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**From:** Joe Van Clock, Noah Lieb, Apex Analytics

**Subject:** ESRPP Baseline Forecast

**Date:** February 6, 2023

This memo summarizes assumptions underlying Apex Analytics’ forecast for the naturally occurring (non-program) baseline market share for ENERGY STAR® Most Efficient refrigerators and ENERGY STAR clothes washers. Estimates of baseline and with-program uptake are provided in the “Apex Unit Volume and Savings Forecast” spreadsheet that accompanies this memo.

ComEd currently offers incentive for these two products through their ESRPP participation and targets two tiers within each product category, a basic tier and a higher efficiency tier. For clothes washers, ComEd incentivizes top-load washers only, consistent with NEEA. ComEd incentivizes two clothes washers tiers, a basic tier of standard ENERGY STAR® (ES) models and an advanced higher efficiency tier of ENERGY STAR® Most Efficient (ESME). ComEd also incentivizes high efficiency ENERGY STAR® refrigerators but does not distinguish between different model types for program qualifying criteria. ComEd incentivizes two refrigerator tiers, a basic tier of ENERGY STAR® most efficient (ESME) models and an advanced efficiency tier of Emerging Tech Award (ETA) models. It should be noted that incentive levels are the same across tiers for both products, set at $8/unit.

# Background

In spring 2020, ComEd joined ESRPP, a national market transformation initiative designed to drive increasing energy efficiency for various appliance categories. Evaluation of the program will be performed by Guidehouse following IL TRM v. 9.0 Volume 4, Attachment C: Framework for Counting Market Transformation Savings in Illinois, which was created in anticipation of ComEd and other Illinois utilities introducing MT programs into their energy efficiency portfolios.

An examination of the program for 2020 was performed by Guidehouse, but results were preliminary only and not reflective of future evaluation methods and procedures. 2021 represents the first full-year evaluation of ComEd’s involvement in RPP, and conversations with Guidehouse and stakeholders have been taking place for the last several months regarding the application of the TRM framework to program evaluation. ComEd’s RPP participation is the first instance of an Illinois utility attempting to claim savings under this framework. The outcome of this evaluation plan has long-term significance for ComEd’s ability to meet savings goals, as establishment of a predictable MT savings methodology is paramount to decision-making about future program involvement.

ComEd sought expert support establishing a natural market baseline, as well as in developing a forecast for its RPP involvement (current product categories include clothes washers and refrigerators). This memo proposes an initial natural market baseline forecast based on the best data available to ComEd and Apex at the time the memo was drafted. Additional data and market insights may help to refine this forecast. Call-out tables are included throughout the memo detailing outstanding research questions and the implications to the baseline assumptions. Additional research areas are also consolidated and summarized at the end of the memo.

# Baseline Estimates

## General Approach

Apex estimated natural market baseline market shares for RPP products that reflect anticipated uptake of products meeting RPP qualification criteria in the absence of either RPP or ComEd’s downstream Retail Appliance Program. The forecasting approach described below is agnostic of baseline market conditions: it can accommodate either an increasing or a decreasing baseline market share of efficient products and does not assume that efficient market shares will naturally increase.

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| **Future Research Question** | **Baseline Implications** |
| Should a baseline forecast assume that the natural state of appliance markets is for the market share of products meeting ENERGY STAR and/or above ENERGY STAR efficiency tiers to increase? | If there is natural market pressure for efficient market shares to increase in a baseline condition, it may be necessary to reconsider aspects of this baseline approach, including the decision to flatten the baseline forecast in Phase 2. |

These baselines consist of estimates of market trends across a series of distinct phases, each of which are based on different assumptions about the market.[[1]](#footnote-2) Table 1 summarizes these phases and the assumptions that go into our market share predictions for each phase. We briefly describe each phase following the table.

Table 1: Baseline Estimation Phases

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| Phase | Timing | Key Assumptions | Impact on Market |
| 1 | Forecast period begins when ComEd incentives first offered; Phase 1 is up to first 3 years of forecast period | Market share will continue trajectory observed during baseline period. | Continued linear trend of market share change. |
| 2 | 3 years after beginning of forecast period to first anticipated standard/ specification change | Market share will stabilize. | No additional change in market share. |
| 3 | Date of final revised standard/specification to anticipated effective date. | Timing of standard/specification  Stringency of standard/specification | Market share will grow as market adapts to new specification |
| 4 | Date of final revised standard/specification to next standard/specification revision or end of forecast period | Change in market share of current specification following adoption of new specification | Market share of current (program) specification will grow as uptake of new, higher specification grows |

### Phase 1

As Table 1 shows, our baseline approach begins (Phase 1) with the assumption that historical market trends are a reasonable predictor of uptake of efficient products in the near future. If efficient market shares show a trend of growth or decline in the pre-program period, it is reasonable to assume that trend will continue during the forecast period. We use a linear model to forecast market share trends from pre-program data into the future.[[2]](#footnote-3)

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| **Future Research Question** | **Baseline Implications** |
| Is it reasonable to extrapolate historical data on efficient market shares to predict baseline uptake? If so, for how many years is it reasonable to assume that a linear trend will continue? | If expert panels or a deeper exploratory data analysis determine that historical market share is not a reasonable predictor of future trends or reveal limitations in the length of time for which those trends are likely to continue, this could impact the timing of the shift to Phase 2 of the baseline, assuming evaluation or ComEd advisory support staff can validate these limitations. |
| To what extent is retailers’ increased focus on carbon emissions, and specifically their Scope 3 carbon reduction goals, likely to increase market share of efficient products?  How might these efforts be different if the retailers were not participating in ESRPP?  What impact would these efforts have on uptake of products meeting above ENERGY STAR efficiency specifications, given that retailers typically do not recognize these levels? | Retailers have recently adopted goals around reducing Scope 3 carbon emissions by increasing the energy efficiency of the products they sell. Because these efforts are relatively new for some retailers, a linear forecast based on historical market share may not capture their effect on the market. To the extent it is possible for future research to quantify the impact retailer efforts to meet Scope 3 emissions reduction goals have on market share of ESRPP qualified products (recognizing that their ESRPP participation may influence the way retailers approach Scope 3 emissions reduction efforts), it may be appropriate to alter the predicted rate of market share growth to accommodate that impact. |

### Phase 2

Our choice to stabilize baseline market share estimates (flatten the baseline curve) in Phase 2 reflects the uncertainty of predicting market trends into the medium- or long-term based on limited data. Market share growth or decline is unlikely to continue indefinitely without other market intervention (like a standards update). Some products are unlikely to be designed to efficiency specifications (primarily very low-cost products, or very high-end products that prioritize performance over efficiency), creating an upper bound for efficient market share. Demand from committed consumers who prioritize efficiency in their purchasing decisions likely creates a lower bound of market share. At the same time, shifting market trends may alter the trajectory of an efficient market share trend before it reaches either of these boundaries. Given this uncertainty, we predict that efficient market share will remain steady beginning three years after the start of the forecast period.

