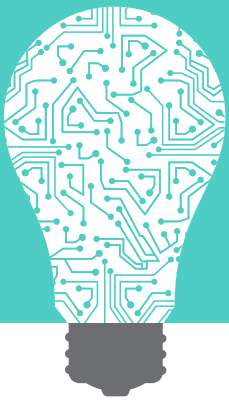# 2015 Non-Residential Lighting Market Characterization

BONNEVILLE
POWER ADMINISTRATION

OCTOBER 2015

EXECUTIVE SUMMARY

BPA conducts market research to quantify momentum savings, inform program strategy, and help planners assess resource potential and cost effectiveness. This report contains the findings of a detailed characterization of the Northwest non-residential lighting market.

A NEW LIGHTING MARKET

The project's research challenge was twofold: First, track the entire non-residential lighting market to estimate regional Momentum Savings. Second, understand how the rapidly changing lighting market will impact lighting efficiency programs. Our findings provide planners and program managers with information they will need to maintain cost-effective lighting programs as LED technology fundamentally changes the market.

FROM WIDGET TO SYSTEM, FROM HARDWARE TO SOFTWARE

Our research revealed that the adoption of LED technology will drive the market away from bulbs and fixtures and toward complete systems that offer more than just light. This underlying market dynamic will change the lighting game for market actors, end-users, and programs alike. Three forces propel this emerging trend.

1. The long lifetime of LEDs means end-users will not replace bulbs nearly as often, making full-system retrofits a more prevalent share of the market.

2. LED luminaires are most efficient and reliable when the components are designed together as a system.

3. Integrated systems will be able to do more for end-users, a necessity if manufacturers are to avoid commoditization.

Manufacturers are already adding software-driven capabilities like the ability to change brightness depending on the task, change color depending on the time of day, monitor energy use, communicate with security systems or retail customers, and much more. As a system, lighting is no longer just lighting.

DRAFT MOMENTUM SAVINGS

From 2010 to 2014, 249 aMW of Momentum Savings occurred in BPA's territory. These draft savings are measured against the Northwest Power and Conservation Council's Sixth Plan baseline and are net of regional program savings and NEEA's Net Market Effects. The savings result from a rapid and broad-based improvement in lighting product efficiency, driven by efficiency standards and technology improvements. Our savings estimates draw on several sources, most notably sales data provided by 18 regional electrical distributors.

MOMENTUM SAVINGS (aMW) FROM NON-RESIDENTIAL LIGHTING

Year	REGIONAL MOMENTUM SAVINGS	BPA MOMENTUM SAVINGS
2010	8.1	3.4
2011	33	14
2012	50	21
2013	77	32
2014	81	34
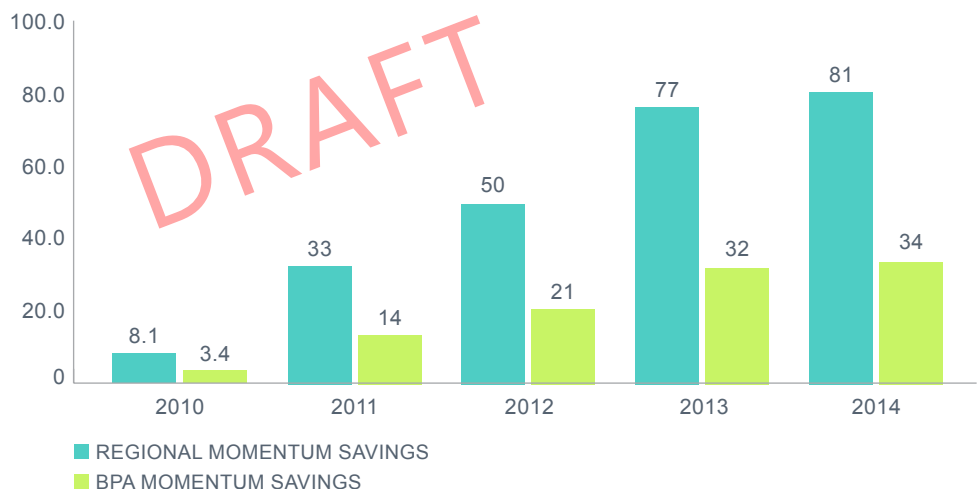
IMPACTS ON MARKET ACTORS

The shift to a system-based lighting world alters the 'who' and 'how' of previous market intervention strategies. Understanding how this shift impacts various actors in the lighting distribution chain will help utility programs evolve tactics to maximize their impact.

| MARKET ACTOR	CORE FUNCTION	HOW CHANGING
MANUFACTURERS	PRODUCTION	As makers of systems, fixture manufacturers are naturally positioned to gain from the LED-driven shift to system-based lighting. **Fixture manufacturers are adding lighting controls such as occupancy sensors, dimmers, and photosensors,** as well as non-energy features to their product lines. Utilities will need to quantify these energy and non-energy benefits and determine which should be targeted in their programs. Clear specifications in qualified product lists and strong relationships with fixture manufacturers will be critical to these efforts.
WHOLESALE DISTRIBUTORS	LOGISTICS, FINANCING, AND ON-DEMAND PRODUCT AVAILABILITY	Distributors are used to selling products they have in stock, then replenishing the stock. But **large increases in the number of products and a faster product cycles have challenged their ability to stock LED systems profitability.** Combined with the eventual slowdown in lamp sales (due to fewer replacements), these factors impact distributors' lighting business. How they react—shifting focus to project sales rather than immediate product availability—will be important to how utility programs partner with them.
MANUFACTURER REPRESENTATIVES	SALES GENERATION	Typically focused on selling fixtures rather than lamps, **manufacturer representatives could prove increasingly important to educating architects, specifiers, and electrical contractors.**
ELECTRICAL CONTRACTORS	INSTALLATION AND SALES	Electrical **contractors will need to be well versed in advanced systems** and controls. Programs can help differentiate the quality installers.
COMMERCIAL END USERS	ULTIMATE DECISION MAKER	End-users are facing increasingly complex and dynamic solutions. New non-energy related product features may drive more lighting purchase decisions in the future but **buyers will need a trusted source to separate hype from reality.**
LIGHTING PROGRAMS	MARKET INFLUENCER	**Measures are becoming more difficult to define** as lighting solutions can now include many advanced, non-energy related features. A long-term slowdown in simple lamp replacement means programs will need to look deeper for energy savings.

1. LINEAR FLUORESCENT LAMPS STILL DOMINATE THE NON-RESIDENTIAL MARKET.

While LEDs get the headlines, 32-watt T8 lamps remain the market's bread and butter. Replacing this market staple with its reduced-wattage version (28 or 25 Watts) is a savings opportunity, particularly in the oft-overlooked maintenance market segment.

2. THE LED MARKET PROGRESS WILL CHALLENGE THE ABILITY OF PLANNERS AND PROGRAMS TO KEEP UP.

Price declines (see graphic to right), efficiency improvements, and rapid product development have challenged timely management of savings estimation, baselines, rebate levels, and qualified product lists.

TLED PRICES (2013-2020)

Purchase price will reduce by half from 2014 to 2017

ACTUAL
FORECAST
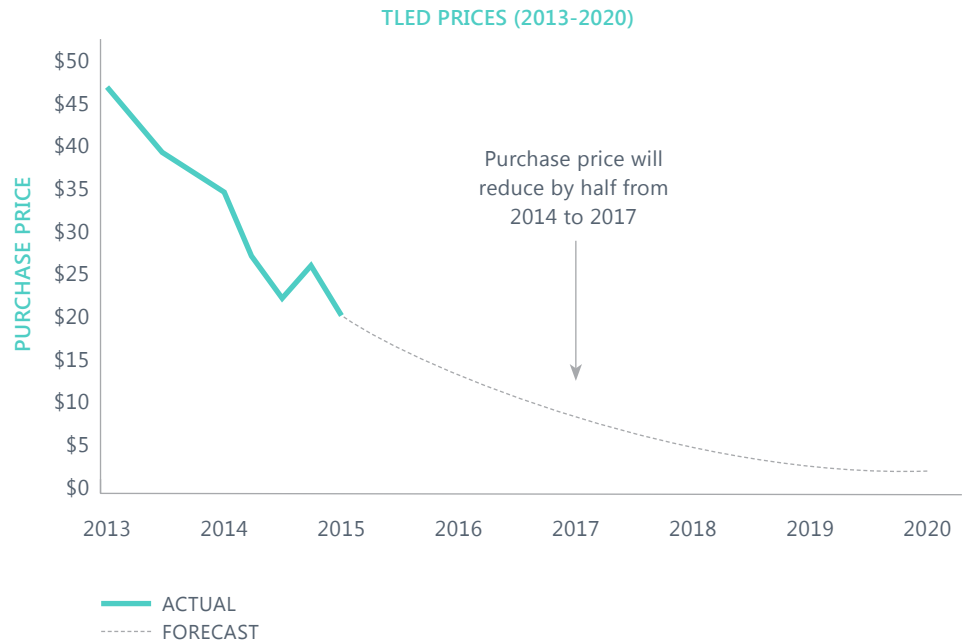
Source: Navigant analysis of retailer websites

3. LIGHTING WILL INCREASINGLY BE ABOUT SYSTEMS, NOT PRODUCTS.

The technical nature of LEDs enables the easy integration of controls, a variety of new shapes and sizes, and non-energy related features. As longer product lifetimes result in fewer replace-on-burnout scenarios, it becomes increasingly important for manufacturers to shift to full system products as opposed to lamps and ballasts.

4. THE LED TRANSITION IS CHANGING THE POINTS OF INFLUENCE IN THE LIGHTING DISTRIBUTION CHAIN.

The LED revolution has altered the business of many market actors: lamp and fixture manufacturers are adjusting to a market increasingly about systems and non-energy product features; distributors are changing stocking practices and looking for new ways to generate sales; and manufacturer representatives are gaining more influence.

5. MARKET SEGMENTATION IS BECOMING MORE IMPORTANT TO IDENTIFYING SAVINGS OPPORTUNITIES DUE TO REGULATIONS AND LED TECHNOLOGY.

The host of recent lighting standards rarely apply to an entire product category, leaving gaps within product categories. As LED systems grow as a share of the new construction market, the maintenance market and its large installed base of linear fluorescent lamps, remains a ripe savings opportunity.

1. DESIGN PROGRAM STRATEGIES FOR BEST "MEASURE-MARKET FIT."

The lighting market is diverse. To maximize impact, targeted approaches trump one-size-fits all designs. Programs could emphasize products exempt from standards (e.g., candelabra base lamps) or target lighting specifiers for advanced lighting controls programs or maintenance contractors for energy savings on replace-on-burnout events.

