Non-residential Lighting Distributor Sales Data Gaps

BONNEVILLE POWER ADMINISTRATION

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# Introduction

Through its Non-residential Lighting Market Model (the model), the Bonneville Power Administration (BPA) tracks how total non-residential lighting energy consumption changes over time. The model is an important regional resource in understanding non-residential lighting energy consumption changes and market trends over time. To support the model, BPA partners with the Northwest Energy Efficiency Alliance (NEEA) to collect sales data from regional lighting and electrical distributors annually.

This report describes the process that Cadeo (the research team), BPA, and NEEA, used to collect and analyze distributor sales data for the non-residential lighting market in the Pacific Northwest. It also discusses the resulting data’s strengths and uncertainties. The research team has organized the content of this report into the following sections:

* Data Summary and Representativeness
* Outreach and Data Collection
* Data Structure
* Summary of Data Gaps and Sources of Uncertainty
* Extrapolation Methodology and Findings
* Recommendations for Addressing Data Gaps

# Data Summary and Representativeness

## Data Summary

During the 2023 non-residential lighting data collection effort, the research team gathered distributor data from 2021 to 2022. A total of 24 distributors submitted data to the research team in 2023. The research team merged these data with data collected in previous studies spanning the years 2013 to 2020, resulting in a data set spanning 2013 to 2022.

## Data Representativeness

The research team reviewed participation data for 2022 and the cumulative data collected since 2013 to determine the extent that the data set accurately represents the non-residential lighting market. This review had two components: representation within specific segments (e.g., individual business models) and representation across channels (e.g., sales beyond traditional distributors). The following section uses two figures to demonstrate data representativeness and outlines possible data collection and analysis improvements that could lead to more accurate representation in the future.

### Representativeness Findings

Figure 1 shows the mix of the 24 participating distributors by relative size, distribution area, and business model compared to the mix of 48 participating distributors and extrapolated[[1]](#footnote-1) distributors represented in the 2022 data set and the distributor population mix in the Pacific Northwest. Appendix 1: Summary of Distributor Business Model Types describes each business model type in detail.

Figure : Characteristics of Distributors Submitting Data Compared to the Pacific Northwest Distributor Population

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Source: 2023 BPA distributor database (population)

Population data comes from BPA’s database. In 2023, the research team conducted outreach and web research to comprehensively update the distributor database. The research team collected updated participant distributor information through the standardized survey tool distributors use to submit sales data as well as outreach following data submission to confirm key information like business model type. For nonparticipating distributors, the research team conducted web searches for participating firms and populated the relevant firmographic details, like number and locations of branches, in the database. These updates were not comprehensive, as the research team was limited to what information was available on the web. However, these changes refined the number of distributors represented in the database and the population distributions in Figure 1 and shares of branch locations by state in Figure 2 below.

Figure 2 shows the distribution of lamp shipments and known branches for participating distributors by state. Figure 2 also shows the share of total commercial building floor space by state, as quantified by the regional 2019 Commercial Building Stock Assessment (CBSA). The research team observed these metrics within and between each state to determine whether sales data volume reasonably correlated with expected market size across the four-state region.

Figure : Distributor Lamp Shipments, Floor Space, and Branches by State, 2022

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*Note: Total percentages may not add up to 100% due to standard rounding conventions*

Source: 2023 distributor sales data analysis, 2019 CBSA floor space by state, and 2023 BPA distributor database

### Representativeness Analysis

The research team found some variations in the distribution of characteristics in the sample compared to the region’s population. These variations are within an acceptable range and therefore the research team did not make any weighted adjustments to the data. With the goal of continually narrowing the gap between the data set and the actual regional population, this section outlines possible data collection and analysis improvements within the following topics: distributor characteristic mix, geographic coverage, participation, and specific segments.

#### Distributor Characteristic Mix

Figure 1 shows the mix of participating distributors in 2023 by relative size, distribution area, and business model compared to the extrapolated distributor mix and the distributor population mix in the Pacific Northwest. The research team uses these comparisons to evaluate whether the participating distributor pool is reasonably representative of the total population of distributors in the region, both for 2022 data (participant sample) and across all study years (extrapolated sample). Comparing the distributor mix from the extrapolated sample to the population confirms that over time, the collected and extrapolated data set is representative of the distributor population.

Variation in representativeness between the participant sample and the population highlight opportunities for the outreach team to refine outreach strategies for certain distributor types. The research team found that the collected data from participants in 2023 include a mix of sizes, geographic scopes, and business models that are reasonably proportional to the population with the following variations:

* A higher portion of small distributors and a smaller portion of medium and large distributors submitting sales data, relative to the population.
* A larger portion of local and regional distributors and a smaller portion of national distributors submitting sales data, relative to the population.
* A smaller portion of full-line distributors and a larger portion of lighting consulting distributors submitting sales data, relative to the population.

As shown in Figure 1, the mix of business models in the population differed from the mix of business models that submitted data. In 2016, the research team reviewed the sales data in these categories and found that some sales trends (e.g., the portion of sales that are LED and the portion of sales that are lamps versus fixtures) may correlate with the business model types. However, the research team and BPA determined that weighting data submissions to reflect the relative presence of these three business models in the market may not improve the accuracy of the sales data because there is too much uncertainty around nonparticipating distributors’ sales trends and business models. The research team did not find sufficient new data during 2023 data collection to change this conclusion.

Many of the new distributors participating since 2019 have been lighting consultants selling only LEDs, which increased the representation of this business model type. This trend could either indicate that lighting consulting businesses are becoming more common in the region or that the participating distributor pool overrepresents this business model. If this business model is overrepresented, this could lead to a bias toward efficient technologies in the data. The research team will monitor this trend in future studies to determine whether any adjustments to representativeness are needed.[[2]](#footnote-2) The research team will also consider changes to the outreach strategy to bring the sampled full-line distributor portion more in-line with the population portion.

#### Geographic Coverage

As seen in Figure 2, lamp sales collected from 2022 are approximately proportional to each state’s share of regional commercial floor space and distributor branches. The research team used floor space and branches as comparisons because these two metrics should nearly correlate with sales.

Figure 2 illustrates that the proportionality of sales versus floor space and branches is a close but imperfect match. With the updates to the distributor database, the research team identified an increase in branch locations in Idaho, mirrored by an increase in sales data collected from Idaho branches, beginning in 2018 and continuing through 2021. The result is a higher percentage of reported sales and branch locations in Idaho, proportionally, than commercial floorspace in Idaho. Despite this slight divergence, other states’ metrics are approximately proportional, confirming that the research team has reasonable representation of distributors and their data.