### Phase 3

We anticipate that changes in ENERGY STAR specifications or federal standards will bring about more significant shifts in market share that deviate from the general trends described in Phase 1 and Phase 2. We assume that the market will begin to respond to a revised specification or standard (Phase 3) once the new specification or standard is finalized. In the case of federal standards, there is typically a three-year period between a standard’s finalization and its effective date. As standards are mandatory, we anticipate that the market will fully adapt to a new standard by its effective date. ENERGY STAR specification updates typically take effect within a few months of finalization, and, as a voluntary specification, we anticipate that the market will continue to adapt in the year following the effective date.

### Phase 4

The impact on market share of a standards or specification update depends on the stringency of the updated standard in relation to the new standard. For example, a new federal standard that codifies the existing ENERGY STAR efficiency levels would lead market share of the existing ENERGY STAR specification to grow to 100%, as all models would be required to meet that standard. An ENERGY STAR specification revision that draws on an existing higher-level specification (e.g. ENERGY STAR Most Efficient (ESME)) would also likely result in an increase in market share of models meeting that specification, as manufacturers will be more motivated to produce models that qualify for the more widely-known designation.

## Exceptions

The general baseline estimation approach described above may not accurately represent the market for all products. Apex identified two specific situations in which this approach may not be appropriate, although others may arise.

### New Specifications

The approach described above assumes that trends in the pre-program period will continue into the first portion of the baseline period (Phase 1) in a linear way. This assumption may not be accurate if there is an event that causes a significant shift in the market for efficient products during the pre-program period. Adoption of an efficiency specification that had not previously been articulated, particularly if that specification applies to a technology for which efficiency specifications did not previously apply, are examples of these types of events.

Clothes dryers provide an example of a technology that was first recognized by efficiency specifications shortly before ESRPP incentives began in the Northwest and other markets. Market share of qualified products grew quickly shortly after the specification became effective, before stabilizing into a slower rate of growth (Figure 1). This likely reflects manufacturers certifying models that either already met the efficiency specification, prior to its launch, or that could be modified to meet the specification relatively easily. The subsequent, slower growth likely reflects the growing consumer demand for efficient products and diffusion of efficient technologies into a wider range of models that drive market share growth for more established efficiency specifications.

Figure 1: Annual Electric Clothes Dryer ENERGY STAR Market Share in the Pacific Northwest Following Adoption of First ENERGY STAR Specification

Source: NEEA ESRPP sales data, excludes online sales

A linear baseline forecast that extends the initial, rapid market share growth these product categories experience shortly after a new efficiency specification takes effect is unlikely to be reflective of the market. This type of forecast would ignore the natural decline in market share growth once the low hanging fruit has been certified. In these situations, a logarithmic curve that accelerates rapidly before gradually flattening is likely a better reflection of market dynamics. As Figure 2 shows, a logarithmic trend line based on the first 18 months of market data more closely reflects future clothes dryer market share than a linear trend line based on the same data.

Figure 2: Monthly Electric Clothes Dryer ENERGY STAR Market Share in the Pacific Northwest with Linear and Logarithmic Trend Lines

Source: NEEA ESRPP sales data, excludes online sales

### Influence of Environmental Factors on Sales

Weather and other environmental factors can strongly influence sales of some products, causing large volatility in sales volume from one year to the next and impacting efficient market shares. Room air conditioners are one example of this type of product. Air conditioner sales are likely to grow significantly as customers seek relief during a heat wave. At the same time, efficient market shares may fall as customers may not consider their options as carefully to identify efficient models as they would for a less urgent purchase and product availability may be limited due to the surging demand. Room air cleaners may see similar sales volatility during poor air quality events, like wildfires.

A baseline forecast that relies on data from a period in which environmental factors led to surging demand may not accurately reflect the market over the long term. In these cases, a longer period of observed data may be necessary to reduce the influence of any short-term surges in demand, or forecasters may need to use other methods to control for the effects of environmental factors.

### Other market trends

There are yet other market trends, including consumer preferences for product-specific features or configurations, supply chain issues (including production, labor, or material shortages or inflation), and other harder to quantify consumer/retailer/manufacturer preferences that are not captured yet likely influence sales of higher efficiency products. Consumer preference for top-versus-front-load washing machines is a good example of this evolving market dynamic. Consumers shifted preference from traditional top-load to front-load in the late 1990s/early 2000’s but have since reverted back to top-load models. A baseline forecast that does not capture these natural market trends is therefore not accurately disentangling program influence.

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| **Future Research Question** | **Baseline Implications** |
| What other market trends might impact the availability of efficient products? (This could include both trends in consumer demand for certain features or configurations, and supply side considerations like labor costs, automation of production, availability of materials/components, etc.) | If expert panels or a deeper exploratory data analysis reveals quantifiable market share trends that can be forecasted with a reasonable degree of certainty (connecting the trend with other larger economic factors), and evaluation or ComEd advisory support staff can validate these limitations, it may be appropriate to consider approaches to the baseline forecast that incorporate these trends, rather than relying on a simple, linear forecast based on historical data. |

## Product-Specific Assumptions

### Refrigerators

ComEd offers RPP incentives for refrigerators meeting two distinct efficiency requirements: a basic tier, which was the basic ENERGY STAR specification in 2020 and increased to the ENERGY STAR Most Efficient (ESME) specification effective since 2019 (ESME 2019+) in 2021, and an advanced tier, which was the ESME 2019+ specification in 2020 and increased to the 2020-2021 Emerging Technology Award for Advanced Adaptive Compressors (ETA) in 2021.