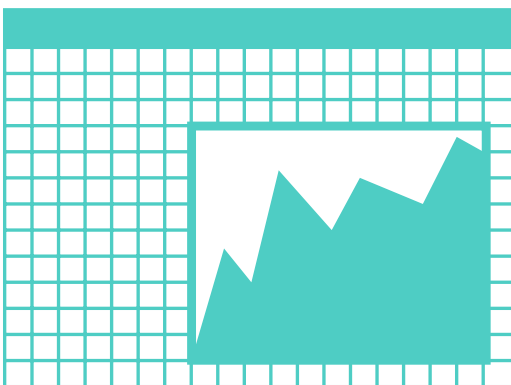### 2. TAILOR PROGRAM TRANSITION STRATEGIES BY MEASURE.

A transition strategy doesn't have to mean dropping measures entirely: changing incentive levels and structures can also provoke shifts in the market. For example, as screw-in LEDs become standard practice in the commercial sector, consider moving from a dollar-per-unit incentive structure to more creative arrangements that reward partners for other metrics such as increasing market share or average product efficacy.

3. REQUEST FULL CATEGORY SALES DATA FROM DISTRIBUTORS AND RETAILERS—ESPECIALLY FROM PROGRAM PARTNERS.

Because the product mix is changing so rapidly, full category data is essential to accurate baselines. At present, lighting baselines cannot be addressed with good engineering assumptions alone—they need market data. Data from program partners is a must, but BPA and NEEA should also continue broader efforts to collect from additional market actors.

4. MONITOR LED COST AND PERFORMANCE TRENDS FREQUENTLY.

For LED measures, planners and programs should consider updating baselines, rebate levels, and measure characterizations at least annually. Flexible upstream program models can reduce the risk of misallocating resources, increase regional savings, and improve cost-effectiveness.

5. DEVELOP SPECIFICATION AND INSTALLATION GUIDANCE FOR ADVANCED LIGHTING SYSTEMS.

Especially for controllable lighting systems that offer deeper savings and non-energy benefits, programs could help trade allies become confident in offering advanced systems to their customers.

6. IMPROVE YOUR PROGRAMMATIC DATA SYSTEMS (AND INTELLIGENCE).

Up-to-date, accurate, and granular data on programmatic activity will enable program managers to steer a more strategic course. Knowing which technologies and which market segments are 'trending' (and which need more help) requires measure-level data. Consider offering online data submission tools to your trade allies to standardize data formats and enable timely analysis.

Table of Contents

Table of Figures

Table of Tables

Acknowledgements

This report benefited from the contributions of several lighting market experts, utility program managers and distributors across the Northwest. The team would like to thank Carrie Cobb in particular for her direction, guidance, and continuous efforts to raise the bar. This report would also not have been possible without the work of Elaine Miller of NEEA, who worked tirelessly to engage distributors and market actors. The team would also like to acknowledge the contributions of the following individuals:

Lighting/Regional Experts

Foreword

Bonneville Power Administration (BPA) is pleased to release this non-residential lighting market characterization report. This research will provide readers with a deeper understanding of the lighting market structure, market actors, technology shifts, and sales trends in the Northwest. We hope the report's findings will inform future program strategy and illuminate new avenues for market influence.

In this project, the team successfully collected regional sales data to help inform our program baselines and our market characterization, led by the tireless efforts of Elaine Miller at Northwest Energy Efficiency Alliance (NEEA). In addition to Elaine's leadership, John Wilson of BPA and Jacob Henry from Grays Harbor PUD provided connections with distributors and insights that made this work possible.

The non-residential lighting sector is home to massive technological change, which has led to significant energy savings both in and out of programs. One goal of this research project was to update estimates for non-residential lighting Momentum Savings in the Northwest. BPA is releasing this report with "DRAFT" estimates for Momentum Savings in the non-residential sector for two primary reasons: (1) the models are complex, and Excel was not a transparent enough platform for the more sophisticated elements of our analysis—the workbooks were, of necessity, too convoluted to maintain transparency, and (2) we do not have the analytical framework to estimate uncertainty or do robust sensitivity analysis.

The non-residential lighting savings are estimated to be large enough that easily accessible and transparent savings are critical. Therefore, over the next year we are:

- Redesigning the Momentum Savings model in a more appropriate platform

- Continuing to invest in data collection to reduce uncertainty around critical inputs

This work will help improve certainty in our estimates and make reviewers' jobs easier. We are also working to develop a rigorous third-party review process for our savings estimates. We appreciate the work of the Northwest Power and Conservation Council, in particular Charlie Grist, who has worked closely with us on this analysis over the past three years and helped us in characterizing this very important market.

Carrie Cobb

October 2015

Introduction

Over the course of 2014 and early 2015, Navigant and Cadeo ("the research team") investigated the non-residential lighting market on behalf of Bonneville Power Administration (BPA). The team gathered market intelligence through interviews with numerous market actors and analyzed sales data provided by 16 regional electrical distributors. The result of this research effort was twofold. First, the team drew several qualitative conclusions about the current state of the market: where non-residential lighting is now, where it is heading, and how those findings affect program planning. Second, the quantitative sales data allowed the team to estimate the Momentum Savings associated with the technology and market changes in the region.

Background

BPA published the first Non-Residential Lighting Market Characterization in April 2014. This study began in late 2012 and included a baseline characterization for general service linear fluorescent (GSFL) and high-intensity discharge (HID) lamps, and provided an estimate of non-residential lighting Momentum Savings for 2010-2012. A major element of the 2014 study was BPA's first annual Northwest electrical distributor survey, which successfully collected detailed lighting sales data representing roughly 45% of the Northwest non-residential lighting market. The success of the 2014 study relied on the coordinated efforts of BPA staff, NEEA staff, and frequent engagement with the Northwest Power and Conservation Council. Building upon that success, BPA initiated the current BPA Lighting Market Characterization and the associated second annual distributor survey in the summer of 2014.

Objectives

The goal for this study was to deliver actionable insights based on more recent lighting market information, with a focus on LEDs.

The current study began with two major research objectives:

1. **Characterize the Market.** The study seeks to understand the rapid pace of change in the lighting market and its impact on sales trends across all lighting categories, supply chains, and market structure. As part of the study, the team compiled a separate LED Market Intelligence Report,[1] delivered in April 2015, to provide program managers and planners immediate feedback on the current state of the LED market. This report builds on that effort and provides an expanded context regarding the implication of change in the broader non-residential lighting market.

2. **Estimate Momentum Savings**. The study quantifies Momentum Savings for the non-residential lighting market. Momentum Savings are cost-effective savings that occur above the Sixth Plan baseline and are neither incentivized by utility programs, nor included in NEEA's net market effects. Momentum Savings have various drivers, including codes and standards (beyond those

---

[1] Bonneville Power Administration. *LED Market Intelligence Report.* April, 2015. http://www.bpa.gov/EE/Utility/research-archive/Documents/Momentum-Savings-Resources/LED_Market_Intelligence_Report.pdf

already captured in the Sixth Plan), baseline shifts, and general market transformation effects.

This study also provided an important opportunity to align BPA's data and analysis processes with its vision for regional lighting efforts. Specifically, BPA envisions using market research and analytics to gather the market intelligence that regional program managers need to make effective and timely responses to changing market conditions. This will allow BPA to allocate ratepayer dollars for conservation acquisition in the most efficient way.

Organization of Report

The remainder of the report includes five sections, which describe the details of analysis activities and discuss the sources of data:

- Section 2: Data Collection and Research Approach

- Section 3: Sales Data Findings

- Section 4: Market Structure

- Section 5: Momentum Savings

- Section 6: Key Findings and Recommendations

Accompanying appendices provide additional information including interview guides, a detailed description of the data collection tool, and other relevant background material.

Data Collection and Research Approach

In this chapter, the team begins by describing the distributor recruitment process and primary data collection methods used. Next, the team discusses the quality of data received from distributors and the representativeness of the sample.

Recruitment

In the non-residential lighting market, the majority of lamps flow through distributors to contractors and, ultimately, commercial and industrial end-users; by contrast, most lamps for the residential sector flow through the retail channel. In order to properly calculate Momentum Savings for this market, the research team recruited regional distributors to participate in interviews and provide recent lighting sales data. For many distributors, the key to recruitment was their participation in NEEA's Reduced Wattage Lamp Replacement initiative, or the opportunity to do so.

Following the initial electrical distributor survey in 2013, BPA received feedback from distributors that the completion of the sales data request, and the 60-90 minute interview, represented a substantial time investment. In short, participation was a significant 'ask' of distributors. BPA recognized the challenge of data collection and directed the research team to work with both BPA research and program staff, as well as staff at NEEA, to craft a stronger value proposition to regional distributors. Through these discussions, the team revamped its distributor outreach package and data request to encourage collaboration on the current study.

BPA and NEEA enhanced the participation value proposition by increasing the financial incentive from $500 to $1,000. The team also committed to providing each participant with a regional lighting and distributor market intelligence report. This report, only available to participants, would contain a regionally-specific market share analysis for key measures. It also offered a customized snapshot of each distributor's position relative to other competitors in the non-residential lighting market for key market metrics.

The research team also offered to sign non-disclosure agreements (NDA) with the prospective participants to provide further assurances of data protection. Under these NDAs, the team is legally obligated to protect each distributor's individual company data and only externally report aggregated data, even to BPA.

The team developed a recruiting package for distributors consisting of a welcome e-mail, a high-quality "sample" market intelligence report, a one-page flyer detailing the benefits of participation (shown in Figure 1), a copy of the NDA, the interview guide, and the sales data request form.

For prior participants, BPA and NEEA conducted the outreach efforts and often met face-to-face to go over the "recruiting package." Navigant and Cadeo conducted the initial outreach for first-time participants.

Figure 1: Marketing Flyer for Electrical Distributors

Source: Navigant and Cadeo

Primary Data Collection

The research team interviewed several stakeholder groups and market actors to better understand and characterize the non-residential lighting market. Table 1 summarizes these interviews.

Table 1: Summary of Qualitative Primary Data Collection

Group	Number	Description
Distributors	18	In-depth interviews
Manufacturers	16	Short interviews
Regional Lighting Specialists	4	Focus groups with two to four specialists each
Utility program staff	4	In-depth interviews
Manufacturer representatives	4	Short interviews

Source: Navigant and Cadeo

The team developed interview guides for each group (provided in Appendix A. Northwest Electrical Distributors Interview Guide).

In-depth Interviews

The team held in-depth interviews with both distributors (as described above) and utility program staff. These interviews, which lasted approximately 60 to 90 minutes, touched on a variety of issues, but focused on the way LED technology was changing their business and the industry as a whole.

Focus Groups

The team conducted four one-hour focus groups with regional experts from Evergreen Consulting, a firm based in the Northwest that supports many regional commercial lighting trade ally networks on behalf of regional utilities.[2] Each focus group included two to four participants who have experience working in the industry as:

- Manufacturers

- Contractors and Electricians

- Technical experts

- Other roles: manufacturer representatives, two or more of the above

The team developed specific questions for each group.