#### Participation

Participation in 2023 (24 distributors) was the same as participation in 2021. In 2023, one participant from the 2022 data collection effort did not participate because of time constraints. Nonparticipating distributors’ sales may be different from participating distributors’ sales. This would create nonresponse bias of an unknown direction and magnitude. However, the research team attempted to minimize this bias by performing repeated outreach. The research team attempts to connect with distributors at least three times before ceasing outreach and uses an incentive to encourage participation.

##### Specific Segments

The research team assumes submitted data from full line, maintenance, repair, and operations (MRO) and online, and lighting consultant participants is representative of total sales within these distributor types in the market. To validate this assumption, the research team reviewed this year’s participating distributors’ sales mixes by business model to determine whether participating distributors within a business model type show similar sales patterns. The research team analyzed participating distributors’ sales mixes within each business model type and found that participating distributor’s sales mixes within each segment are generally similar.[[3]](#footnote-3) This supports the assumption that the submitted data are representative within each business model category.

The research team finds the representativeness of this year’s data set acceptable and comparable to past years. The research team will continue to work to address representation gaps through the outreach recommendations covered in the next section. These recommendations will allow the research team to strategically target distributors in underrepresented or hard-to-reach segments using lessons learned over the previous study years.

# Outreach and Data Collection

The research team, contracted by NEEA, worked in collaboration with Evergreen Consulting (Evergreen) to facilitate distributor outreach. The research team conducted outreach and recruited distributors to participate in the data collection effort.

The research team’s strategy followed these general steps:

1. One of the outreach organizations contacted distributors and asked them to participate, providing an information packet that BPA developed. The outreach organization offered a monetary incentive to participating distributors.
2. If the distributor agreed to participate, the research team sent the distributor the sales data collection form, instructions for submitting data securely, and an optional nondisclosure agreement.
3. The research team logged all communication in a distributor data tracker and provided outreach updates in a weekly outreach team meeting.

NEEA’s continued involvement in data collection and Evergreen’s outreach to existing contacts were essential to the outreach team’s success. In the last four years of the study, the research team reached out directly to select long-term participants who proved responsive in past studies. The research team aimed to organize outreach assignments to reduce the number of touchpoints for distributors and streamline the total number of outreach steps. NEEA, Evergreen, and the research team discussed and agreed on all outreach assignments at the beginning of each study.

## Final Outreach Disposition and Results

Table 1 provides details on the final disposition for the distributors included in the research team’s outreach.

Table 1: Summary of Distributor Outreach, Final Disposition

|  |  |
| --- | --- |
| Category | Number of Distributors |
| Total distributors included in outreach\* | **64** |
| Distributors submitting data | **24** |
| * Repeat participants | 23 |
| * New participants | 1 |
| Distributors declining to participate | **15** |
| * Lack of time and/or interest | 12 |
| * Data reporting limitations | 3 |
| * Prohibited by company policy | 0 |
| Distributors unresponsive to outreach | **25** |

\*Includes individual distributor branches that operate independently  
Source: 2023 distributor outreach tracking

This year, 24 distributors submitted data—the same as in 2022. Of the 24 participants from the previous year, one did not participate this year. The outreach team assumes the reason for nonparticipation is lack of time in this case. However, the research team successfully re-recruited one participant that had historically participated but did not participate last year. This year, the number of distributors who declined to participate (15) is higher than last year (12). This increase is partially due to the outreach team increasing outreach efforts to understand distributors’ reasons for nonparticipation. The outreach team was more successful at contacting typically unresponsive distributors this year to clarify their reason for nonparticipation. These distributors declined either by ceasing to respond to outreach efforts or citing a lack of time or interest. Three of the declining expressed concerns about data security as a primary limitation of participating.

# Data Structure

In each data collection effort, distributors have the option of submitting sales data in two different formats:

* The standardized survey tool provided. All 24 participants in 2023 submitted data using the standard data collection tool.
* A custom protocol developed through discussions with the distributor to understand and work around data reporting limitations. No distributors participated using a custom protocol in 2023.

Between 2019 and 2021 (data years 2018 to 2020), NEEA worked with distributors that participated in various initiatives to streamline requests by requesting raw data extracts of all product sales from some of their partner distributors. These “data dumps” represented full-year, full-category data (except for controls) for participating distributors, not just linear fluorescent and tubular LED (TLED) data. This change was part of NEEA’s ongoing development of a distributor platform that supports distributor partnerships on multiple initiatives. Starting in 2021, NEEA did not collect data dumps from distributors, so the research team discontinued the data dump option for participating distributors.

The research team merged the data collected from both data submission formats with historic data submissions from 2013 to 2021 in a single SQL server database. Collectively, these data span sales from 2013 to 2022. The research team used five fields to organize the sales data by lamp and luminaire characteristics, which Table 2 summarizes.

Table 2: Lighting Product Description Fields Used in Database

|  |  |
| --- | --- |
| Field Name | Description |
| Lighting\_Technology\_Type | The technology category includes either the lighting technology type (e.g., LED, linear fluorescent, etc.) or controls. |
| General\_Category | This field lists the lamp shape (e.g., T8, T5, A-Type, Reflector, etc.), fixture type, or type of high-intensity discharge (HID) lamp (e.g., high-pressure sodium, metal halide, or mercury vapor). |
| Dimension | Where applicable, this field provides the length or dimensions of the lamp or fixture. This field primarily applies to linear lamps and fixtures (e.g., 4-foot and 8-foot lamps). |
| Subcategory | This field provides additional detail on lamp and fixture characteristics. Details may include a specific wattage, wattage range, lumen output, or more specific lamp shape (e.g., MR16 within the “Reflectors” general category). |
| Base\_Type | This field specifies whether the product is a fixture; for lamps it indicates whether the base type is screw-in, mogul-base screw-in, or pin. |

Appendix 2: Summary of Unique Database Category Entries provides a complete list of possible entries for these fields, and Appendix 3: Detailed Data Cleaning Approach describes the analysis process.

Under the 2013 data collection effort, distributors provided data back to 2010. But, for the 2023 analysis, the research team focused only on sales in years 2013 through 2022. Data quality and number of participants increased significantly in 2013 due to expanded outreach and revisions to the data collection instrument.

