conclusion 5: Effective energy consumption measurement and specification compliance is critical to the success of all other intervention strategies.**

Strategies like midstream incentives, promotion of emerging technology, and specification advancement depend on NEEA's ability to effectively assess the efficiency and energy use of different models within a product category and differentiate or promote the most efficient options. Differentiating efficient

products is also critically important for consumers. In product categories like soundbars, where measurement and compliance challenges make it difficult to effectively assess product efficiency, it is difficult to identify which additional strategies might be effective or what the energy savings potential of the category is.

**Recommendation:** NEEA should carefully analyze DOE and ENERGY STAR specifications, test procedures, and qualified products lists to identify any potential measurement and compliance issues when adding a new product to the RPP portfolio. Identifying measurement and compliance issues early on, supported by RPP sales data, will help NEEA target the most appropriate product strategies

## 8. Appendix A: Detailed Product Assessments

The following table includes all six of Apex submitted product specific memos along with the data validation memo as well. The Apex team has included a brief description for each attachment.

Product Document	Description
 Freezers Product Memo	A more detailed market, strategy, and baseline assessment for the freezer product category.
 Refrigerators Product Memo	A more detailed market, strategy, and baseline assessment for the refrigerator product category.
 Clothes Washers Product Memo	A more detailed market, strategy, and baseline assessment for the clothes washer product category.
 Clothes Dryers Product Memo	A more detailed market, strategy, and baseline assessment for the clothes dryer product category.
 Soundbar Air Cleaner Television Product Memo	A more detailed market, strategy, and baseline assessment for the sound bar, air cleaner, and television product categories.
 Room Air Conditioner Product Memo	A more detailed market, strategy, and baseline assessment for the room AC product category.
 Model Matching Documentation and Validation	A more detailed data validation assessment across five RPP products.

## 9. Appendix B: RPP Product Qualification Levels and Incentives

Since 2016, as part of the RPP, NEEA has worked to promote eight consumer appliance or electronic products, such as refrigerators and soundbars. The specific ENERGY STAR tiers, RPP tiers, configurations, and incentives have evolved over time, with the current (as of Q2 2019) criteria listed below in Table 14.

**Table 14. NEEAs Eight RPP Products (as of Q2 2019)**

Product	Current ENERGY STAR Tier	Federal Standard	RPP Tiers	Incentives	Key Configurations
Refrigerators	V5.0, ESME	Revision 4	Basic	\$0	<i>Freezer mount location: top, bottom, or side</i>
	Effective: 9/15/2014	Effective: 9/15/2014	Advanced	\$15	
Freezers	V5.0	Revision 4	Basic	\$15	<i>Upright or chest</i>
	Effective: 9/15/2014	Effective: 9/15/2014	Advanced	\$50	
Clothes washers	V8.0, ESME	Revision 5	Basic	\$8 (top-load only)	<i>Top- or front-load</i>
	Effective: 2/5/2018	Effective: 9/15/2014	Advanced	\$0	
Clothes dryers	V1.1, ESME	Revision 3	Basic	\$0	<i>Electric, gas, heat pump</i>
	Effective: 5/5/2017	Effective: 9/15/2014	Advanced	\$100	
Soundbars	V3.0		None		<i>None</i>
Room Air Cleaners	V1.2		None		<i>Capacity (by CADR/W)</i>
Televisions	V8.0		None		<i>Screen size, HD or UHD</i>
Room Air Conditioners	V4.0	Revision 3	Basic	\$10	<i>Cooling capacity and type</i>
	Effective: 10/26/2015	Effective: 6/1/2014	Advanced	\$10	

\*\*NEEA stopped offering RPP incentives for televisions in April 2018 and for soundbars and air cleaners in April 2019.