Short Interviews

In May 2015, members of the Navigant/Cadeo research team attended LightFair, the world's largest annual lighting trade show and conference. Alongside staff from BPA and NEEA, the research team completed over 20 in-person interviews with attending lamp, fixture, and controls manufacturers and their sales representatives. These interviews typically lasted between 15 and 30 minutes.

Sales Data Collection

The research team provided distributors with an Excel-based data request form for the purpose of collecting regional sales data. These completed forms provided the most significant quantitative contribution to the current study's research. To reduce the time investment required from distributors, the research team condensed some lamp categories and product families in the data collection tool based on lessons learned from the previous survey (see appendix B for detail). Based on feedback from 2014 participants, the team offered a 'data dump' option for participating distributors who did not have digital systems capable of querying their data in the format requested. This option resulted in a submission of all raw sales data without binning sales across lamp types. 16 distributors submitted data in the 2015 study. This is an increase from 2014, when 12 distributors provided data. Between the two years, a total of 18 unique distributors have submitted sales for some or all of the years from 2010 – 2014

---

[2] Northwest Lighting Network, 'About Us': http://nwlightingnetwork.com/about-us/

Data Representativeness

The team gathered a list of all known electrical distributors, ultimately identifying 53 currently active in the Northwest region. Working with NEEA and BPA program staff, the team categorized each of the 53 distributors along three key dimensions:

Relative size. Each distributor was identified as "large," "medium," or "small" based on each distributor's number of branches in the Northwest.

Distribution area. Each distributor was identified as "local," "regional," or "national" based on the reach of their service.

Business model. Each distributor was identified as a full-line electrical distributor, a maintenance, repair, and operations (MRO) distributor, or a lighting only distributor based on a qualitative assessment of its website, marketing collateral, and interview responses.

The team attempted to interview and collect data from all 53 identified distributors, but only 18 agreed to the interview, and only 16 provided sales data. Interviewees provided a mix of qualitative and quantitative results, which contributed to the team's understanding of the distributor sales data. The team estimates the data received represented 35 to 70% of the total market, depending on the product. .

Figure 2 shows the mix of participating distributors by relative size, distribution area and business model, compared to the mix of 53 distributors the team originally identified.

Figure 2: Mix of distributors in the sample compared to the population
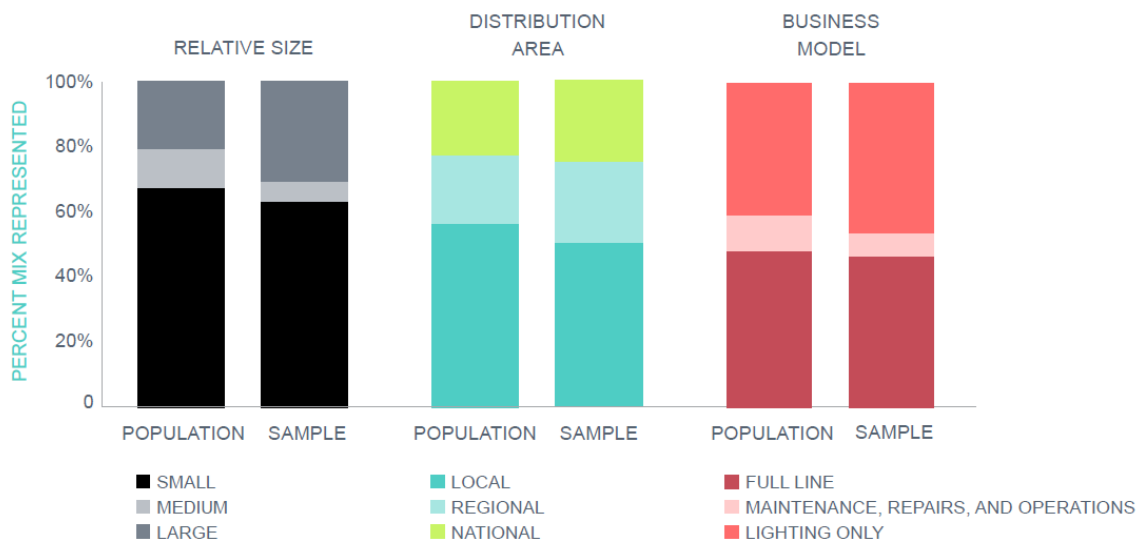
Source: Navigant and Cadeo analysis of distributor sales data

Figure 3 shows the share of distributor data received by state, along with state shares of total commercial floor space and known distributor branch locations by state for context. Relative to commercial floor

space, shipment quantity appears to be largely representative of the region with the majority of sales going to Washington (55%) and Oregon (33%)

Figure 3: Distributor Lamp Shipments, Floorspace and Branches by State
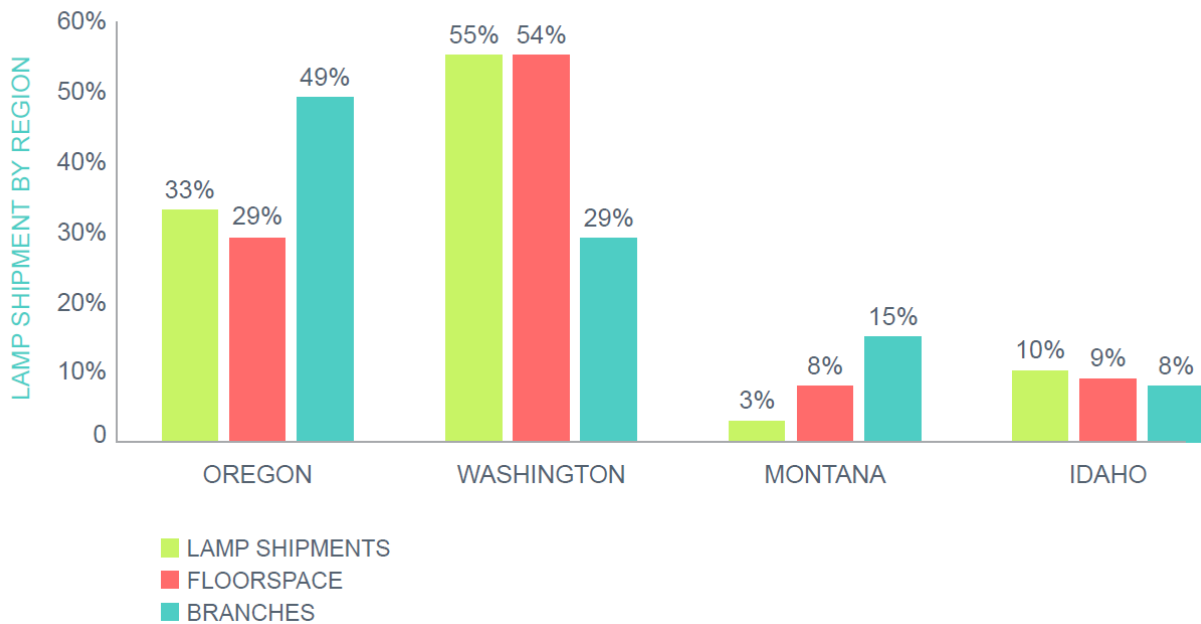
Source: Navigant and Cadeo analysis of distributor sales data

Data Quality

This section discusses the nature of the raw sales collected by BPA, its imperfections, and the methods the research team employed to standardize and clean the data in preparation for analysis. The research team found three common data imperfections requiring attention: incompleteness of the data, alternative formatting of the data, and scaling adjustments due to out-of-region sales, partial 2014 data, and distributor types. The following sections describe these imperfections and the steps the research team took to address them.

Incomplete Data: Reduced Granularity

BPA solicited the sales data from participating distributors using a pre-constructed survey form. Most of the lighting suppliers provided full datasets in the requested granularity, but two distributors only reported the total lamp sales within a category for 2013 and 2014. The two distributors did include full granularity for previous years so the research team applied the sales mix from 2012 to the two years of aggregate-only data.

Table 2 shows an example of reduced granularity in 2013 and 2014 where the number of sales at each relevant wattage level (e.g., 25W, 28W, 32W, other) is not specified as requested.

Table 2: Example of Incomplete Data: Reduced Granularity

Wattage	2010	2011	2012	2013	2014
25W	7,000	5,000	3,000		
28W	160,000	170,000	150,000		
32W	50,000	55,000	60,000		
Other	1,000	1,000	1,000		
Total	218,000	231,000	214,000	220,600	204,000

Source: Navigant and Cadeo
Note: Example data only

Incomplete Data: Missing Years and Technologies

Distributor sales data was also inconsistent in both the years provided and the technologies covered. For example, two lighting distributors submitted 2010-2012 sales data for the previous study conducted in 2014, but did not provide data for 2013 or 2014 as requested by the current study. Other distributors failed to report data for all lighting categories reflected in the data request. To assess the completeness of the data as received, the research team organized all sales data by distributor, technology, and year. The five technology groups requested were linear fluorescent (LFL), high intensity discharge (HID), LED, incandescent and halogen (INC/HAL) and compact fluorescent (CFL). Table 3 shows the total number of distributors that provided sales data by category for each year.

Table 3: Number of Distributor Datasets Received by Year and Technology

Category	2010	2011	2012	2013	2014
LFL	12	14	15	11	12
HID	12	14	15	9	12
LED	12	14	15	10	15
INC/HAL	6	6	7	9	10
CFL	6	6	7	9	10

Source: Navigant and Cadeo

The research team used a two-step sequence to address these deficiencies.

1. The team first computed the market shares—of total reported sales—for each technology category that was missing data using the distributor's market share from adjacent years. For example, if a distributor reported HID sales from 2010-2012 with an average market share of three percent, but failed to report sales in 2013, the team assumed a market share of three percent in 2013 and filled in the appropriate number of lamps accordingly.

2. With the total sales in a technology category filled out, the team filled out sub-categories using the same technique described in step 1 to add granularity to existing data (using the sub-category breakdown of an adjacent year for the same distributor). For example, if a distributor did not provide HID sales for 2013 but had reported HID sales from 2010-2012, the percentage

breakdown of lighting sub-categories in 2013 would be filled out using the observed percentages from 2010-2012.

These adjustments resulted in a more accurate distribution of lighting sales by year across the region. The team made these adjustments to the LED, LFL and HID technology sales but did not have sufficient data to fill in gaps for CFL or incandescent/halogen.

Alternative Data Submission Formats

Two distributors did not use the Excel-based form (Table 4) because they found it easier to provide a raw sales data extract for both 2013 and 2014. Navigant also leveraged similar data that NEEA collects from certain distributors as part of its Reduced Wattage Lamp Replacement initiative, to reduce burden on these participants.