The RPP program differentiates refrigerators by three configuration types, according to the positioning of the freezer relative to the refrigerator compartment: top mount, bottom mount, and side mount. It is particularly important to differentiate top mount units since the ESME qualification criteria for these units are different from the qualification criteria for other configurations. Both the ESME 2019+ specification and the prior ESME specification, in effect from 2016 through 2018, require only that top-mount models meet the base ENERGY STAR specification and have annual energy consumption values less than 637 kWh/year.[[3]](#footnote-4) As a result of these exceptions, the ESME 2019+ market share of top-mount models is notably higher than that of other refrigerator configurations.

With two efficiency tiers and three product configurations, Apex created six distinct baseline estimates for refrigerators. Figure 1 illustrates these NMB forecasts and the timing of the phases driving our predictions. Note that the timing of the phases differs somewhat between the top mount ESME forecast and the other configurations and efficiency levels because the top mount forecast is largely driven by the federal standard update, while the other configurations are driven by ENERGY STAR specification updates anticipated to accompany that federal standard. As noted above, ENERGY STAR updates generally provide less lead time between the finalization of the specification and its effective date and, as voluntary specifications, continue to impact the market after they take effect.

Figure 3: Refrigerator NMB Forecast by Configuration and Efficiency Level

#### Phases 1 & 2

The ESME 2019+ requirements had not been articulated as an efficiency specification prior to their launch in 2019. As a result, historical sales data prior to 2019 is of limited value in determining a baseline market share.[[4]](#footnote-5) Top-mount units are the exception in this regard, as the top-mount ESME requirements did not change between the 2016-2018 specification and the 2019+ specification. Apex drew on the 12 months of historical data that ESRPP retailers reported to generate linear forecasts of uptake for ESME 2019+ bottom-mount and side-mount refrigerators.

Apex drew on larger sets of historical RPP data from the Northwest (NEEA) and Wisconsin (Focus on Energy) to generate linear forecasts of baseline uptake for ESME 2019+ top-mount refrigerators. We began with a comparison of market shares across regions, which found that efficient market shares in Wisconsin were, on average, 4% higher than market shares in the Northwest. During the pre-program, baseline period, we found that market shares in ComEd’s service territory (net of units receiving downstream incentives) were, on average, 1% below market shares in the Northwest. As a result, we reduced Wisconsin market shares by 5% to develop a comparable historical baseline estimate for ComEd.

Figure 4: Top-Mount Refrigerator Historical ESME Market Share (Includes ETA Models)

The ETA for refrigerators was designed to recognize the efficiency benefits of advanced adaptive compressors, an emerging refrigerator technology. The ETA included an alternative test procedure designed to capture advanced adaptive compressor efficiency. The test procedure the U.S. Department of Energy (DOE) currently uses to measure refrigerator energy consumption, which is also the basis for ENERGY STAR certification, does not capture the efficiency gains from advanced adaptive compressors.[[5]](#footnote-6) As a result, refrigerators using advanced adaptive compressors effectively were not recognized by efficiency specifications prior to adoption of the ETA.

As described above, a logarithmic baseline can provide a more accurate representation of the market for products that have not previously been recognized by an efficiency specification. Between the release of the ETA in March of 2020 and the time ComEd began offering incentives for ETA refrigerators in April of 2021, market share of qualified models grew quickly before beginning to flatten, consistent with a logarithmic curve. Figure 5 shows ETA market share of bottom mount refrigerators from the specification’s release in March of 2020 through the end of 2021.

Figure 5: Monthly ETA Bottom Mount Refrigerator Market Share with Logarithmic Trend Line

It is important to note that the logarithmic baseline illustrated in Figure 5 assumes that the EPA would have developed the ETA for refrigerators with advanced adaptive compressors and initial uptake of qualified models would have been similar absent ComEd participation in ESRPP. NEEA and other ESRPP program sponsors were involved in discussions with EPA on ways to support advanced adaptive compressors beginning at least in 2017, and prior research conducted for NEEA found that those discussions contributed to the creation of the ETA.[[6]](#footnote-7) The research also found that the potential for ESRPP incentives may have motivated manufacturers to develop a wider range of ETA-qualified models than they otherwise would have.

It is difficult to assess the contribution that ComEd has made to these developments since it joined the ESRPP program in 2019. While ComEd was not directly involved in early discussions with EPA, its involvement helped to build the program’s scale and would have contributed to any influence the availability, or potential availability, of program incentives had on manufacturer decisions to incorporate ETA technologies into a wider range of models. It is not possible, from the market data available, to assess the influence of ComEd, specifically, on availability of ETA refrigerators and to quantify that influence as a change in market share that could be used to adjust our baseline estimates. As a result, there is a need for policy guidance to determine whether and how to value ComEd’s contribution to the creation of the ETA and its initial market share growth.

The ETA for refrigerators with advanced adaptive compressors was in effect in 2021 and 2022. We assume that in a baseline case, in which there was no ESRPP program intervention, ETA market share would plateau once the award was no longer in effect as there would be no third-party certification to recognize qualified models and no program activity to motivate a continued focus on them.

#### Phases 3 & 4

Our baseline estimates assume that a revised federal efficiency standard for refrigerators will be in effect at the beginning of 2027. Currently, the U.S. Department of Energy (DOE) is early in the process of revising the federal standard for refrigerators.[[7]](#footnote-8) We assume that DOE will publish a revised standard by the end of 2023, to take effect three years later, by the end of 2026.[[8]](#footnote-9) We further assume that EPA will update the ENERGY STAR specification for refrigerators, with the updated specification to take effect at the same time as the revised federal standard. We anticipate that, without program intervention, EPA would not update the ENERGY STAR specification prior to the revised federal standard as manufacturers would likely push back strongly against the prospect of adapting to multiple ENERGY STAR specification updates in a relatively short period.

Our baseline forecast assumes that the revised federal standard will be equivalent to the current ENERGY STAR specification. DOE’s technical analysis explores the impacts of four different efficiency levels, ranging from one roughly equivalent to the current ENERGY STAR specification to a Max Tech standard that incorporates all of the most efficient technologies that are currently commercially available.[[9]](#footnote-10) While the current ENERGY STAR specification is the lowest efficiency level DOE’s technical analysis considers, we believe it is a reasonable assumption because, in a baseline case, there would be less support for stringent standards. Efficient market share may be lower without ESRPP influence and ESRPP program sponsors, including ComEd, would not contribute comments and analysis based on sales data in support of more stringent standards. Nonetheless, ComEd should monitor the timing and stringency of the federal standard update and revise its baseline estimate if they differ significantly from these assumptions.