# Summary of Data Gaps and Sources of Uncertainty

The research team identified the following data gaps and sources of uncertainty based on the 2023 study participation and analysis:

* **Inconsistent distributor participation contributes to uncertainty but that uncertainty can be mitigated.** Changes in distributor participation year over year create gaps in reported sales data. The research team can fill these gaps if the distributor participates again in a future year (e.g., if a distributor participated in 2021, did not participate in 2022, and then participates in 2023, the research team will ask that distributor to supply the missing year of data). Additionally, the research team has developed an extrapolation approach, discussed below, to estimate sales for distributors who contributed data in the past but did not contribute data in every year. The extrapolation process allows the research team to estimate missing distributors’ sales based on historic market shares and other participants’ sales. This allows the research team to leverage data from past and present participants but does not fully resolve the uncertainty due to limited data from some distributors.
* **Collected sales data only represent the distribution sales channel.** Market intelligence gathered by the research team indicates that the distribution channel is the largest sales channel for non-residential lighting. However, the sales data collected does not include sales from the following channels:
  + **National Account Distributors:** The research team did not collect sales data from any specialized national account distributors. Despite multiple attempts over previous study years to connect with national account distributors, the research team has yet to secure participation from any of them. Although some participating distributors serve national account customers among other types of customers, previous research on national accounts suggests that many national accounts get their lighting products from specialized distributors that serve national accounts exclusively. It is possible that some lighting consultants serve more national accounts than traditional full line or MRO and online, but the research team did not explore this possibility specifically as part of this study. If participation from lighting consulting distributors remains high in future studies, the research team will explore whether having increased lighting consulting representation impacts the representation of national account sales.
  + **Retailers:** The research team collected sales data from only one low-volume sales retailer, giving a small, nonrepresentative look into the retail channel. Through market intelligence gathered over previous study years and modeling efforts, the research team believes that the retail channel could represent a meaningful volume of non-residential lighting sales, particularly in the linear product technology categories. The research team has not had success in its efforts to collect sales data from other retail channels like Home Depot. In future years of the study, the research team will work to further define the size and importance of this sales channel as well as the sales mix of technologies sold through the retail channel.
  + **Online Sales Channels:** The research team did not collect sales data from any specialized online distributors or retailers, but some online sales are reflected in the collected data.One long-time online distributor stopped participating in the study in 2018, and since then the research team has been unable to collect data from this segment. In previous years, the research team determined through webinars and informal interviews with traditional distributors that most traditional distributors are attempting to reach the online sales channel both through their own online sales platforms and through partnerships with third-party vendors like Amazon. In 2021, the research team added questions to the standard data collection tool to ask what percentage of sales were from online channels and if these sales were from their own websites or through third-party vendors. In 2023, 7 of the 24 participants reported online sales. All distributors with reported online sales indicated that they included these sales in the sales reported through the standard data collection tool, indicating that the research team is already collecting online sales from participating distributors. Three additional distributors indicated that they offer product online through their websites but reported zero online sales, indicating that more distributors may be pursuing online sales channels. In future years of the study, the research team will work to further define the size and importance of this sales channel as well as the percentage of online sales within data already collected in this study.
* **The research team adjusted some reported sales data, with distributor verification, to account for residential sales.[[4]](#footnote-4)** For 2021 and 2022 sales data, all distributors indicated what percentage of their sales go to residential versus non-residential customers in the data collection tool. The research team confirmed with each distributor the split of sales and whether their reported sales included any residential sales. Distributors with both residential and non-residential sales confirmed the split between these sales and provided additional insights into which product categories contained residential sales. For these distributors, the research team normalized reported sales to only include non-residential sales.

# Extrapolation Methodology and Findings

## Extrapolation Methodology

To maintain consistency in the distributor database over time, the research team applied an extrapolation approach to leverage information submitted by nonparticipants in previous study years.[[5]](#footnote-5) Extrapolation provides a mechanism to use the best available information in any given year by projecting sales for previous study participants based on overall market trends and each participant’s past market activity.

In this year’s study, the research team applied the same methodology to extrapolate missing sales data for each combination of distributor and technology as in previous years. The research team leveraged distributor-specific sales data to inform the extrapolation process. One distributor submitted 2020 data, did not participate in 2022, then participated in 2023 and submitted 2021 and 2022 data. The research team updated previous extrapolation results for 2021 to incorporate this additional data submission.

The extrapolation methodology relies on two core assumptions:

1. Distributors that did not participate retained a similar market share within lighting technologies and categories (e.g., LED downlights) as they did in the previous year. In other words, distributors that did not participate experienced a similar trend in sales as the rest of the market within each technology and category. For example, if participants that submitted data for this study year (2022) and the previous year (2021) observed a 25% decrease in full-line compact fluorescent lamp (CFL) A-type lamp sales, then the research team assumed each nonparticipating distributor’s full-line CFL A-Type lamp sales decreased by 25% in 2022.
2. The mix of subcategories**[[6]](#footnote-6)** (lamp shape, wattage, and base type) for a given distributor remains consistent over time. For example, if a participating distributor’s sales show that in 2021 5% of full-line 4-foot T8 lamp sales are 28W lamps, the analysis assumes that 5% of the missing distributors’ 4-foot T8 lamp sales were 28W lamps in 2022.

At a high level, the extrapolation methodology is broken into three steps:

1. Identify distributors that participated in both the extrapolation year (i.e., 2022) and the previous year (i.e., 2021).
2. Calculate the year-over-year percentage change in sales within each technology category (e.g., LED a-type lamps) for the distributors that participated in both years (identified in step 1).
3. Apply the percentage change calculated in step 2 to each nonparticipating distributor’s previous year sales within each technology and category.

After extrapolating each nonparticipating distributor’s technology category sales, the research team applied each distributor’s subcategory breakdown to the extrapolated numbers using the distributor’s subcategory proportions from the previous year.[[7]](#footnote-7)

## Strengths and Weaknesses of Extrapolation Methodology

There is one main strength of the extrapolation process: **using historical data provides a more comprehensive and representative view of the market, regardless of participation.** Every year, the data set comprises collected data from participating distributors and extrapolated data from previous participants. This provides the research team with a more comprehensive and representative data set than only including participant data.

The research team leveraged past information to identify what products certain companies sell and estimate how much they sell within certain market segments. Over the course of the study, the research team collected sales data from 48 distributors. Of those, 24 are consistent participants with no extrapolated data in the 2022 data set (50% of participants). For the other 50%, extrapolation leverages current market trends and distributors’ historical data to predict sales for nonparticipants. This allows the research team to leverage the best available information to estimate market sales in each study year. The basic assumption is that the historical market share for nonparticipants will continue unless new evidence suggests otherwise.

Full-line distributors have decreased, and lighting consulting distributor participation have increased as a percentage of participants, but the extrapolation methodology allows the research team to represent a larger percentage of full-line distributor sales in the final extrapolated data set than what could be represented without extrapolated data.