Table 4: Example of Raw Sales Data Extract

Manufacturer	Category	Product ID	Product Description	Quantity	Date Sold
Sylvania	LFL	1001234	SYL FO32/741/XP/ECO 32W,48" MOL, T8	20	8/12/2014
Sylvania	LFL	1001234	SYL FO32/741/XP/ECO 32W,48" MOL, T8	15	8/11/2014
Philips	LFL	1003456	PHI F54T5 850 HO ALTO 40PK 13	35	8/13/2014
Sylvania	LFL	1001234	SYL FO32/741/XP/ECO 32W,48" MOL, T8	10	8/9/2014
Philips	LFL	1005678	PHI F32T8 TL850 ALTO 30PK 281	10	8/10/2014
Philips	LFL	1005678	PHI F32T8 TL850 ALTO 30PK 281	25	8/8/2014
Sylvania	LFL	1007890	SYL LS2/L/25/740/T5/UNV/BZ 25W FX	20	8/6/2014

Source: Navigant and Cadeo
Note: Example data only

The team sorted the raw sales into the appropriate lighting categories using the product descriptions to merge it with the data provided in the requested format. However, it was difficult and time consuming to accurately bin raw sales data due the cryptic and often disparate naming conventions used by lighting distributors. The size of the datasets further compounded this challenge. For example, one of the two distributors provided a dataset containing 65,000 unique sales transactions.

As a result of the task's scale and complexity, the research team automated the binning process to the extent possible. The team wrote a computer algorithm in SQL that searched for key text or alphanumeric strings associated with particular input fields—lamp type, wattage, light temperature—and then binned each sale into the BPA categories using its identified characteristics. The team completed multiple rounds of quality control to ensure the code identified characteristics and binned sales appropriately using the following steps:

- Review of initial results to catch mistakenly categorized data and identify any new patterns

- Review of revised results to confirm accuracy of updates

- Manual assignment of remaining product descriptions with significant sales using internet research

- Final quality control review

After each round of quality control the research team updated the code to improve its accuracy. The result of this process was an index of key product specifications such as type, length, and wattage which could then be used to bin unit quantities by desired specifications.

An initial source of ambiguity within the raw data was the convention of listing lamps per package in the lamp product description. Lamp product descriptions indicated anywhere from 1, to 10, to 30 or more lamps for a single line item while also listing lamp sales of this line item. After a conference with NEEA representatives, and reaching out to distributors who participated in the survey, the research team cleared up this discrepancy. Common practice in the non-residential lighting industry is to track products by packages, while selling individual lamps. Therefore, even in cases where a product description lists the product as a 30 pack, the distributor could indicate selling 10 lamps, broken out from this package.

The team took the following quality control steps for the review of linear lamp sales data received through NEEA's Reduced Wattage Lamp Replacement Initiative:

- **Filtering raw sales to include only in-region sales, as determined through distributor-specific branch location codes**. Distributors may submit data from branches outside of the Northwest and each distributor uses internal location codes to assign sales to each branch.

- **Cross-checking product designations with NEEA's categorization where possible**. NEEA's implementation team categorizes lamps as 25W, 28W, TLED, other T8, or other T5 or T12. The research team ensured that all final designations were consistent with NEEA's categories.

- **Double-checking lamp length assignments**. The team's initial analysis mislabeled three-foot 25W lamps as reduced wattage four-foot 25W lamps. This mistake is easy to make as the lamp naming conventions may only include lamp wattage. The following products illustrate this issue:

    o PHI F25T8/TL835/ALTO FL LMP is a three-foot, 25W T8 (wattage in beginning of product name)

    o PHI F32T8 ADV835 XLL ALTO 25W is a four-foot, 25W T8 (wattage at end of product name)

Other Adjustments to Raw Distributor Data

The research team also made three scaling adjustments to finalize the survey data and enable analysis:

1. Scaling of distributor sales to include only sales in the Northwest

2. Annualizing partial year 2014 data

3. Scaling for market share by distributor type

Sales Out of Region

Four of the 16 participating distributors reported that their data submittals included at least some sales outside the Pacific Northwest. These distributors also reported the percentage of sales occurring within the region, so the team scaled down the reported totals by this percentage to reflect only regional sales. The analysis team applied the percentage adjustment evenly across all lighting categories in the distributor's dataset.

Scaling of Incomplete 2014 Data

The research team began compiling data in the fall of 2014 and received partial 2014 data from seven distributors before the end of the calendar year. To extrapolate to a full year of sales, the team annualized 2014 sales based on submission date. This scaling procedure assumed that total sales are proportional to the number of days reported. Since the first distributor provided data in mid-November 2014, this assumption only led to small adjustments and did not impact total sales significantly.

Adjustment by Distributor Type

Not all distributors are alike. Some distributors have different business models that lead to different sales mixes. Using regional expert interviews, phone calls to distributors, and internet research, the lighting analysis team defined three types of lighting distributors—MRO, full line, and lighting only. The basic characteristics of each distributor type are as follows:

MRO distributors:

- Primarily serve scheduled regular maintenance orders

- Often receive orders online or via email

- Generally larger companies

Full line electrical distributors:

- Distribute 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 usually a small portion of overall business

Lighting distributors:

- Specialize in lighting.

- Often focus on new buildings, new spaces or system upgrades

- May specialize in a specific technology, such as LED

- Tend to have more efficient sales mix

Lighting distributors from all three categories submitted reports. However, compared to category mix estimations across the Northwest region, participation over-represented the full line category and under-represented the MRO and lighting only categories. The team adjusted for this discrepancy by scaling final lighting numbers in each distributor category up or down to make the survey totals more representative of the Northwest region.

The team estimated that MRO, full line, and lighting only distributors serve 60 percent, 20 percent, and 20 percent of the market respectively. The team developed market share estimates for each distributor type through a three step process. First, the team developed a census of all lighting distributors serving the Northwest non-residential lighting market. Second, based on interviews and web site research the team assigned each distributor to the one of the three categories. Third, the team estimated the market sure of

each individual distributor and summed the total market share represented by each of the three distributor types.

Estimating the market share of each distributor is not without uncertainty as no publically available data exists. The market share estimates were based on a synthesis of several sources, including the collected sales data, the number of branches per distributor, interview findings, and financial reports from those distributors that are publically traded companies.

Sales Data Findings

This section outlines the team's findings from the distributor sales data collected for the 2015 study.

The most prominent trend observed in the sales data is the rapid sales growth of LED lamps and fixtures. This growth was consistent across all distributor types and, as shown in Figure 4, for the region overall.

Figure 4: LED Unit Sales, 2010-2014
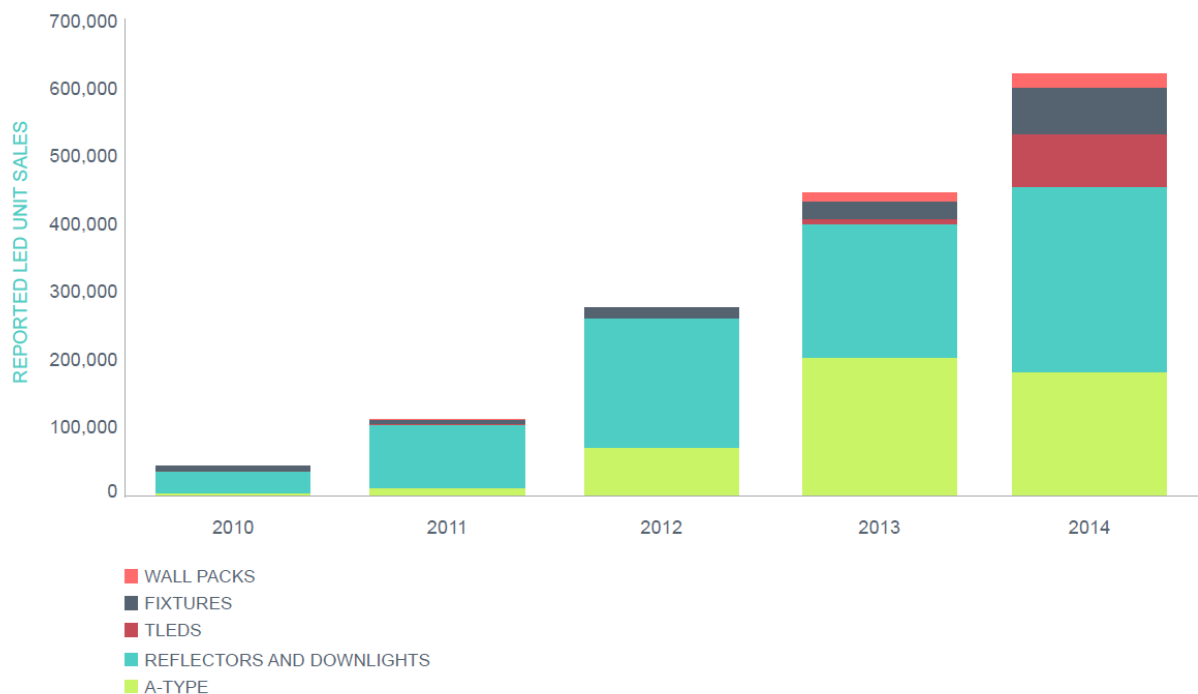
Source: Navigant and Cadeo analysis of distributor sales data

LED lamps appear to be penetrating all lighting applications and are taking market share from all incumbent technologies. As shown in Figure 4: LED Unit Sales, most LED unit sales are currently lamp replacement products, usually screw-in based. These LED reflector and general purpose A-line lamps typically replace incandescent, halogen, or compact fluorescent lamps. Several distributors noted how easily these lamps sold, as their prices are among the lowest of non-residential LED options. The reflector and general purpose lamp types have been in development and available longer than the other options. The data also suggests that growth may be slowing in LED A-line lamp sales from distributors relative to other LED applications. In contrast, Tubular LEDs (TLEDs) and fixtures showed tremendous growth in 2013 and 2014. TLEDs in particular saw very strong sales growth in 2014, despite tepid utility support due to quality concerns. Although they were nearly non-existent in 2013, manufacturers launched a myriad of next generation "plug-and–play" TLEDs—which run off the existing fluorescent ballast—with greatly improved performance and lower costs. TLED installation costs for these models can also be quite low as an electrician is not required to install a new fixture.

During interviews, distributors noted that prices have fallen significantly in recent years (Figure 5), creating

an entry point for TLEDs. However, many also noted that TLEDs remain five times the cost of highly efficient T8 fluorescent lamps, which have similar lifetimes in some cases.

Figure 5: TLED Prices, 2013-2020

Source: Navigant analysis of retailer websites

HID technology appears to be giving way to TLED lamps and fixtures (Figure 6). Manufacturers and distributors interviewed noted the long lifetimes made for a compelling value proposition for retrofit projects involving HID in high bay or outdoor applications. The reduced time electricians must spend on lifts replacing difficult to reach lamps reduces injury and temporary operation shut-down times. This justifies many of the initial capital costs of the relatively expensive LEDs. Additionally, interviewees noted that outdoor street lighting is an increasing application for LEDs. This appears to be a national trend as the two leading fixture manufacturers in the country also reported that outdoor new construction projects are virtually entirely LED.