Because essentially all ENERGY STAR top-mount refrigerators qualify for the ESME 2019+ specification, market share of ESME 2019+ top-mount refrigerators would grow to 100% with adoption of a federal standard equivalent to the current ENERGY STAR specification. We assume this growth would occur at a regular pace between the time the final revised federal standard is adopted and its effective date.

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| **Future Research Question** | **Baseline Implications** |
| For each product what are the thresholds above and below which market share of qualified products is unlikely? (What share of the market is unlikely to pursue energy efficiency? What share is likely to prioritize it above all else?) | If expert panels or other research efforts are able to identify market share thresholds and evaluation or ComEd advisory support staff can validate the thresholds, baseline forecasts should be adjusted if needed to ensure that forecasted market share remains within these bounds. |

We assume that, with adoption of a federal standard that increases efficiency requirements to the current ENERGY STAR level, EPA would increase the stringency of the ENERGY STAR specification to the current ESME level, maintaining ENERGY STAR models at a level 10% more efficient than the new federal standard.[[10]](#footnote-11) None of the current ESRPP products provide an effective precedent to assess the change in market share of products meeting an above-ENERGY STAR specification when that specification is adopted as the base ENERGY STAR level.

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| **Future Research Question** | **Baseline Implications** |
| What is the likely impact on market share of products meeting an efficiency specification when that specification goes from an above ENERGY STAR level like ESME to become the base ENERGY STAR level? How much is market share likely to increase? How soon after the ENERGY STAR specification update? | This memo suggests one approach to estimating the impact on market share of products meeting an above-ENERGY STAR specification of adopting that specification as the base ENERGY STAR level. The approach described here is based on broad assumptions about the market. To the extent that future research is able to provide more precise findings about the likely extent or timing of market share growth, those data could refine the extent and timing of market share growth predicted in Phase 3. |

ENERGY STAR is a better-known specification than ESME, and we anticipate that manufacturers would prioritize meeting the base ENERGY STAR specification in a larger number of models than the ESME specification. Thus, adoption of the ESME specification as the base ENERGY STAR level would lead to an increase in market share of products meeting the specification. Therefore, we treat ESME market share prior to the specification update as a lower bound for market share post-update.

At the same time, a more stringent ENERGY STAR specification would be more costly to meet, and manufacturers would likely determine that the benefits of certification do not justify the costs for all models meeting the current ENERGY STAR specification. As a result, we anticipate ENERGY STAR market share would fall immediately after a specification update, and the baseline ENERGY STAR market share prior to the update is an upper bound for post-update market share. Without additional market data, we assume that the market share of products meeting an ESME specification would rise to the midpoint between these two bounds (the ESME market share and the base ENERGY STAR market share) in the 12 months following a specification update that adopted the ESME specification as the base ENERGY STAR level. After that initial increase, we anticipate market share growth would slow to its rate prior to the specification change.

The ETA includes an alternate test procedure that recognizes the efficiency of models using advanced adaptive compressor technology. The standard test procedure largely does not reflect the efficiency benefits of advanced adaptive compressors, making it difficult for manufacturers to market a key benefit of the technology. In a baseline case, without this recognition, we anticipate limited adoption of ETA models. The federal standard revision currently in progress is unlikely to adopt test procedure changes needed to recognize the efficiency benefits of ETA models.

EPA’s adoption of the ETA indicates, however, that they recognize the efficiency benefits of advanced adaptive compressors, and we assume the ENERGY STAR specification update accompanying a revised standard will recognize advanced adaptive compressors. With program support, ETA market share grew notably in 2021, indicating potential for relatively rapid increases in uptake. In a baseline case, we assume ETA models would grow at a similar rate once an ENERGY STAR specification recognizing them takes effect.

### Clothes Washers

Through ESRPP, ComEd has offered incentives for a single clothes washer efficiency level (ENERGY STAR Version 8.1) and a single product configuration (top load). Thus, Apex created one baseline estimate for clothes washers.

#### Phases 1 & 2

The most recent ENERGY STAR specification update for clothes washers left the energy efficiency requirement for top load washers unchanged from the previous version. As a result, the current efficiency requirements for top load washers have been in effect since 2015. Given this long history of consistent efficiency levels, we drew on historical RPP data from outside of ComEd’s territory, dating back to 2015, to develop baseline forecasts (specifically, data from Wisconsin from Focus on Energy and data from the Northwest from NEEA).

Using this historical data is important in developing an accurate forecast for top-load washers, as a forecast based only on the 12 months of retailer-provided, pre-program data for ComEd’s territory would indicate a growing market share of ENERGY STAR top-load washers. Drawing on a longer historical timeframe, however, indicates a longer-term trend of declining market share (Figure 3).

Figure 6 Top-Load Clothes Washer ESRPP Pre-Program Baseline Scenarios

*\*Note, Apex backfilled the “gap” between FOE and ComEd with NEEA-equivalent market share.*

It is important to note when using historical data, however, that the retailer mix of ComEd’s ESRPP program differs notably from that of other regions due to the inclusion of Abt Electronics in ComEd’s program. Abt is consistently one of the top sellers of qualified washers in ComEd’s territory, and tends to have a high market share of qualified products relative to other ESRPP retailers.

#### Phase 3 & 4

We assume a revised federal standard for clothes washers will take effect by the beginning of 2028. The most recent federal standard update occurred in 2018. DOE is currently in the process of reviewing the test procedure in preparation for a standard update. We anticipate the standard revision process will be complete in 2024 and the new standard will take effect by the end of 2027.[[11]](#footnote-12) We anticipate that the new federal standard will adopt an efficiency requirement for top-load washers equivalent to the current ENERGY STAR specification. The ENERGY STAR specification is one of four efficiency levels analyzed in the Technical Support Document published as part of the DOE clothes washer rulemaking, along with a lower, “gap fill” level and two higher efficiency levels. Assuming the federal standard update adopts the current ENERGY STAR level, we anticipate that market share of models meeting the specification will grow to 100% by the time the standard takes effect.