One main weakness of the extrapolation process is that it **introduces uncertainty.** The extrapolation process applies the market’s sales trend for distributors who did not participate. As a result, the research team assumes that nonparticipating distributors possess the same sales trends and patterns as the rest of the market. The strategy is susceptible to inaccurate representations for specific distributors whose sales may differ from the overall market. Additionally, the assumption that each distributor’s subcategory mix remains stable over time could distort the extrapolated mix of subcategories if incorrect. **However, where possible, the research team mitigates this weakness by applying adjustments based on distributor-reported trends.**

To better quantify uncertainty resulting from the extrapolation process, the research team applied an uncertainty analysis to the extrapolated sales quantities in 2021.[[8]](#footnote-8) The uncertainty analysis found that though the extrapolation methodology used does introduce some margin for error and uncertainty in the final estimates of annual lamp sales, the error introduced appears small. The overall margin of error for each technology ranges from 2% to 22% when using a 90% confidence interval. The margin for error due to extrapolation is small enough to reinforce an understanding of directional trends (i.e., if a lighting technology is generally increasing or decreasing and at what magnitude) within most individual lighting technologies. Although uncertainty related to extrapolation will naturally increase over time as the percentage of extrapolated data increases, the results of the uncertainty analysis confirm a high degree of confidence in the extrapolated data.

## Extrapolation Findings

Table 3 shows the percentage of extrapolated data by year and technology from 2013 through 2022. The overall percentage of extrapolated data increases year over year. With each additional distributor that drops out of the study, their data requires extrapolation. Therefore, the cumulative amount of extrapolated data increases. Decreases in overall extrapolated data can occur if a distributor participates again after a period of nonparticipation.

Participation changes in 2021 and 2023 resulted in higher levels of extrapolation in 2020, 2021, and 2022 sales data than in previous years. Participation changes in 2021 impacted CFLs, halogens, high-intensity discharge (HID) lamps, and incandescents most directly. Participation changes in 2023 impacted all lighting technologies, but HIDs and incandescents were most impacted. The research team will conduct outreach specifically to address these changes in participation in 2024. While year-over-year extrapolation percentages are increasing, the total extrapolated data percentage in all years remains relatively low for all product categories.

The extrapolation percentage for linear fluorescents increased sharply between 2020 and 2021. NEEA’s Reduced Wattage Lamp Replacement (RWLR) initiative collected sales data on linear fluorescent and TLED lamps for all participating distributors through 2020. NEEA has ceased RWLR data collection, so 2020 was the last year of this study that included RWLR data. Several RWLR participants also participated in this study (i.e., submitted sales data for other technologies), but for some distributors, the research team only received the RWLR linear product (linear fluorescent and TLED) data.[[9]](#footnote-9) In 2021, eight distributors for which the research team had RWLR data did not participate in the data collection study. The research team therefore extrapolated these eight distributors’ sales of linear products in 2021 for the first time, resulting in an increase in the extrapolated percentage in this technology category.[[10]](#footnote-10)

Table : Percentage of Data Extrapolated by Year and Technology

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lighting Technology Type | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | All Years |
| CFL | 40% | 26% | 2% | 17% | 15% | 17% | 18% | 37% | 41% | 74% | 24% |
| HID | 7% | 4% | 1% | 8% | 10% | 11% | 13% | 24% | 27% | 74% | 12% |
| Halogen | 24% | 13% | 1% | 11% | 15% | 23% | 24% | 34% | 35% | 67% | 19% |
| Incandescent | 30% | 20% | 6% | 16% | 16% | 20% | 21% | 36% | 34% | 69% | 22% |
| LED | 22% | 13% | 13% | 18% | 22% | 23% | 26% | 37% | 37% | 60% | 33% |
| Linear Fluorescent | 25% | 5% | 7% | 5% | 11% | 12% | 14% | 15% | 45% | 82% | 19% |
| All Technologies | 26% | 11% | 6% | 11% | 16% | 18% | 21% | 30% | 39% | 64% | 25% |

Source: 2023 Distributor sales data analysis

# Recommendations for Addressing Data Gaps

Each year of data collection brings new insights and challenges as distributors submit additional data. This year, as in past years, the research team found distributor participation to reasonably represent the Northwest region, as reflected in the mix of distributor sizes, distribution areas of sales, and business model types. However, changes in participation over time create gaps in collected sales data. The research team will continue refining the outreach process to maximize distributor participation and fill existing data gaps caused by nonparticipation. The research team recommends the following refinements to the outreach process:

* **Increase efforts to reengage past participants, focusing on large, national, full-line distributors.** Over the last six years, several large, national full-line distributors who previously participated in the study have dropped out. These distributors largely declined to participate due to timing constraints related to day-to-day business obligations. For the next year of the study, the research team should focus on reengaging these large regional and national full-line distributors in the study. The research team recommends discussions, including in-person meetings where possible, among NEEA, the research team, and the distributor to underscore the distributor’s importance as a partner. In these discussions, the research team can offer options to ease the burden of participation, including extending data submission deadlines, developing custom data collection strategies, or increasing incentives. If past participants are unresponsive in the first month, the research team should engage other reasonable contacts at a given distributor to rebuild rapport with the unresponsive contact. Many unresponsive cases this year were impacted by staffing changes, so this process may result in an introduction to the new point of contact.
* **Develop an outreach strategy to address data security concerns among distributors.** Many distributors who declined in 2023 did so data due to security and sharing concerns. The research team takes extensive precautions to ensure data security, including nondisclosure agreements, secure data transfer, and aggregated anonymized reporting. Despite those measures, some distributors had concerns. The research team recommends increasing the emphasis on data security and secure data transfer protocols in distributor outreach in 2024 to assuage distributor concerns and increase comfort with the study among potential new participants.

# Conclusion

The collaboration between BPA and NEEA to collect annual sales data from regional lighting and electrical distributors ensures the Non-residential Lighting Market Model’s accuracy and its value as a regional resource for understanding market trends in the Pacific Northwest. BPA intends the model to serve as a valuable resource for stakeholders and decision-makers in the region, enabling them to make informed decisions and develop effective strategies for energy efficiency and conservation. Based on the data gaps and uncertainties discussed in this report and the recommendations for addressing these issues, BPA will continue data collection efforts with the aim to improve representativeness and enhance data quality to strengthen the accuracy and reliability of the model.

###### Appendix 1: Summary of Distributor Business Model Types

The Cadeo team (the research team) defines each business model as follows:

* **Full line:**
  + Traditional electric distributors selling all general electric products, including, but not limited to, scheduled regular maintenance orders.
  + Larger businesses that typically have in-house lighting and/or electrical staff.
  + Lighting is usually a small portion of the overall business.
* **Maintenance, repair, and operations and online:**
  + Primarily serve scheduled regular maintenance orders.
  + Often receive orders online or via email.
  + May sell a variety of products or just lighting.
  + Tend to have a higher proportion of lamps to fixtures in sales.
* **Lighting consultants:**
  + Small companies with a focus on energy efficiency projects.
  + May only sell LED products and lighting controls.
  + May sell only lighting or a variety of products.

###### Appendix 2: Summary of Unique Database Category Entries

Table 4 through Table 10 summarize the possible entries for the General\_Category, Dimension, Subcategory, and Base\_Type fields for each lighting technology type.