Figure 6: HID Unit Sales by Type, 2010-2014
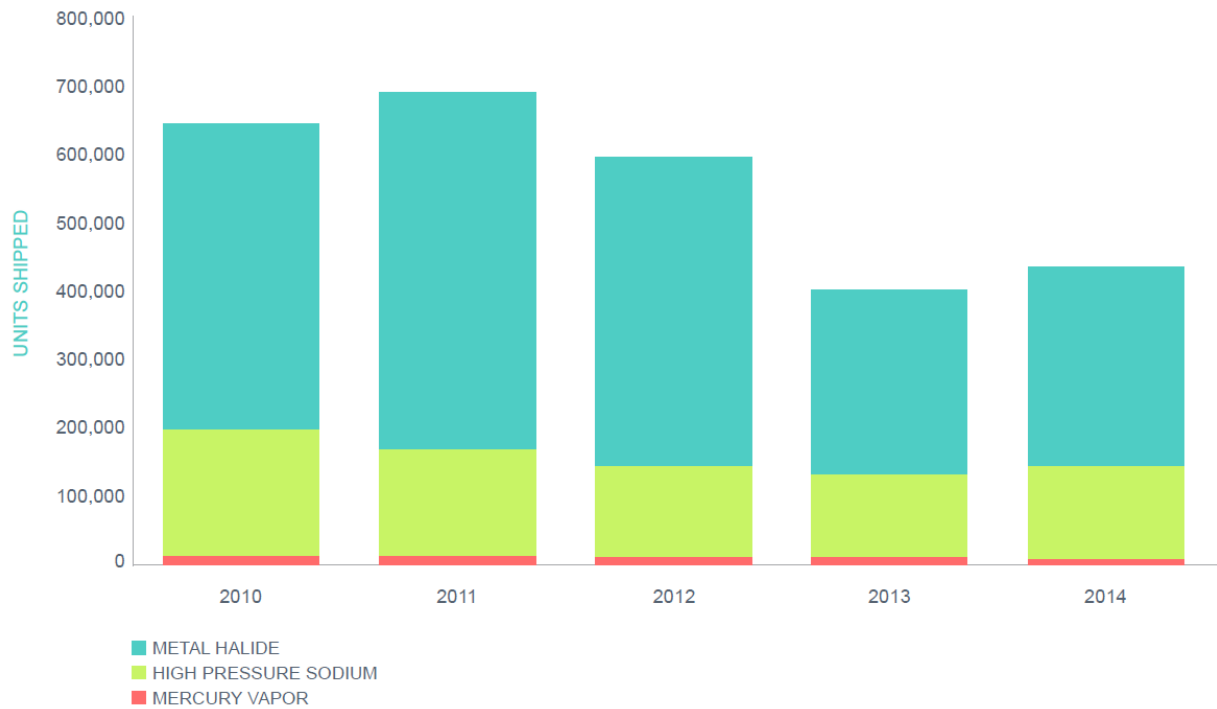
Source: Navigant and Cadeo analysis of distributor sales data

Prior to the growth in LEDs, existing HID applications were already prey to new linear fluorescent systems, typically of the T5 High Output and T8 variety. Distributor sales data shows that linear fluorescent lamps remain the dominant technology in the non-residential sector, albeit with a changing mix, as shown in Figure 7.

Figure 7: Reported 4ft Linear Fluorescent Sales, 2010-2014
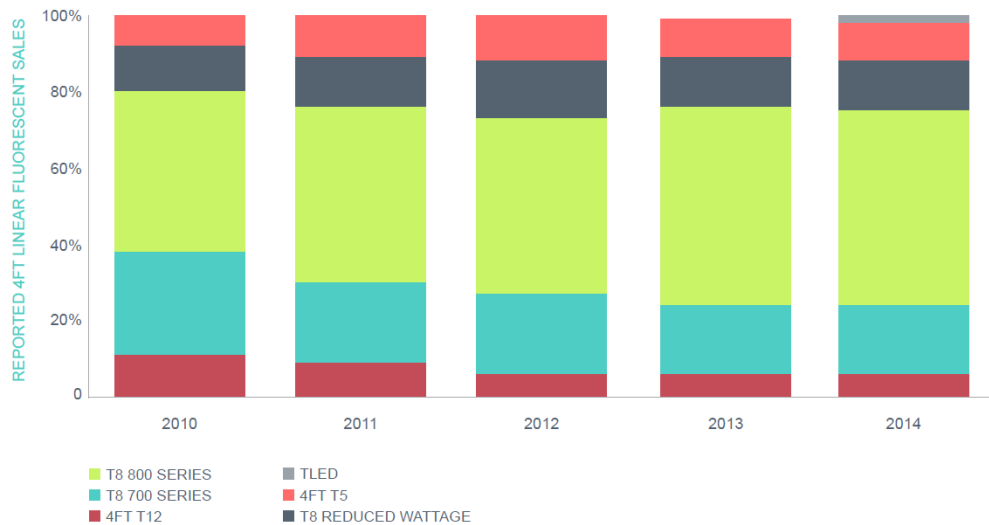
Source: Navigant and Cadeo analysis of distributor sales data

Market Structure

BPA also asked the team to inquire further about the impacts LEDs are having on the non-residential lighting market as a whole. The team used responses from the distributor, manufacturer, manufacturer representative, and utility program staff interviews, as well as secondary sources such as manufacturer and distributor annual reports, to get a better understanding of the current market structure and lighting supply chain.

In this chapter, the team first discusses the existing 'traditional' supply chain and market actors in the non-residential lighting market. Next, the team describes three underlying trends that are disrupting the market and illustrates how these trends impact key market actors.

The Current Market Structure

The research team used findings from the market actor interviews and input from BPA and NEEA lighting program managers, to create a simplified supply chain map for the current non-residential lighting market (Figure 8). As depicted, lighting products typically move from manufacturer to non-residential end-user through one of four market channels: distribution, retail, online only, and direct.

Figure 8: Simplified Lighting Distribution Chain
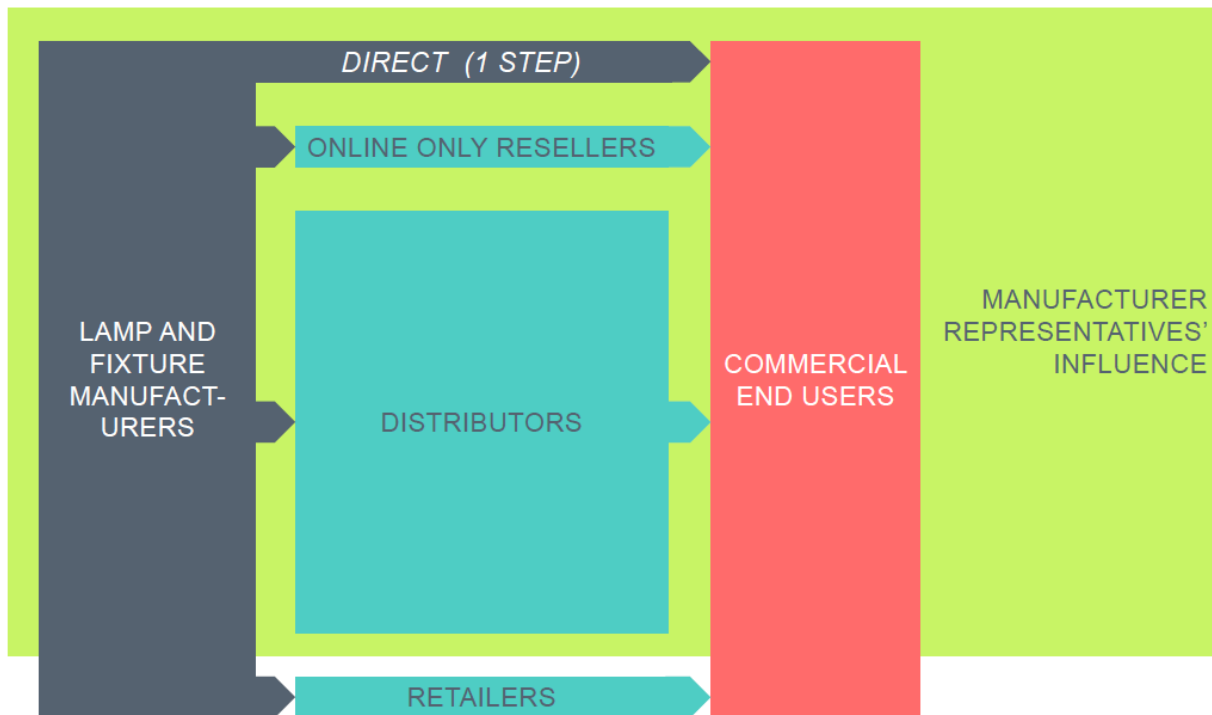
Source: Market actor interviews, Navigant and Cadeo analysis

There are two important nuances to keep in mind when reviewing the supply chain. First, the relative volume of sales through each channel varies based on the type of lighting product. Second, the physical flow of products does not always match the payment flow. The team discusses each of these caveats before detailing the roles of each of the market actors in the chain.

Product Type Variation

In the commercial sector, most lighting products flow from manufacturer to distributor to end-user. However, the share of total sales through each channel changes depending on the type of lighting product. The biggest difference is between screw-in lamps and fixtures. While fixtures for commercial applications almost never go through the retail channel, a relatively larger share of screw-in lamps do, especially A-type and reflector lamps.

Physical Flow versus Payment Flow

The physical flow of the lighting products can differ from the flow of dollars paying for those products. For example, it is not uncommon for fixture manufacturers to ship fixtures directly to the site of a large project. While a distributor doesn't physically touch these products, the flow of payment for those fixtures typically funnels from the end-user, through the distributor, back to the manufacturer.

There are several reasons manufacturers, particularly established manufacturers, do not sell directly to the end-user. First and foremost, they would be directly competing with their distributor customers. Second, distributors serve a valuable role for manufacturers in marketing their products, maintaining local availability, establishing local brand awareness, and providing logistical support such as managing warranty claims. Most manufacturers have taken the position that cutting out distributors on direct sales is not in their own long-term interest.

This distinction between physical flow and payment flow is important because it speaks to the representativeness of the sales data that the research collected. Even though some products physically flow directly from the manufacturer to the end-user, distributors capture the records of those sales because they are technically purchasing them from the manufacturer and reselling to their end-users.

Four Market Channels

The research team identified four distribution channels. Three of these—distribution, retail, and online-only—are similar in that they reflect two sales steps. That is, a manufacturer sells the lamps to a third-party (e.g., Grainger, Home Depot, 1000bulbs.com, etc.), which then sells to end-users. In this common two-step model, the third-party, or "middleman," takes actual ownership, if not physical possession, of the product and then resells it to the customer at some markup. By contrast, in the direct channel the manufacturer sells directly to the end-user.