# With-Program Market Share Estimates

In addition to estimating baseline market shares, Apex forecasted market share of RPP-qualified products with program incentives available. Our forecasting approach for with-program market shares largely paralleled the phased approach we used to forecast the natural market baselines, as summarized below:

* **Phase 1:** We assume with-program market share trends will continue in a linear fashion for up to three years from the beginning of the forecast period. These linear forecasts extend market share trends from retailer-reported sales data from ComEd’s entry into the RPP program in June of 2020 through December of 2021.
* **Phase 2:** As discussed above, given the uncertainty of predicting market trends into the future, we assume market share values will stabilize beginning three years after the start of the forecast period.
* **Phase 3:** We use the same assumptions regarding timing and stringency of federal efficiency standard updates and ENERGY STAR specification revisions in with-program forecasts as in baseline forecasts.[[12]](#footnote-13)
* **Phase 4:** As in baseline forecasts, we assume that market share growth will reflect the relationship between the program qualification level and the new specification or standard.

For each product, we developed three with-program market share scenarios, reflecting different levels of program influence. As described in Table 2, we developed these scenarios using a consistent approach across product types, with the exception of ETA refrigerators. Because refrigerators and freezers were officially eligible for the ETA only during 2020 and 2021, we do not anticipate market share will continue to grow in the same way it would for a specification that remained active. Our max forecast predicts market share will continue to grow through 2022 before stabilizing, while our average forecast predicts market share will stabilize with the end of the award period in 2021.

Table 2: With-Program Market Share Scenario Approach

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| Forecast Scenario | General Approach | Adaptation for ETA Refrigerators |
| Max | Forecast based on reported sales data for Jun 2020 – Dec 2021, using 4-phase process described above. | Ends Phase 1 in Dec. 2022. |
| Average | Midpoint between annual baseline market share and max forecast market share | Uses same forecast process as max scenario, but ends Phase 1 in Dec. 2021. |
| Low | Midpoint between average forecast and baseline forecast | None |

# Unit Sales and Energy Savings Forecast

Apex used the forecasted natural market baseline and with-program market share forecast scenarios, along with a forecast of anticipated annual unit sales volumes and unit savings values, to predict electric energy savings attributable to the ComEd ESRPP program. This section describes the logic and assumptions underlying these savings forecasts. We first define each of the unit and energy savings forecasts equations and then follow with descriptions for each of the primary components used in the equations.

As detailed below, we opted for constant values in some cases. We note that while in many cases, shifts in these variables are possible, and could impact ESRPP savings, we determined that the additional uncertainty introduced by attempting to forecast changes in these elements outweighed the potential benefits of incorporating those changes into the model.

## Unit Sales

Apex calculated predicted total qualified unit sales volumes each year under a natural market baseline, and max, average, and minimum with-program scenarios based on Equation 1, below. Hyperlinks (hover, use CTRL and select item with mouse) are provided to the relevant description/definition associated with the newly defined components in each equation below.

Equation 1: Total Qualified Sales Volume

*Total Qualified Sales Volume*

=

*Market Share*

x

*Total Market Size*

x

*Configuration Share*

We then calculated the volume of qualified sales passing through ESRPP participating retailers based on estimates of the share of total sales passing through ESRPP retailers (Equation 2).

Equation 2: Qualified Sales Volume Sold Through ESRPP Retailers

*ESRPP Retailer Sales Volume*

=

*Total Qualified Sales Volume*

x

*ESRPP Retailer Market share*

We calculated the gross volume of qualified sales attributable to ESRPP using the negotiated share of qualified sales occurring in non-participating retailers attributable to ESRPP (Equation 3).

Equation 3: ESRPP Gross Sales Volume

*ESRPP Gross Sales Volume*

=

*With Program Total Qualified Sales Volume*

+(

-

*With Program ESRPP Retailer Sales Volume*

)x

*Share of Non-Participant Sales Attributed to ESRPP*

*With Program ESRPP Retailer Sales Volume*

Finally, we calculated net sales attributable to ESRPP by deducting baseline sales and units sold through ComEd’s downstream Retail Appliance Program (RAP) that meet ESRPP qualification criteria and could be attributable to the ESRPP program from the net total (Equation 4).

Equation 4: ESRPP Net Sales Volume

*ESRPP Net Sales Volume*

=

*ESRPP-qualified sales attributable to RAP in ESRPP retailers*

-(

+

*ESRPP-qualified sales attributable to RAP in non-ESRPP retailers*

x

*Share of Non-Participant Sales Attributed to ESRPP*

)-

*ESRPP Gross Sales Volume*

*Baseline Total Qualified Sales Volume*

The market share inputs reflect the natural market baseline as well as the max, average, and low with-program forecasts, as described above. The following sections detail the remaining inputs to these calculations.

### Total Market Size

To estimate total market size, we drew on initial market size estimates that NEEA provided to ComEd. NEEA generated these estimates by applying the share of US households in ComEd territory to national shipment data.[[13]](#footnote-14) Our forecast assumed that market size would increase annually based on new housing construction, drawing on a housing completions forecast provided by ComEd.[[14]](#footnote-15) We applied household penetration of washers or refrigerators by housing type (single family vs. multifamily) from 2020 RECS data to the number of forecasted housing completions to estimate annual growth in market size in ComEd territory.

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| **Research Question** | **Baseline Implication** |
| What, if anything, are the main drivers of sales beyond equipment replacement and new construction? Are they likely to impact qualified products any differently from non-qualified products? | Changes the sales volume of qualified products (either through trends related to qualified product uptake specifically or general changes in market size) will impact the total energy savings the program generates. To the extent a forecast can reliably incorporate these trends, it will increase the accuracy of savings estimates. |

### Configuration Share

We drew on NEEA’s analysis of the share of clothes washer sales that are top-load vs front-load and the share of refrigerator sales that are bottom-mount, side-mount, and top-mount.[[15]](#footnote-16) We assumed that these configuration shares would remain constant. Front-load washers gained market share as they first entered the US market before subsequently losing market share as some consumers had negative experiences with early models. At this point we consider front-load washers to be a largely mature technology and anticipate that shares of front- vs. top-load units will stabilize. This is consistent with the assumptions in the Technical Support documents produced for DOE to support the federal efficiency standard revision for washers that is currently underway.[[16]](#footnote-17) Likewise, side-mount refrigerators have gradually lost market share to top- and bottom-mount units, but we anticipate limited capacity for these shifts to continue. This is also consistent with the approach taken in DOE’s Technical Support document for refrigerators.[[17]](#footnote-18)

|  |  |
| --- | --- |
| **Research Question** | **Baseline Implication** |
| How, if at all, is uptake of different product types or configurations likely to shift over time? | The energy savings resulting from selecting a program-qualified model over a baseline model may differ between product types and configurations. In addition, some product types or configurations (like front-load washers) may fall outside of the program’s scope. Thus, accurately predicting shifts in market share of product types or configurations can increase the accuracy of energy savings forecasts. However, efforts to predict these trends without a strong rationale could introduce additional uncertainty into a savings forecast. |

### ESRPP Retailer Sales Volume

We assume the percent of sales going through retailers participating in ComEd’s RPP program versus non-participating retailers would remain constant. The ESRPP program is not currently seeking to expand its base of participating retailers, and we have no reason to believe the market share of participating retailers will change significantly.