Table : Lighting Technology Type: Linear Fluorescent[[11]](#footnote-11)

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| T12 | 4-foot | 34W | Lamp |
| 4-foot | 40W | Lamp |
| 4-foot | U-Shape | Lamp |
| 4-foot | Other | Lamp |
| T8 - High Performance 800 Series or Better | 4-foot | 25W | Lamp |
| 4-foot | 28W | Lamp |
| 4-foot | 32W | Lamp |
| 4-foot | Other | Lamp |
| T8 - Standard 700 Series | 4-foot | 32W | Lamp |
| 4-foot | U-Shape | Lamp |
| 4-foot | Other | Lamp |
| T5 | 4-foot | 28W | Lamp |
| 4-foot | 54W | Lamp |
| 4-foot | Other | Lamp |
| T12 | 8-foot | Slimline | Lamp |
| 8-foot | High Output | Lamp |
| 8-foot | Other | Lamp |
| T8 | 8-foot | Slimline | Lamp |
| 8-foot | High Output | Lamp |
| 8-foot | Other | Lamp |

Table : Lighting Technology Type: High-Intensity Discharge

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| Mercury Vapor |  | ≤400W | Mogul-Base Lamp |
|  | >400W | Mogul-Base Lamp |
| High-Pressure Sodium |  | ≤400W | Mogul-Base Lamp |
|  | >400W | Mogul-Base Lamp |
| Metal Halide |  | ≤400W | Mogul-Base Lamp |
|  | >400W | Mogul-Base Lamp |

Table : Lighting Technology Type: LED

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| A-Type |  | 100W Incandescent Equivalent | Screw-Base Lamp |
|  | 75W Incandescent Equivalent | Screw-Base Lamp |
|  | 60W Incandescent Equivalent | Screw-Base Lamp |
|  | 40W Incandescent Equivalent | Screw-Base Lamp |
| Reflectors |  | MR16 | Pin-Base Lamp |
|  | PAR | Screw-Base Lamp |
|  | R/BR | Screw-Base Lamp |
|  | Other Reflectors | Screw-Base Lamp |
| LED Downlights |  | PL Replacement | Pin-Base Lamp |
|  | ≤4-inch | Fixture |
|  | >5-inch | Fixture |
|  | ≤4-inch | Retrofit Kit |
|  | >5-inch | Retrofit Kit |
| LED Tubes | 4-foot | UL Type A - Plug-and-Play/Direct Replacement | Lamp |
| 4-foot | UL Type B – Ballast Bypass | Lamp |
| 4-foot | UL Type A/B – Dual-Mode/Hybrid | Lamp |
| 4-foot | UL Type C – Remote Driver | Lamp |
| 4-foot | T5 Replacements | Lamp |
| 4-foot | Other | Lamp |
| Other LED Linear Fixtures |  | Linear Strip Fixture (Lightbar) | Fixture |
|  | Panels < 3,500 Lumens | Fixture |
|  | Panels ≥ 3,500 Lumens | Fixture |
|  | Troffers and Wraps <3,500 Lumens | Fixture |
|  | Troffers and Wraps ≥3,500 Lumens | Fixture |
| Decorative |  |  | Screw-Base Lamp |
| Flood Light |  | Screw Terminal Base Flood Lamps | Lamp |
| Flood Light Fixtures/Luminaires |  |  | Fixture |
| LED Decorative Post-Top and Bollard |  |  | Fixture |
| LED Other Outdoor Area and Site Fixtures |  | <15,000 | Fixture |
|  | ≥15,000 | Fixture |
| LED Track Head |  |  | Fixture |
| LED Garage Fixtures |  |  | Fixture |
| LED Canopy Fixtures (e.g., Gas Stations) |  |  | Fixture |
| LED Roadway (e.g., Cobra type) |  |  | Fixture |
| LED Other Form Factors |  |  | Fixture |
| LED Wall Packs |  |  | Fixture |
| Industrial Applications |  | High-bay ≥ 15,000 | Fixture |
|  | Low-bay 5000-15,000 | Fixture |
|  | High-bay ≥ 15,000 | Mogul-Base Lamp |
|  | Low-bay 5000–15,000 | Mogul-Base Lamp |
|  | Medium Base Corn Lamps | Lamp |

Table : Lighting Technology Type: Incandescent

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| A-Type |  | 100W Incandescent Equivalent | Screw-Base Lamp |
|  | 75W Incandescent Equivalent | Screw-Base Lamp |
|  | 60W Incandescent Equivalent | Screw-Base Lamp |
|  | 40W Incandescent Equivalent | Screw-Base Lamp |
| Reflectors |  | R/BR | Screw-Base Lamp |
|  | PAR | Screw-Base Lamp |
|  | Other Reflectors | Screw-Base Lamp |
| Decorative |  |  | Screw-Base Lamp |
| Flood Light |  | Screw Terminal Base Flood Lamps | Lamp |

Table : Lighting Technology Type: Halogen

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| A-Type |  | 100W Incandescent Equivalent | Screw-Base Lamp |
|  | 75W Incandescent Equivalent | Screw-Base Lamp |
|  | 60W Incandescent Equivalent | Screw-Base Lamp |
|  | 40W Incandescent Equivalent | Screw-Base Lamp |
| Flood Light |  |  | Fixture |
|  | Screw Terminal Base Flood Lamps | Lamp |
| Reflectors |  | R/BR | Screw-Base Lamp |
|  | PAR | Screw-Base Lamp |
|  | MR16 | Pin-Base Lamp |
|  | Other Reflectors | Screw-Base Lamp |
| Decorative |  |  | Screw-Base Lamp |

Table : Lighting Technology Type: CFL

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| A-Type |  | 100W Incandescent Equivalent | Screw-Base Lamp |
|  | 75W Incandescent Equivalent | Screw-Base Lamp |
|  | 60W Incandescent Equivalent | Screw-Base Lamp |
|  | 40W Incandescent Equivalent | Screw-Base Lamp |
| Flood Light |  |  | Fixture |
| Spiral GU24 Base Type |  | <20W | Fixture |
|  | ≥20W | Fixture |
| Single, Double, Triple Tube |  | <20W | Pin-Base Lamp |
|  | ≥20W | Pin-Base Lamp |
| Reflectors |  | R/BR | Screw-Base Lamp |
|  | PAR | Screw-Base Lamp |
|  | Other Reflectors | Screw-Base Lamp |
| Decorative |  |  | Screw-Base Lamp |

Table : Controls

|  |  |  |  |
| --- | --- | --- | --- |
| General Category | Dimension | Subcategory | Base Type |
| Daylight Dimmers |  |  |  |
| Networked and Other Advanced Controls |  | Luminaire Level Networked |  |
|  | Other Networked/Advanced Controls |  |
| Occupancy/ Vacancy Sensors |  | Ceiling Mounted |  |
|  | Wallbox |  |
| Photocells |  | Indoor |  |
| Scheduling Clock/Timers |  |  |  |
| Wireless |  |  |  |
| Wireless Relays |  |  |  |

###### Appendix 3: Detailed Data Cleaning Approach

The Cadeo team (the research team) performed two levels of quality control (QC) review on incoming data submissions. First, the research team reviewed submissions within 48 hours of receipt to identify any notable data gaps that required follow-up requests to the distributor. Second, the research team reviewed the final submitted data relative to previous submissions (where applicable) and to other distributors’ sales trends. The research team aggregated all sales data into a common format in a SQL server database to perform this second review. The following sections describe these processes.