Wholesale distribution. Traditional distribution remains the dominant channel through which most non-residential lighting products reach end-users. While the exact percentage varies by product type, the research team estimates that approximately 85% of total sales flow through distribution based on

interviews with manufacturers and distributors.[3] Not all of these sales actually sit physically at a distributor branch before being sold. Manufacturers "drop-ship" some portion directly from factory the project site. As discussed above, distributors usually book these sales, meaning they are accounted for in the sales data provided by to research team.

Retail. The research team estimates that less than 10% of the commercial lighting market flows through the retail channel, however additional research is necessary to quantify this estimate. For fixtures, the share is probably lower and for lamps it is probably higher. Retailers typically sell products through traditional brick and mortar storefronts and websites to smaller contractors who primarily serve the lamp replacement market. According to interviews, larger contractors and end-users tend to choose distributors over retailers, because they offer more product expertise and after-market sales support.

Online Only. The 'online-only' channel includes players, such as 1000bulbs.com, which are distinct from retailer and distributor websites in that they offer little or no aftermarket customer service. They also have no brick and mortar locations, but rather ship their products to the customer from central warehouses.

Direct. The direct channel, in which the manufacturer sells products directly to the end-user, appears to be the smallest portion of the market. No third-party reseller takes ownership in the direct channel. Interviews revealed two reasons for direct sales. First, a large national customer with buying power demands it. Second, new manufacturers, particularly LED manufacturers, do not have established relationships with distributors and need to sell directly to customers.

Manufacturer representatives. While not a channel, manufacturer representatives, sometimes called 'reps' or 'sales agents,' are an essential component of the distribution chain. Manufacturer representatives act as a broker, 'pulling' sales through the supply chain.

Figure 8 shows their sphere of influence. It is important to note that while manufacturer representatives can be independent or an in-house department of a manufacturer, they never take ownership of the product. Instead, they receive a commission on transacted sales and therefore tend to focus on higher priced fixtures rather than lamps.

Industry Disruption

LED technology has enabled three new underlying forces to disrupt the long held structure of the lighting industry. The first is the massive influx of new lighting companies. The second is a shift to longer life products. Lastly, LED technology is transitioning the lighting world from interchangeable replacement components—bulbs, ballasts, and fixture housing—to integrated systems. This section discusses how these forces have and will impact the lighting market structure and market actors described in the previous section.

Many New Manufacturers and Resellers

LED lighting has drawn thousands of new manufacturers and product resellers into the lighting market. As

---

[3] This estimate is corroborated by a literature review of lighting programs across the country that tentatively concluded seven percent of retail efficiency program sales ended up in non-residential applications. Cadmus, DNV-GL, Navigant, NMR, TetraTech, *Massachusetts Residential Lighting Cross-Sector Sales Research Memo*. March, 2015. http://ma-eeac.org/wordpress/wp-content/uploads/Residential-Lighting-Cross-Sector-Sales-Research-Memo.pdf

of April, 2015, more than 250 manufacturers have certified LED lighting products under ENERGY STAR's listing. More than 1000 manufacturers have qualified products on the U.S. Department of Energy's (DOE) LED Lighting Facts list. By comparison, according to the DOE, there are 15 manufacturers of linear fluorescent lamps. Unlike traditional lighting technologies, LED lighting technology has not has not matured and standardized to the point where economies of scale advantages are significant enough for large incumbent lighting companies to ward off new threats. Although this proliferation provides more LED lighting options for consumers, several distributors noted that many are of poor quality and, in some cases, may be the same product with a different brand name.

Product quality is a major issue with many new LED manufacturers, especially those from companies contracting with the thousands of manufacturers in China. One distributor noted that number of new LED suppliers was analogous to the explosion of mediocre CFL manufacturers in the early 2000s. Increasing LED regulation through listings such as the Design Lights Consortium, ENERGY STAR and the Lighting Design Lab, which require lifetime and efficacy tests[4] at the very minimum, have played an increasingly important role in setting minimum quality standards.

Despite this fragmentation, LED sales in the Pacific Northwest do not appear to be affected much by these lower quality products. Distributor sales data shows the majority of products sold come from the traditional 'Big Three' (GE, Philips, and Osram Sylvania), as well as some newcomers of substantial scale like Cree and Green Creative.

The influx of LED manufacturers and resellers is also impacting distribution channels as competition rises to get products into the hands of end-users. Many distributors interviewed spoke of new "remote control manufacturers" who do not design their own products, nor do they own the factories in which they are made. These manufacturers simply establish a supply source for lamps, brand them, market them, and then lean on existing distributors to get them into the hands of the public. Nearly all of the distributors interviewed reported being inundated with calls, emails, and marketing literature from this wave of new manufacturers and resellers.

Established fixture and lamp manufacturers have taken steps to wall off access to their distribution channels by pressuring or incentivizing their distributors and independent sales agents to exclusively stock and sell their own key product lines. This incumbent defensive maneuver requires newcomers to seek alternate modes of distribution, such as selling directly to consumers. Many have also partnered with online-only resellers like 1000bulbs.com. This small, yet growing component of the market is one reason wholesale distributors are changing the way they think about their lighting business.

Shift to Long Life Products

LEDs last up to 25 times longer than the lamps they replace. This is of great value to consumers who save the expense of continually replacing burnt out bulbs in a given socket. The inverse of this dynamic, however, has dramatic consequences for the lighting industry. All of those replacement bulbs—now unnecessary due to the long life of LEDs—no longer require manufacturing, stocking, or purchasing. The replacement cycle—the core of the bulb and ballast business—will shrink significantly. The team estimates

---

[4] U.S. Department of Energy, '*Understanding LM-79 Reports*'. March, 2012.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/understanding_lm79_reports.pdf

that 60 to 75% of current lamp sales flow into the maintenance market,[5] where this market shrinking has the most impact.

Manufacturers—and distributors through markups—could price LED lamps higher to capture some of the foregone future sales, but this is not the nature of competition amid technological disruption. New LED lamp manufacturers have no concerns about lost revenue from the legacy replacement cycle. Therefore, these new LED players are much more incented to drive adoption through aggressive LED pricing, making the adjustment to a long-life product world more troublesome for incumbent manufacturers.

For the traditional lamp manufacturers, change is inevitable. The introduction of LED technology has required these companies to shift strategy faster than at any point in their history. One distributor described the pace of LED technology changes as akin to the tech industry, more than anything seen in the historical rate of advancement for lighting products. The three largest incumbent lighting companies, Osram Sylvania, General Electric, and Philips, have been preparing for this change. In 2013, corporate giant Siemens spun off Osram Sylvania.[6] Soon after, Osram Sylvania decided to sell of its lamps business in order to focus on automotive lighting and services business segments.[7] In 2014, Phillips chose to sell its LED chip business, Lumileds,[8] which was ultimately purchased by a consortia of Chinese private equity investors. In 2015, Philips further announced its intention to sell at least a portion of the entire lamps and fixture business.[9] For its part, the GE lighting business has been rumored to be for sale for years, though the company continually denies it.[10] These conglomerates' strategic decisions reflect either a recognition that the legacy lighting businesses are not worth retaining in these corporate portfolios—because LED growth has not offset the revenue decline from traditional products—or that the competitive dynamics require smaller, more nimble companies to compete with the many new LED entrants.

Manufacturers are not the only ones disrupted by the change in business model long life lamps require. If manufacturers are selling fewer lamps, distributors will be stocking and selling fewer lamps as well. The steady 'stock and flow' lighting business for electrical distributors may look much different in a world of longer-lived products.

Shift from Products to Systems

The third trend, which to date has revealed itself more in manufacturer strategy than in recent sales trends, is the transition from standardized products to complete lighting systems: from lamps to luminaires, from products to solutions, and from interchangeable parts to integrated systems. This emerging transition has already changed the fortunes of entrenched lighting companies and disrupted

[5] Bonneville Power Administration. *Northwest Nonresidential Lighting Market Characterization 2010-2012*. May, 2014. http://www.bpa.gov/EE/Utility/research-archive/Documents/Northwest_NonRes_Lighting_Market_Characterization.pdf

[6] Osram. "World's largest pure-play lighting company goes public." Posted May 7, 2013. http://www.osram.com/osram_com/press/press-releases/_business_financial_press/2013/osram-is-independent/index.jsp

[7] Prodhan, Georgia. "Osram to separate from lamps and focus on automotive." *Reuters*. April 21, 2015. http://www.reuters.com/article/2015/04/21/us-osram-licht-divestiture-idUSKBN0NC1NG20150421

[8] Wright, Maury. "Philips plans spinout of Lumileds and automotive lighting business." *LEDs Magazine*. June 30, 2014. http://www.ledsmagazine.com/articles/2014/06/philips-plans-spinout-of-lumileds-and-automotive-lighting-business.html

[9] Van Groningen, Elco and Celeste Perri. "Philips to Sell Lighting Unit to Investors for $2.8 Billion." *Bloomberg Business*. March 30, 2015. http://www.bloomberg.com/news/articles/2015-03-31/philips-to-gain-2-8-billion-from-sale-of-lighting-unit-stake

[10] Higginbotham, Stacey. "Smart Lighting Heats Up." *Fortune*. May 22, 2015. http://fortune.com/2015/05/22/philips-ge-osram-smart-light-war/

long-held business practices in the distribution chain. This shift is not yet reflected in the available sales data due to the large existing stock of traditional lighting products (e.g., linear fluorescent and incandescent lamps), and because the immediate uptake of LED products has been in "easy" upgrade applications like screw-ins and TLEDs. However, many manufacturers shared during our interviews, and in their discussions of strategy in the investor literature, that they are looking ahead and actively preparing for this change.

There are forces working both for and against this trend. Direct lamp replacements remain the lowest cost way to achieve the energy savings offered by LEDs. The infrastructure of existing buildings works against this shift because it is relatively costly to retrofit entire spaces to integrated LED luminaires and systems, particularly if it is not part of the normal renovation cycle. On the other hand, several strong, long-term drivers of the transition to systems and solutions include:

Technical necessity for design optimization. All system components, from the LED chip (the actual light 'source') to the drive to the luminaire's optics and thermal management strategy, must be fully integrated and coordinated. The design and coordination required to optimize the overall LED system performance, means, to no small degree, that the fixture (luminaire) manufacturer is now the provider of the actual light source. This is particularly true given the supply chain for LED lighting componentry is so fragmented and currently lacks standardization.[11]

Fewer replacements. The shift to long-lived products is shrinking the traditional lamp maintenance market that currently accounts for the majority of unit sales. This makes other purchase events[12] such as renovations, retrofits, and new construction—lighting projects—relatively more important. Such purchase events are more likely to feature fixture and lighting systems.

Market need for differentiation. With intense price competition in the LED market, there will be ever more pressure to differentiate products. LEDs enable a wide variety of differentiation opportunities, including aesthetic and architectural design appeal, and enhanced functionality like advanced controls. Both of these differentiators occur largely at the fixture level, as some LED replacement lamps are already approaching commoditization.