### Share of Non-Participant Retailer Sales Attributed to ESRPP

In a competitive appliance market, retailers will react to shifts in the strategies of their competitors. Non-participating retailers may respond in a variety of ways to ESRPP retailers’ changes in assortment or promotion strategies related to qualified products, and those responses may have varying impacts on the share of qualified products non-participating retailers sell. In response to this complexity, in 2021, ComEd and its evaluators agreed to attribute 50% of the expected lift in qualified sales among non-participating retailers to the ESRPP program. Our projections assumed no change in this share, as it is primarily a policy decision.

### ESRPP-Qualified Sales Attributable to Downstream Program

Apex used a linear forecast based on reported RAP rebate volumes and net-to-gross ratios for the years 2018-2021 to forecast downstream incentive uptake through 2030. We adjusted these forecasted sales volumes to account for differences in qualification criteria between RAP and ESRPP, as summarized below:

* **Refrigerators:** ComEd has defined more stringent efficiency levels for ESRPP refrigerator incentives than RAP incentives, providing ESRPP incentives only for the subset of ENERGY STAR products that also meet the ESME or ETA specifications. Apex analyzed RAP program data for the years 2019-2021 to assess the distribution of rebated products by configuration and efficiency tier and applied the resulting shares in our forecast.
* **Clothes Washers:** While RAP provides rebates for all ENERGY STAR clothes washers, ESRPP incentives apply only for top-load washers. Analysis of RAP program data found that top-load models account for approximately 50% of rebated models.[[18]](#footnote-19)

Our analysis of RAP data also assessed the share of rebated units likely to have been sold through ESRPP participating retailers.[[19]](#footnote-20) We found that approximately 90% of RAP refrigerators and clothes washers were sold through ESRPP retailers and applied those percentages in our calculations.

## Energy Savings

Apex applied per-unit savings estimates provided by NEEA to the ESRPP net sales volume for each of the with-program scenarios to forecast ESRPP energy savings. We used effective measure life (EUL) estimates from the Illinois TRM (V10) to calculate CPAS savings. We assumed per-unit savings values and EULs would remain constant throughout the forecast period.

# Results

Example forecast results are presented below for top-load clothes washers and top-mount ESME refrigerators. The remainder of the refrigerator bins results are included in the accompanying worksheet, “*Apex RPP Unit Volume and Savings Forecast\_V3.xlsx*’”.

## Refrigerators

Figure 4 below presents the forecast results for top-mount ESME refrigerators. RPP-influenced sales ramps up into 2024 and then declines approaching 2026. The entirety of the top-mount refrigerators will meet ESME requirements due to ENERGY STAR revisions by 2027, as noted above.

Figure 7: Projected ESME Top Mount Refrigerator Sales Volumes

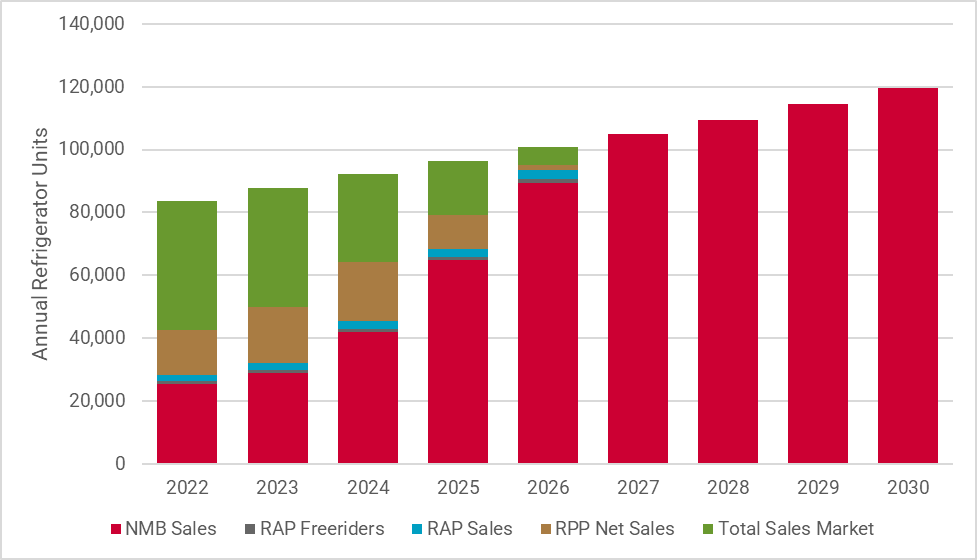


Table 3 shows the first year annual and CPAS lifetime savings (in MWh) for top-mount ESME refrigerators resulting from RPP program influence.

Table 3: Top-Mount ESME Savings Projections

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Uptake Scenario | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| Net 1st Yr MWh | Max Potential | 1,007 | 1,289 | 1,211 | 739 | 219 | 0 | 0 | 0 | 0 |
| Avg. Potential | 608 | 761 | 796 | 451 | 72 | 0 | 0 | 0 | 0 |
| Low Potential | 280 | 365 | 451 | 165 | 0 | 0 | 0 | 0 | 0 |
| CPAS MWh | Max Potential | 1,007 | 2,295 | 3,506 | 4,245 | 4,464 | 4,464 | 4,464 | 4,464 | 4,464 |
| Avg. Potential | 608 | 1,369 | 2,165 | 2,616 | 2,689 | 2,689 | 2,689 | 2,689 | 2,689 |
| Low Potential | 280 | 645 | 1,096 | 1,261 | 1,261 | 1,261 | 1,261 | 1,261 | 1,261 |

## Top-Load Clothes washers

Figure 5 below presents the forecast results for top-load clothes washers. RPP-influenced sales ramps up into 2025 and then declines into 2027. The entirety of top-load clothes washers will meet ES requirements due to ENERGY STAR revisions by 2028, as noted above.