Initial Data QC Review

The research team used a standard QC checklist to review all data submissions. The checklist covers the major areas where errors in data input are likely to occur. It also ensures the appropriate information for aggregating the data for analysis is present. A summary of the initial data QC follows.

1. **Scope of review.** The research team ensured distributors did not report sales outside of the Pacific Northwest region (Idaho, Montana,[[12]](#footnote-12) Oregon, and Washington); branch information was included for data sets spanning multiple locations, and sales totals were expressed in units and dollars. The research team also checked that the data did not violate any data validation rules.
2. **Data gaps.** The research team reviewed all data sets, flagged any sales field that was missing data (either a 0.00 or blank cell), and followed up with the distributor to confirm the gap. If the distributor confirmed zero products were sold, the research team filled in zeros. However, if a product was sold but the distributor could not report it, the research team left it blank. For example, some distributors could not extract sales for controls or fixtures due to reporting system limitations.
3. **Data magnitude.** The research team also reviewed each tab to ensure the magnitude of sales for each application was reasonable and flagged any cell that could have been an error (e.g., 0.25 or 250,000,000 sales for a particular application, or an unusual increase or decrease in sales year over year).
4. **Data reporting.** Lastly, the research team confirmed that distributors reported all sales data in terms of individual lamps and not packages of multiple lamps.

Merging Data from Multiple Sources

Mapping Sales Survey Forms to Standardized Fields

The research team created a data import process to bring data from the Excel survey forms into SQL. Using a data extraction template created by the research team, Cadeo extracted all key data fields from the survey forms into a comma separated values (CSV) file. The research team then imported these CSV files directly into the SQL server database. The research team repeated this process for each of the returned distributor surveys.

Mapping Historic Data (2013–2016) to Standardized Fields

Each year, the research team revisits the Excel-based sales survey form sent to distributors to capture any new product categories and to look for opportunities to collapse categories to ease the reporting burden. Thus, the research team had to ensure that data from previous collection efforts (originally stored in Excel) mapped to the proper lamp and luminaire characteristics in the new database.

Mapping Reduced Wattage Lamp Replacement Data to Standardized Fields

The Northwest Energy Efficiency Alliance (NEEA) Reduced Wattage Lamp Replacement (RWLR) initiative collected sales data on linear fluorescent and tubular LED (TLED) lamps for all participating distributors through 2020. NEEA cleaned this data to identify the share of 4-foot T8 lamps that are reduced wattage (25W and 28W) and standard wattage (32W). Participating distributors submitted sales data for all 4-foot T8 lamps, including T12 and T5 lamps, monthly. As NEEA’s goals and data structure differed from this project’s goals and data structure, the research team had to map NEEA’s data to the standardized fields in the database and, in some cases, add granularity to the data provided. The research team took the following steps in this process:

1. **Identify and eliminate products that are not linear fluorescent or TLED.** The research team does not have complete product data for these RWLR participants outside of linear fluorescent and TLED data, so the additional sales in other categories are incomplete. The research team removes these sales because the research team cannot verify that reported sales in nonlinear fluorescent and TLED categories represent all of that distributor’s sales in those additional product categories. The research team also removed black light lamps, gold tubes, and germicidal lamps. Some distributors submitted sales of hardware and wiring, CFLs, and metal halide lamps; the research team also removed these products. The research team used the following fields to identify products to exclude, in the order listed:
   1. Technology type
   2. Bulb description
   3. Bulb type
2. **Standardize the naming conventions for incorporation in the SQL server database.** In some cases, multiple product descriptions are mapped to the same category in the SQL server database. Table 11 provides an example of 15 unique combinations of the NEEA fields “Shape” and “Category” that map to U-shape lamps. In this step, the research team expanded definitions to incorporate new categories: UL Type A/B TLEDs, and UL Type C TLEDs.

Table : Inconsistent Naming Convention Example: U-Shape Lamps

|  |  |
| --- | --- |
| Shape | Category |
| T8-6U | T8LEDU |
| T8-6U | Other |
| U-Bent | Other |
| T8-1-5/8 (U-Bend) | Other |
| T8-1-5/8 (U-Bend) | U-Bend-T8 |
| T8-6U | U-Bend-T8 |
| T8-6U | 32W |
| U-Bend | Other |
| T8-U | T8 |
| T8-U | 32W |
| T8 U-Bend | Other |
| T8-6U | T8-6U |
| T8-6U | T8 |
| T8-U | T8LEDU |
| T8 U-Bend | U-Bend-T8 |

Source: NEEA RWLR database

1. **Review for incorrectly categorized lamps.** Table 12 provides examples of the classifications given to four model numbers that correspond with a single LED lamp type (with two different correlated color temperatures). In two cases, these lamps were incorrectly identified as 4-foot fluorescent lamps, and in two cases they were correctly classified as LED U-shape lamps. The research team reviewed online manufacturer catalogs to verify correct product classification.

Table : Incorrect Product Categorization Example

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Model Number | Description | Shape | Technology | Watts | Lumen | Length |
| PHIL 16.5T8/244000 IF6U |  | T8-6U | Fluorescent | 16.5W | 1900 | 48 |
| PHIL 16.5T8/24-4000 IF-6U |  | T8-6U | Fluorescent | 16.5W | 1900 | 48 |
| PHIL 16.5T8/245000 IF6U | Fluorescent - Tube - T8 | T8 | LED | 16.5W | 1950/2150/290\* | 24 |
| PHIL 16.5T8/24-5000 IF-6U | Fluorescent - Tube - T8 | T8 | LED | 16.5W | 1950 | 24 |

\*Lumen output with different ballast options.   
Source: NEEA RWLR database

1. **Map data to SQL data categories.** The research team used the following data to map to the SQL server database linear fluorescent and TLED data categories:
   1. Lighting technology type (LED or linear fluorescent)
   2. Lamp shape (T8, T5, T12, or LED tubes)
   3. Lamp wattage
   4. Lamp length
   5. T8 series (for 4-foot or 2-foot U-shape T8 lamps between 29W and 32W: 700 series or 800 series based on color rendering index)
   6. UL Type for TLEDs. The two main UL Types are Type A, which is ballast compatible and often referred to as “plug-and-play,” and Type B which requires bypassing the ballast. This year, the research team also added Type A/B Dual-Mode/Hybrid and Type C Remote Driver TLEDs.