Controls. One strategy manufacturers expect to employ to add value to their lighting solution portfolio, is the integration of total lighting system controls. Several new control companies have built solutions around 'smart' systems offering advanced features, and large existing manufactures are actively acquiring or partnering with such companies.

The team also interviewed market actors regarding their sales of controls, and their interest in pursuing control systems in the future.[13] In terms of sales projections, most distributors expected strong growth in the controls segment, while a small number projected flat sales. No distributors projected declining sales.

---

[11] Industry Groups, including the Zhaga Consortium, have made attempts to promote standardization and compatibility among manufacturers of LED lighting systems, though it is too early to determine when and how this effort will impact the market.

[12] "Purchase event" refers to the reason or trigger for the purchase of a given lamp system. Primary purchase events include new construction, lamp failure, retrofit, and renovation. Please see BPA's *Northwest Nonresidential Lighting Market Characterization 2010-2012* (http://www.bpa.gov/EE/Utility/research-archive/Documents/Northwest_NonRes_Lighting_Market_Characterization.pdf) for a full description.

[13] The research team requested sales data for various types of dimmers and controls, but, unfortunately, received limited data. As a result, the research team cannot be confident that the data is representative of the total regional non-residential lighting market and draw reliable conclusions. Therefore the team opted to exclude quantitative results on controls.

There is a large and growing interest in dimming products and integrated controls, but these technologies are still considered too expensive to install without a utility incentive. Distributors said that their customers are aware of integrated controls, but that non-residential end-users and contractors still know very little about them. Some distributors admitted their own lack of education in controls, limited their ability to promote these advanced systems.

Currently, product compatibility and complexity of installation still do not justify the cost of control systems for many end-users, but as mentioned, the make-up of the lighting industry is changing very rapidly.

Impact on Market Actors

This section discusses the impact of the changes to the non-residential lighting market on manufacturers, distributors, and manufacturer representatives.

Manufacturers. The shift to longer life solutions in the lighting market is changing the balance of power between lamp and fixture manufacturers. The traditional non-residential lighting market was one in which bulbs, ballasts and fixtures could be sold separately from any number of manufacturers and then installed on site with little technical skill. It was a high-volume, interchangeable component-based industry in which companies gained competitive advantage through economies of scale. The shift to lighting system design places the maker of the system, the luminaire manufacturer, as the coordinator of the various design elements, and at the top of the value chain.

This is particularly true for the commercial new construction and retrofit market, where traditional lamp manufacturers are now marketing themselves as "lighting solution providers." They offer customers an overall lighting experience rather than just a manufacturer of replacement units.

Distributors. The new lighting market represents both a threat and an opportunity to distributors. The prospect of a greater share of large project sales, combined with a potential lack of standardized interchangeable components, could reduce the manufacturer's need for the distribution channel altogether. Manufacturers could move into the direct market channel, or rely on manufacturer representatives to sell their lighting solutions. On the other hand, distributors have the opportunity to provide value-added lighting consulting services in a project-based market. Instead of passively waiting for their contractor customers to buy bulbs at their branches as in the past, distributors could focus on creating demand by developing lighting expertise and marketing to end-users about the benefits of retrofits.

Manufacturer Representatives. Manufacturer reps benefit in much the same way as fixture manufacturers from the shift to a system-based lighting world. First, manufacturer reps are primarily focused on fixtures and higher value-added systems will provide higher priced equipment to sell. Second, as discussed previously, the most likely time for these systems to be installed will be during major lighting projects often occurring as part of the renovation or new construction projects. Architects and lighting designers—a core customer base for manufacturer representatives—typically specify systems in request for proposals on which manufacturer reps bid. If this portion of the market becomes increasingly relevant, manufacturer representatives will become increasingly important as well.

Momentum Savings

With the rapid emergence of LED technologies and continued shifts in linear fluorescent and HID product mixes, non-residential lighting has been and will continue to be a major source of energy savings for the region. While programs capture a large portion of these energy savings, there are many end-users who choose efficient options without receiving financial incentives directly from a utility. These choices are reflected in the sales data collected through this research and they result in Momentum Savings. Many factors may drive such choices, including the "momentum" generated by past efficiency programs, new codes and standards, corporate sustainability policies, and technology trends. Momentum Savings are energy savings that are:

- Cost-effective

- Not directly paid for by utilities

- Not part of the Northwest Energy Efficiency Alliance's (NEEA) Net Market Effects

- Above the Northwest Power and Conservation Council's Power Plan baseline (Council baseline)

BPA charged the research team with estimating the Momentum Savings that the region has achieved since the beginning of the Sixth Plan period in 2010. This section describes the methodology currently used for this analysis. As noted in the foreword to this report, BPA is releasing this report with "DRAFT" estimates for Momentum Savings in the non-residential sector for two primary reasons. First, the team does not believe it can fully characterize the uncertainty in its regional Momentum Savings estimates because the current model does not lend itself to robust sensitivity analyses.

Second, the model underlying our savings estimates falls short of the level of transparency BPA needs to enable thorough third-party review. The team has redoubled efforts to remedy these shortcomings in a future report. Specifically, the team is:

- Redesigning the Momentum Savings methodology and model from the ground up
- Investing in targeted new data collection to reduce the uncertainty around critical inputs
- Exploring new modeling platforms to facilitate third-party review, improve uncertainty analysis capabilities, and increase the transparency of the model's inputs, methods, and results

The team has included a short description of key input and modeling areas this future work will address at the end of this section.

The research team answered four key questions to calculate Momentum Savings from the commercial, industrial, and outdoor lighting markets during the analysis period 2010 through 2014. These questions are as follows:

1. What is the market?

2. How big is the market?

3. What are the total market savings?

4. What are the program savings?

Questions 1 and 2 define the lighting market for the purposes of this analysis and estimate its size in terms of total lumen demand. Question 3 presents the methods for calculating the total lighting consumption in average megawatts (aMW) for both the baseline and actual market scenarios. Question 4 defines the program savings achieved in the lighting market. Together, the results of the Four Questions will enable the estimation of Momentum Savings.

Question 1: What is the market?

Question 1 defines the product types, sectors, applications, and geographies included within this analysis. For purposes of this analysis, the research team considers the market to be the total lumens shipped annually to the Northwest to meet the non-residential lighting demand. The team defines the non-residential sector[14] as:

- Commercial buildings

- Industrial buildings

- Outdoor lighting[15]

The current analysis does not include lighting controls.

Question 2: How big is the market?

The research team characterized this non-residential lighting market size in terms of *total lumen demand* for each year of the analysis period. Total lumen demand is the amount of lighting needed in the market, independent of the lighting type or number of fixtures needed to provide that lighting. This analysis assumes that the total lumen demand remains the same in both the baseline and actual scenarios; this is an assumption that the team may revisit in the upcoming methodology redevelopment. Total lumen demand is calculated as the product of three factors:

1. Affected Square Footage

2. Baseline Lighting Power Density (watts per square foot)

3. Baseline Efficacy (average lumens per watt)

Affected square footage includes three scenarios which require new lighting equipment in a given year: new construction, system replacements and upgrades ("natural replacement"), and maintenance (replacing burned out lamps). Figure 9 illustrates the approximate relative magnitude of each of these scenarios' affected square footage using the total commercial and industrial floor space in the region.

---

[14] Note that the analysis does not model agricultural floor space separately, but the overall market efficiency mix in each year does include products shipped to agricultural facilities.

[15] Outdoor lighting includes parking lot lighting, building exterior lighting, street lighting, and outdoor lighting at stadiums and other facilities.

Figure 9: Types of Affected Floor Space in a Given Analysis Year
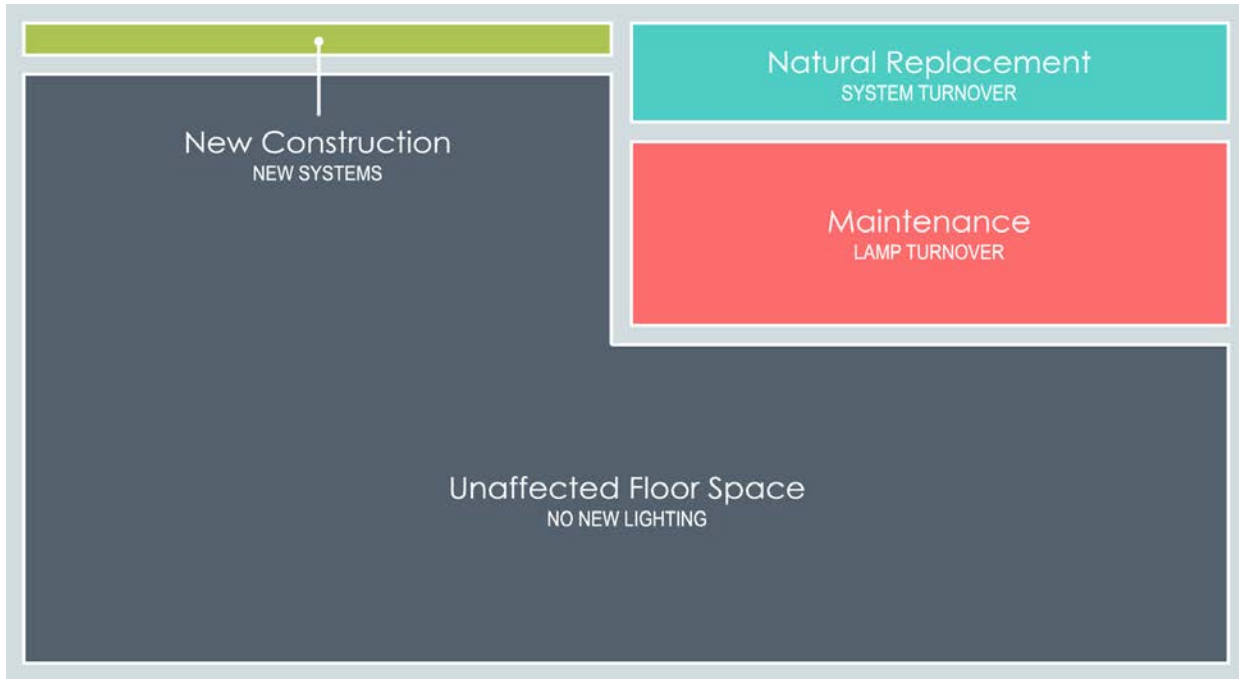
Source: Research team analysis

The research team estimated square footage separately for each of the three scenarios in the commercial, industrial, and outdoor segments, for each year of the analysis. New construction square footage estimates are straightforward, as all new construction square footage will require new lighting. Natural replacement and maintenance square footage estimation requires an estimate of the total existing square footage, as well as an assumed turnover rate (i.e., the percentage of systems or lamps that will be replaced in any given year, based on average system/lamp lifetimes and operating hours). Table 5 summarizes the data sources and calculations for each scenario/sub-market combination.