**Figure 8: Projected Top Load Clothes Washer Sales Volumes**

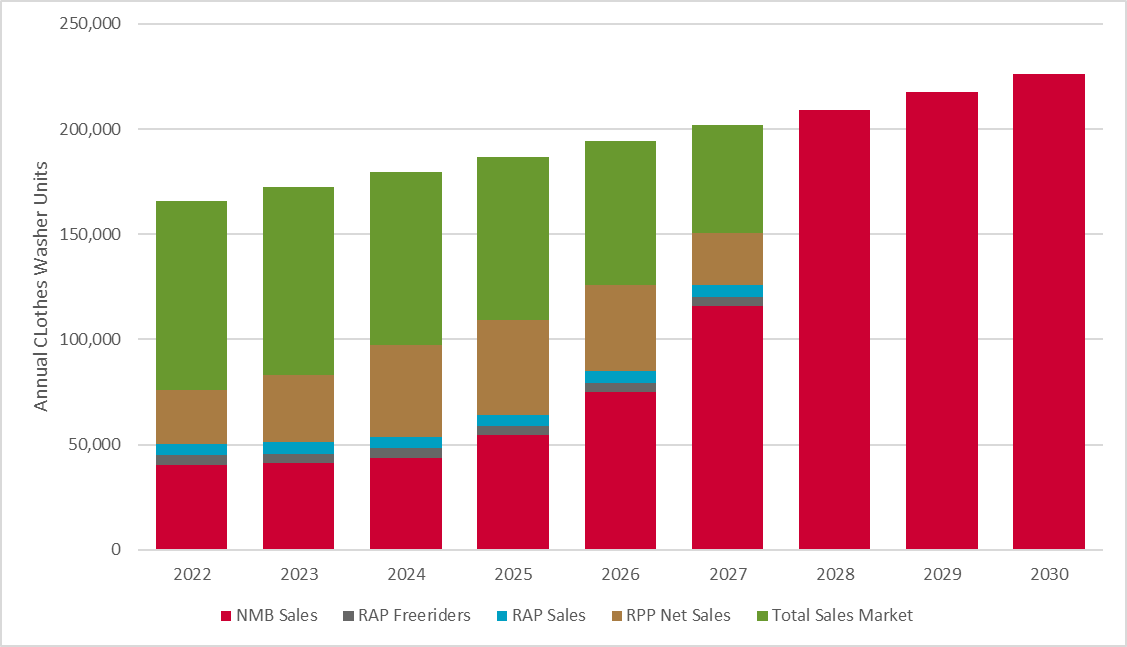


Table 4 shows the first year annual and CPAS lifetime savings (in MWh) for top-load clothes washers resulting from RPP program influence.

**Table 4: Top Load Clothes Washer Savings Projections**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Uptake Scenario | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| Net 1st Yr MWh | Max Potential | 3,166 | 4,139 | 5,050 | 5,375 | 4,959 | 2,933 | 0 | 0 | 0 |
| Avg. Potential | 2,084 | 2,632 | 3,557 | 3,688 | 3,357 | 2,032 | 0 | 0 | 0 |
| Low Potential | 1,543 | 1,878 | 2,811 | 2,844 | 2,555 | 1,581 | 0 | 0 | 0 |
| CPAS MWh | Max Potential | 3,166 | 7,305 | 12,355 | 17,731 | 22,690 | 25,623 | 25,623 | 25,623 | 25,623 |
| Avg. Potential | 2,084 | 4,716 | 8,273 | 11,961 | 15,318 | 17,349 | 17,349 | 17,349 | 17,349 |
| Low Potential | 1,543 | 3,422 | 6,232 | 9,076 | 11,631 | 13,213 | 13,213 | 13,213 | 13,213 |

# Areas for Future Research

The appliance market characterization and projection described in this Energy Savings Framework (ESF) document provides a best-efforts estimate of current (2022 Program Year) RPP savings for ComEd. Market Transformation Program savings projections will always include some uncertainty, but additional research can improve the confidence of the Illinois EE community that the savings are based on a deeper understanding of market fundamentals that are consistent with the experience and viewpoints of business and technical experts in the specific RPP energy efficient appliance industries.

In addition to the ESF, additional research can improve the understanding of how the RPP Program is influencing decisions in the market (and ultimately resulting in increased EE product market share). This research can result in 1) increased confidence that the program is having the intended impact relative to the Preponderance of Evidence standard, and 2) insights into effective program design improvements that can increase market impact.

In 2023, additional research will be conducted through the following efforts:

1. Guidehouse, in conjunction with ComEd and Illinois stakeholders, will recruit an Expert Judgement Panel (EJP). This panel will be interviewed for their perspectives on a variety of issues that are relevant to the RPP Program Design (Logic Model) and Energy Savings Framework.
2. RPP Program participating retailer surveys are conducted by NEEA annually to gauge program influence and identify potential program improvements.
3. Guidehouse will conduct evaluation of RPP Program Market Progress Indicators (MPI’s). This research was first conducted in 2022. The goals of the MPI research are to establish that the RPP Program is working in the market as intended and to assess the program impact based on the Preponderance of Evidence standard.
4. There may be other research avenues that are determined to be useful to pursue by RPP utilities or others.

The following specific issues have been identified that additional research seeks to help address:

1. The best projection for Natural Market Baseline (NMB) without the program. These issues include:
   1. Understanding how the product attributes of energy efficient appliance models translate into value for not just the customer, but for other supply chain actors. Further, how that value motivates customers and supply chain actors to change behaviors that would accelerate the adoption of EE models.
   2. Understanding the recent market history of clothes washers and refrigerators to be able to more confidently project the near-term (next 3 years) trajectory of energy efficient models.
   3. Understand the factors that determine natural market cycles for new appliances. How long should the cycle be expected to last and what factors shorten or extend it?
   4. Understand the factors that determine how new appliances increase sales and gain market share. What mathematical models best reflect the anticipated market trajectory and why?
   5. Understand at a more fundamental level how supply chain actors interact with each other and customer decisions and what are the components of the influence that each actor has upon another.
2. According to the EPA: “Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain.” Reducing and reporting Scope 3 emissions are a relatively new driver for corporations, including the participating RPP retailers (and, potentially, the non-participating retailers). It is expected that 2023 research will more thoroughly determine the role of Scope 3 emissions reduction and reporting as an influence on appliance retailer behavior and EE appliance sales.