For any lamp where one of these fields was missing, the research team used text strings from other product fields or an online web search to fill in the missing data. Table 13 summarizes the linear fluorescent and LED categories in the SQL server database.

Table : Standardized Data Fields for Linear Lamps

|  |  |  |  |
| --- | --- | --- | --- |
| Lighting Technology Type | General Category | Dimension | Subcategory |
| Linear Fluorescent | T12 | 4-foot | 34W |
| Linear Fluorescent | T12 | 4-foot | 40W |
| Linear Fluorescent | T12 | 4-foot | Other |
| Linear Fluorescent | T12 | 4-foot | U-Shape |
| Linear Fluorescent | T8 - High Performance 800 Series or Better | 4-foot | 25W |
| Linear Fluorescent | T8 - High Performance 800 Series or Better | 4-foot | 28W |
| Linear Fluorescent | T8 - High Performance 800 Series or Better | 4-foot | 32W |
| Linear Fluorescent | T8 - High Performance 800 Series or Better | 4-foot | Other |
| Linear Fluorescent | T8 - Standard 700 Series | 4-foot | 32W |
| Linear Fluorescent | T8 - Standard 700 Series | 4-foot | Other |
| Linear Fluorescent | T8 - Standard 700 Series | 4-foot | U-Shape |
| Linear Fluorescent | T5 | 4-foot | 28W |
| Linear Fluorescent | T5 | 4-foot | 54W |
| Linear Fluorescent | T5 | 4-foot | Other |
| Linear Fluorescent | T12 | 8-foot | Slimline |
| Linear Fluorescent | T12 | 8-foot | High Output |
| Linear Fluorescent | T12 | 8-foot | Other |
| Linear Fluorescent | T8 | 8-foot | Slimline |
| Linear Fluorescent | T8 | 8-foot | High Output |
| Linear Fluorescent | T8 | 8-foot | Other |
| LED | LED Tubes | 4-foot | UL Type A - Plug-and-Play/Direct Replacement |
| LED | LED Tubes | 4-foot | UL Type B - Ballast Bypass |
| LED | LED Tubes | 4-foot | UL Type A/B – Dual-Mode/Hybrid |
| LED | LED Tubes | 4-foot | UL Type C – Remote Driver |
| LED | LED Tubes | 4-foot | T5 Replacements |
| LED | LED Tubes | 4-foot | Other |

Source: Distributor sales data structure

Adjusting for Linear Product Overrepresentation

Over the course of the study, linear fluorescent sales have been slightly overrepresented relative to other technologies.The NEEA RWLR data the research team collected included linear lamp sales from nonparticipating distributors (i.e., distributors that did not submit full-category lighting data). Linear product sales may be overrepresented relative to other technology types because these distributors only submitted linear fluorescent and TLED (linear product) data and did not submit sales data for other categories. The research team created an adjustment to address the overrepresentation and ensure the sales mix reported in the adjusted data accurately reflects the best estimate of the overall product mix of the lighting market.

The research team identified four distributors that only provided linear product data through RWLR in the study period. The research team had two core priorities in developing the adjustment:

* Adjust the *overall quantities* of linear products to account for overrepresentation from these four distributors and ensure the *overall* product sales mix across technologies is accurate.
* Maintain the *sales mix* within the linear product category to incorporate the information from these RWLR-only participants and ensure the data reflect the most accurate sales mix.

The research team developed an annual percentage adjustment to linear product sales data to reduce the quantity of these lamps and better reflect the best estimate of the overall product mix. The linear adjustment is included in the associated Market Results Spreadsheet[[13]](#footnote-13) as *Linear Adjustment* and is multiplied by the original *Sales Qty* column to derive an adjusted value (*Sales Qty with Linear Adjustment*). The adjustment is segmented by year, so it preserves the mix within the linear product category—the adjustment utilizes the strong RWLR data while providing an unbiased estimation of overall sales mix. Table 14 shows the adjustments by year.

Table : Linear Adjustments by Year

|  |  |
| --- | --- |
| Year | Linear Adjustment |
| 2013 | 93.1% |
| 2014 | 91.7% |
| 2015 | 92.4% |
| 2016 | 93.7% |
| 2017 | 93.9% |
| 2018 | 94.1% |
| 2019 | 93.3% |
| 2020 | 93.3% |
| 2021 | 93.9% |
| 2022 | 93.1% |

The adjustments the research team developed are equal to the total linear product sales in each year excluding the four distributors, divided by the total linear product sales in each year including the four distributors (e.g., in 2022, 7% of total linear product sales were accounted for by these four distributors, resulting in an adjustment of 100% − 7% = 93%).

Processing Raw Sales Data (Data Dumps) and Mapping to Standardized Fields

In 2018, 2019, and 2020, three distributors did not use the Excel-based form to provide sales. The research team used a combination of R and SQL logic, web scraping, and manual classification to map these raw data to the SQL server database categories. Lighting product descriptions and model numbers do not follow consistent formatting and often vary by manufacturer, making automated classification of products often just as time intensive as a strictly manual approach.

The research team used Python, R, and SQL to:

1. Identify products from previous years leveraging existing mappings to classify as many products as possible.
2. Leverage an automated process to look up model numbers on known manufacturer websites.
3. Extract specific product characteristics from model number and product description fields.

The research team manually mapped products using a combination of available data fields and online model number searches for products that the R and SQL code could not easily map.

###### Appendix 4: Market Scaling Factors

Annual collected distributor sales data is the primary sales data source in BPA’s Non-Residential Lighting Market Model (the model). The model takes additional data sources into account and estimates the full size of the non-residential lighting market, so the sales data size and mix output by the model differs from the sales data size and mix of collected sales data. In the most recent model update (2020–2021), the model was calibrated using the 2019 Commercial Building Stock Assessment (CBSA) to align the model stock estimates with the stock results in the CBSA. This calibration resulted in further adjustments to the estimated total market sales mix to align model stock outputs with 2019 CBSA stock outputs.

In 2021, the research team calculated market scaling factors to express the difference between sales data collected from regional distributors and outputs from the model. The research team calculated these scaling factors by aggregating sales data into technology categories that map to the model technologies, and then dividing the modeled sales in each technology-year by the observed sales collected from distributors (including extrapolated sales). The scaling factor accounts primarily for the market size (i.e., total market sales volume) estimated by the model. The market size is determined as an output of the Market Model, so the accuracy of the scaling factors is dependent on the model parameterization being correct. The research team has leveraged the best available data and developed model inputs with care, but model inputs do have uncertainty associated with them, which may result in changes to model turnover, market size, and consequently market scaling factors. The research team calculated the market scaling factor, shown in Table 15, at the technology level, differentiated by year.

Table : Market Scaling Factors by Technology by Year

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Technology | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |  |
| 25W T8 | 2.41 | 1.87 | 2.13 | 2.32 | 2.58 | 2.92 |  |
| 28W T8 | 1.56 | 1.22 | 1.38 | 1.50 | 1.66 | 1.88 |  |
| 32W T8 | 5.16 | 4.09 | 4.41 | 4.65 | 5.27 | 5.75 |  |
| CFL | 4.63 | 4.79 | 5.53 | 6.99 | 7.81 | 10.78 |  |
| Hal | 8.39 | 7.84 | 7.92 | 9.29 | 10.12 | 14.28 |  |
| High-Pressure Sodium | 1.58 | 1.48 | 1.32 | 1.47 | 1.74 | 2.66 |  |
| Inc | 3.74 | 4.15 | 4.55 | 4.95 | 5.62 | 8.29 |  |
| LED Lamp | 5.57 | 4.18 | 5.09 | 5.29 | 5.52 | 6.88 |  |
| LED Luminaire | 1.12 | 0.99 | 0.93 | 0.90 | 1.05 | 1.19 |  |
| Mercury Vapor | 2.60 | 2.34 | 2.07 | 1.82 | 2.05 | 2.77 |  |
| Metal Halide | 2.30 | 2.38 | 2.56 | 2.65 | 3.23 | 4.61 |  |
| Pin CFL | 1.56 | 1.45 | 1.47 | 1.60 | 1.57 | 1.94 |  |
| T12 | 2.64 | 2.22 | 2.39 | 2.45 | 2.22 | 2.34 |  |
| T5HO | 0.50 | 0.42 | 0.51 | 0.59 | 0.71 | 0.85 |  |
| T5SO | 1.13 | 0.91 | 0.91 | 0.90 | 1.04 | 1.06 |  |
| TLED | 4.00 | 3.11 | 3.40 | 3.41 | 3.98 | 4.13 |  |

The research team observed variation across technologies (and to a lesser extent across years) in the calculated market scaling factors. There are multiple potential drivers for these variations, but the magnitude of each driver is unknown. The research team speculates that the two largest drivers of variation in scaling factors are:

* **Variation in the observed sales data’s representativeness by technology category.** The largest example of this is in 32W T8 lamps. For this category, the market scaling factor is quite high (approximately five, meaning the modeled sales were five times higher than the observed sales). The research team speculates that the sales data NEEA and BPA collects understates the prevalence of T8s in the sales mix because of meaningful sales of those products through channels other than distributor channel (e.g., online and retail sales).
* **Possible misclassification of some lamps in the CBSA.** The research team observed market scaling factors of less than 1.0 for the T5 technologies. This indicates that the modeled sales are lower than the observed sales, which is not an expected result. The driver of this result is the model’s calibration to the CBSA. While we cannot be certain, the research team speculates that some T5s (a relatively uncommon technology category in the stock mix) were miscategorized as T8s in the CBSA, which would result in both the CBSA and the model understating the prevalence of this technology in the stock.

As BPA continues to update the model with new data, the research team will consider whether to recalculate market scaling factors for future years. Presently, the market scaling factors can be interpreted in concert with other supporting information as an approximate indication of which technologies are underrepresented in the sales data collected from distributors. For example, the technologies with high scaling factors (CFL, halogen, and incandescent) are also technologies that would be likely to appear in retail channel sales, corroborating the research team’s indication that retail channel sales are not reflected in this analysis. However, due to the uncertainties described here, the research team cautions against using these market scaling factors alone to draw conclusions about the market.

1. See Extrapolation Methodology and Findings for more details on the extrapolation methodology. [↑](#footnote-ref-1)
2. The research team developed the distributor population from an analysis of distributor interviews and online research compiled into a distributor database in 2016. This population assessment has not been updated comprehensively since then, but the research team does update participating distributor firmographic information each year. Further investment in comprehensively updating the distributor population would be necessary before making any adjustments to improve representativeness. [↑](#footnote-ref-2)
3. The research team calculated the average of the standard deviation of the portion of each lighting technology type within each distributor type. The average standard deviation by business model type for participating full line, lighting consulting, and MRO and online distributors was 10%, 13%, and 10%, respectively. [↑](#footnote-ref-3)
4. Over the course of the study, not all participating distributors have provided percentages indicating what portion of their sales go to residential versus non-residential customers. Because the target market for wholesale distributors is the commercial market, the research team has assumed 100% of reported sales go to non-residential customers in instances where no other percentages were reported. This assumption is consistent with prior years’ analysis and with the research team’s qualitative understanding of those distributors’ sales. [↑](#footnote-ref-4)
5. New distributors are not back cast to years prior to the first year included in their submissions. [↑](#footnote-ref-5)
6. Subcategories for each technology and general category are in Appendix B: Summary of Unique Database Category Entries [↑](#footnote-ref-6)
7. The extrapolation is based on the prior year of data for each non-participating distributor. In the 2021 study, the research team explored using a three-year average to extrapolate market share. Due to year-over-year changes in distributor participation, combined with regular market share changes, the three-year average produced less accurate extrapolated sales, when compared with distributor’s actual sales, than the prior year when evaluated using participants that participated in consecutive years. For more information on this work, consult the Non-Residential Lighting Distributor Sales Data Gaps memo from 2021. [↑](#footnote-ref-7)
8. For more information on this uncertainty analysis, consult the Uncertainty Analysis Memo. [↑](#footnote-ref-8)
9. See Appendix 3: Detailed Data Cleaning Approach for more details on how the research team included RWLR sales data in this study. [↑](#footnote-ref-9)
10. See Appendix 3: Detailed Data Cleaning Approach for more details on how the research team adjusted reported sales data for linear products to account for RWLR sales data from non-study participants. [↑](#footnote-ref-10)
11. The distributor data collection tool does not include nonstandard linear products (e.g., 1-foot 32W T8s) because the research team assumed these products were sold at low volumes. The research team verified this assumption when the data collection tool was built through review by subject matter experts. In 2021, the research team tested this assumption by asking distributors with high sales of other linear fluorescent products if non-standard linear products are still a low sales volume category. The three distributors consulted confirmed low volume of non-standard linear fluorescent products sales. [↑](#footnote-ref-11)
12. The research team accepted data from all of Montana; however, the Pacific Northwest region only includes Western Montana. Thus, using data from the entire state for regional analysis assumes that the sales mixes of the eastern and western portions of the data are similar. [↑](#footnote-ref-12)
13. Contact Juan Carlos Blacker ([jcblacker@bpa.org](mailto:jcblacker@bpa.org)) for more information on the Market Results Spreadsheet. [↑](#footnote-ref-13)