Research conducted in 2023 would also look to improve the general understanding of EE product supply chains, markets and customers. More detailed research questions will be developed as each research effort is scoped in more detail. Those research questions would include the following:

* Is it reasonable to assume that the natural state of appliance markets is for the market share of products meeting ENERGY STAR and/or above ENERGY STAR efficiency tiers to increase?
* Is it reasonable to extrapolate historical data on efficient market shares to predict baseline uptake? If so, for how many years is it reasonable to assume that a linear trend will continue?
* To what extent is retailers’ increased focus on carbon emissions, and specifically their Scope 3 carbon reduction goals, likely to increase market share of efficient products?
  + - How might these efforts be different if the retailers were not participating in ESRPP?
    - What impact would these efforts have on uptake of products meeting above ENERGY STAR efficiency specifications, given that retailers typically do not recognize these levels?
* What other market trends might impact the availability of efficient products? (This could include both trends in consumer demand for certain features or configurations, and supply side considerations like labor costs, automation of production, availability of materials/components, etc.)
* For each product what are the thresholds above and below which market share of efficient products is unlikely? (What share of the market is unlikely to pursue energy efficiency? What share is likely to prioritize it above all else?)
* What is the likely impact on market share of products meeting an efficiency specification when that specification goes from an above ENERGY STAR level like ESME to become the base ENERGY STAR level? How much is market share likely to increase? How soon after the ENERGY STAR specification update?
* How, if at all, is uptake of different product types or configurations likely to shift over time?
* What, if anything, are the main drivers of sales beyond equipment replacement and new construction? Are they likely to impact qualified products any differently from non-qualified products?

1. Note, in terms of theories of diffusion of innovations, this baseline approach assumes that most ESRPP products (with the exception of those receiving new specifications, described below), are in the early- and late-majority adoption phases. Most ESRPP-qualified products represent incremental increases to the efficiency of existing products, rather than innovative, new products. [↑](#footnote-ref-2)
2. Linear trend forecasting is consistent with Guidehouse evaluation logic. [↑](#footnote-ref-3)
3. All the top-mount refrigerators in ComEd’s RPP dataset had annual energy consumption values well below the 637 kWh/year threshold, with none greater than 550 kWh/year. [↑](#footnote-ref-4)
4. It is possible to identify models meeting the ESME 2019+ efficiency requirements in historical data using energy consumption values. However, growth in market share of models meeting the specification’s requirements accelerated after the specification was announced, likely because the specification provided a specific target for manufacturers to incorporate in their designs. Thus, market share prior to the specification provides limited insight into baseline uptake once the specification was announced. [↑](#footnote-ref-5)
5. The current test procedure measures refrigerator energy consumption at a single ambient temperature of 90 degrees Fahrenheit. This steady-state test at a relatively extreme ambient temperature does not effectively capture advanced adaptive compressors’ ability to modulate the compressor’s power in response to more subtle temperature changes. [↑](#footnote-ref-6)
6. Apex Analytics. June 2022. *Refrigerator and Freezer Influence Assessment and Baseline Review*. Prepared for NEEA. Available at: <https://neea.org/img/documents/Refrigerator-and-Freezer-Influence-Assessment-and-Baseline-Review.pdf> [↑](#footnote-ref-7)
7. DOE published a final rule on a revised test procedure for refrigerators in November of 2021 and gathered public comments on its technical analysis around potential revised refrigerator standards in December 2021. [↑](#footnote-ref-8)
8. Past updates to federal efficiency standards for refrigerators have taken effect between three and four years after adoption. We assume three years as a conservative estimate. [↑](#footnote-ref-9)
9. US Department of Energy. October 2021. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Refrigerators, Refrigerator-Freezers, and Freezers.* Available at: <https://www.regulations.gov/document/EERE-2017-BT-STD-0003-0020> [↑](#footnote-ref-10)
10. The current ENERGY STAR specification (V5.1) requires models to have an annual energy consumption value approximately 10% below the maximum allowed under the current federal standard, while the ESME 2019+ specification requires energy consumption values approximately 20% below the federal standard requirement for non-top mount models. [↑](#footnote-ref-11)
11. Historical updates to federal efficiency standards for clothes washers have taken effect between one and six years after adoption, with most updates (3 of 5) taking effect between three and four years after adoption. We use three years as a reasonable, if conservative, assumption. [↑](#footnote-ref-12)
12. We recognize that ESRPP sponsors are often active in federal standard and ENERGY STAR specification update processes and there is potential that the program could accelerate adoption, increase standard or specification stringency, or both. Thus, an assumption that standard and specification timing and efficiency would be the same under the program as in a baseline case risks underestimating program-attributable energy savings. However, we feel the uncertainty resulting from the difficulty of predicting program influence on standard or specification stringency and/or timing and its impact on market share, and ultimately program-attributable energy savings, outweighs the benefit of including potential program influence on specifications and standards in these forecasts. [↑](#footnote-ref-13)
13. NEEA’s calculation also uses RECs data to adjust for any differences in household penetration between the East North Central region, which includes Illinois, and national penetration. [↑](#footnote-ref-14)
14. While we recognize that factors beyond new home construction likely influence annual appliance sales, we determined that the uncertainty of forecasting those drivers outweighs the benefit of including them in our estimates. [↑](#footnote-ref-15)
15. The assumed percentage distribution of product types was derived from the NEEA analysis, found in the “Illinois Sales Estimates” worksheet of the “NEEA 2021 Savings Report\_ComEd\_20220212.xlsx” file. [↑](#footnote-ref-16)
16. Available at: <https://downloads.regulations.gov/EERE-2017-BT-STD-0014-0030/content.pdf> [↑](#footnote-ref-17)
17. Available at: <https://www.regulations.gov/document/EERE-2017-BT-STD-0003-0020> [↑](#footnote-ref-18)
18. The share of top-load washers receiving RAP rebates (50%) is lower than our configuration share estimate for top-load washers (63%). This difference reflects a higher ENERGY STAR market share (and thus greater proportion of RAP rebate-eligible products) among front-load washers than top-load washers. [↑](#footnote-ref-19)
19. There is some uncertainty in these estimates, as we were unable to determine which independent retailers are members of Nationwide Marketing Group (an ESRPP participant that offers purchasing for independent appliance retailers). [↑](#footnote-ref-20)