Table 5: Sources for Affected Square Footage Calculations

Sub-Market	New Construction	Natural Replacement/System Upgrades	Maintenance
Commercial	Seventh Plan assumptions	Estimated using Seventh Plan assumptions of existing square footage and Sixth Plan assumptions of system turnover rates	Estimated using Seventh Plan assumptions of existing square footage (excluding natural replacement square footage) divided by average lamp lifetime in years[16]

---

[16] Individual technology lifetimes from DOE SSL General Illumination and LED Adoption Reports, weighted by mix of technologies in 2010 stock. Mix of technologies from a regional lighting model developed by Navigant for 2014 lighting standards research.

Sub-Market	New Construction	Natural Replacement/System Upgrades	Maintenance
Industrial	N/A; assumed to be zero	Estimated using Energy Information Administration (EIA) data on manufacturing square footage[17] and the Sixth Plan's system turnover rate assumption for the warehouse space type	Estimated EIA data on manufacturing square footage (excluding natural replacement square footage) divided by average lamp lifetime in years
Outdoor[18]	N/A: Outdoor wattage driven by sum of commercial and industrial square footage		

Source: Research team analysis

The analysis assumes that affected square footage each year remains constant in both the baseline and actual scenarios.

Baseline lighting power density (LPD), measured in watts per square foot, LPD is necessary to estimate the total watts sold in the baseline scenario, as well as, the total lumen demand. LPD is the metric representing the Sixth Plan's assumptions on baseline efficacy and lighting technology mix. The Sixth Plan assumes different LPDs for new construction/natural replacement scenarios and maintenance lamp replacement for each commercial space type. Since the Sixth Plan did not define LPD for the industrial sector, the research team adjusted the Sixth Plan's LPD for the warehouse space type based on the difference between the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) codes for manufacturing and warehouses. The team used ASHRAE 90.1-2007 code minimum LPDs in Equation 1 below to extrapolate Sixth Plan assumptions to the industrial sub-market. The team chose the warehouse building type in the Sixth Plan since high bay lighting is common in both warehouse and manufacturing spaces.

<div align="center">Equation 1: Industrial LPD</div>

$$\text{Adjusted Industrial LPD} = \text{Sixth Plan Warehouse LPD} \times \frac{\text{ASHRAE Manufacturing LPD}}{\text{ASHRAE Warehouse LPD}}$$

Table 6 summarizes the LPDs used for each type of affected floor space in the commercial and industrial sub-markets.

---

[17] The project team estimated total industrial floor space by scaling down EIA's estimated national manufacturing floor space using US Census data on manufacturing employment nationally and in the region.

Energy Information Administration. *2006 and 2010 EIA Manufacturing Energy Consumption Survey*, Table 9.1 Enclosed Floorspace and Number of Establishment Buildings; http://www.eia.gov/consumption/manufacturing/data/2010/ and http://www.eia.gov/consumption/manufacturing/data/2006/

US Census. *US Census, Statistics of U.S. Businesses* 2009, 2010, 2011, 2012 datasets - Sum of Manufacturing Employment in All States and for Northwest States (Idaho, Montana, Oregon, Washington)

All sets available at: http://www.census.gov/econ/susb/historical_data.html

[18] For outdoor lighting associated with buildings the team accounted for other exterior lighting (predominantly street lighting) by scaling down national outdoor application shipments (in watts) estimates from DOE's *2010 Lighting Market Characterization*. Scaling was done using national commercial floor space estimates from the EIA and regional commercial floor space estimates from the Sixth Plan.

U.S. Department of Energy. *2010 Lighting Market Characterization. 2012* http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf.

Table 6: LPDs Used to Calculate Watts Shipped by Floor Space Type

Floor Space Type	Commercial LPD Applied	Industrial LPD Applied	Outdoor LPD Applied[19]
New Construction	Sixth Plan "New" LPD	N/A	Exterior Watts per Interior Square foot for New Vintage in 2014 CBSA
Natural Replacement		Adjusted "New" LPD	
Maintenance	Sixth Plan "Existing" LPD	Adjusted "Existing" LPD	Exterior Watts per Interior Square foot for Existing Vintage in 2014 CBSA

Source: Research team analysis

The team then multiplied the total affected floor space by the selected LPD for each sub-market and floor space type to estimate the total watts shipped in the baseline scenario. The watts shipped and LPD of the floor space are specific to the baseline scenario, but affected square footage is constant for both the baseline and actual scenarios.

The outdoor LPD in Table 6 only accounts for outdoor lighting associated with buildings. For outdoor lighting not associated with buildings (namely street lighting), the team scaled down national outdoor lamp shipments using the Northwest share of commercial floor space.[20]

Figure 10 presents a schematic flow diagram of the calculation of total watts shipped in the baseline scenario for the commercial sub-market.

---

[19] For outdoor lighting associated with buildings only.

[20] National shipments source: DOE. *2010 Lighting Market Characterization,* 2012. Tables 4.27 and 4.28: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf; National floor space: U.S. Department of Energy, *Buildings Energy Data Book.* Table 3.2 Commercial Sector Characteristics: http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.2.1; Northwest floor space source: Seventh Power Plan assumptions, provided via email from Massoud Jourabchi, May 1 2015.

Figure 10: Calculation of Watts Shipped for the Baseline Scenario (Commercial only)

KEY

| SQUARE FOOTAGE | WATTS | LIGHTING POWER DENSITY | TURNOVER RATE (%) |

All data except maintenance turnover from 6th plan
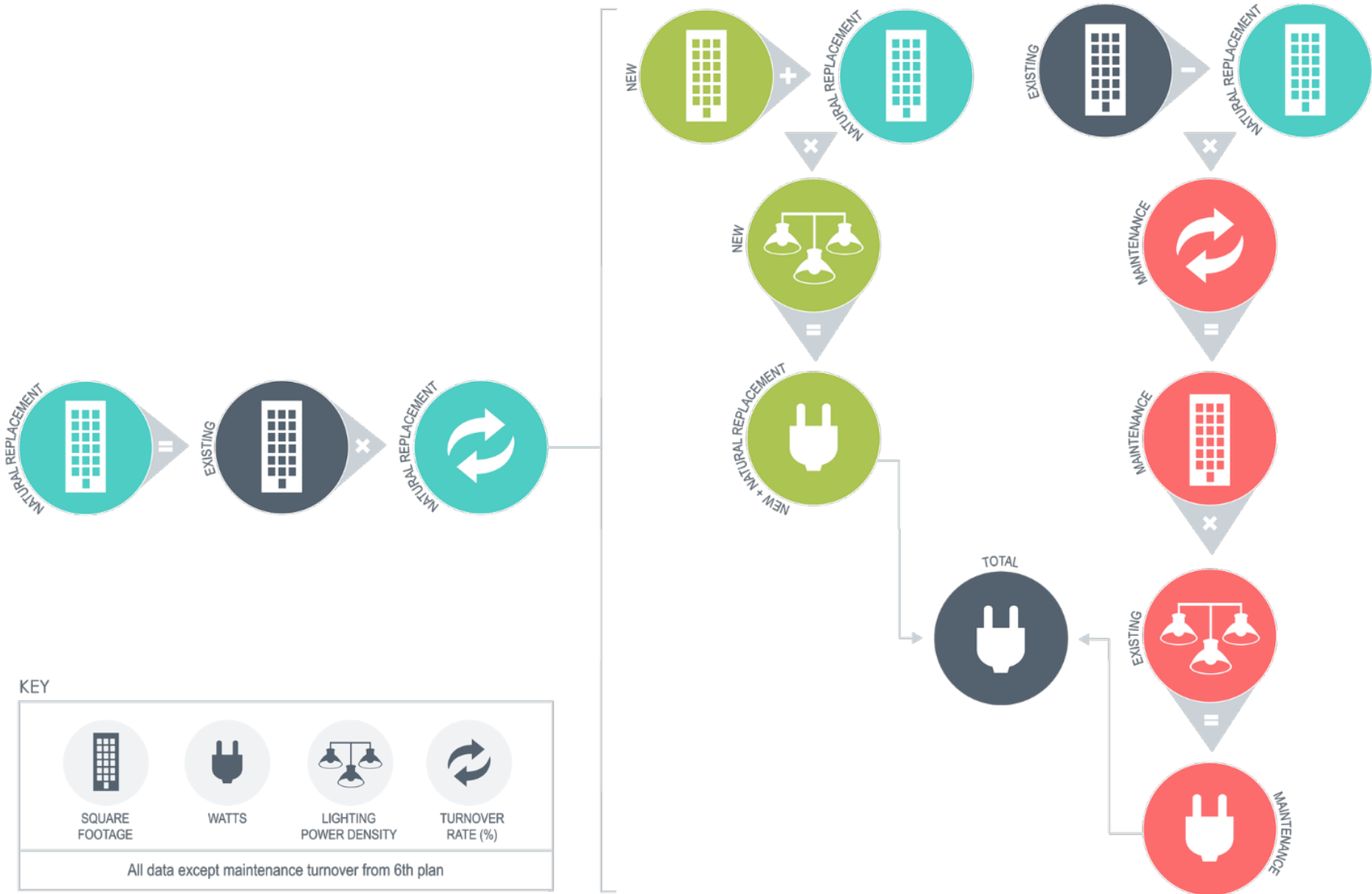
Source: Research team analysis

The team estimated watts shipped separately for new construction/natural replacement and maintenance lamps in the commercial and industrial sectors, then summed those estimates (along with an estimate of the total non-building exterior watts, calculated separately) to estimate **total annual watts shipped in the baseline scenario**. The total annual watts shipped in the baseline scenario is used in the calculation of total baseline energy consumption in Question 3, as well as, multiplied by the baseline efficacy to determine total lumen demand as discussed next.

Baseline efficacy, measured in lumens per watt, is the average efficacy of lighting wattage shipped each year, based on a calculated 2009 baseline and frozen across the remaining years of the analysis. The baseline efficacy is based on DOE lamp and ballast rulemakings data on typical system efficacies weighted by the actual sales mix of different system types as indicated in the distributor lighting sales data. The team first calculated efficacy for the actual market scenario from 2010 – 2014 using distributor sales data and the analysis described in detail in Question 4. The team estimated that products sold in 2009 were most representative of products installed and in operation in 2010, the first year of the Sixth Plan. The team thus sought to "backcast" an estimate of the actual 2009 average sales efficacy from the 2010 – 2014 results.[21]

Finally, the **total lumen demand** (i.e., market size) is calculated by multiplying the total watts shipped in the baseline scenario by the baseline efficacy (lumens per watt).

Question 3: What are the total market savings?

The amount of energy used by non-residential lighting in a given year depends on three factors: the size of the market at that time (in lumens, defined above in Question 2), the efficacy of lighting products entering the market at that time (in lumens per watt, defined above in Question 2) and the operating characteristics of that lighting (e.g., operating hours, HVAC interactions, etc. provided by the Sixth Plan).

Total market savings are equal to the difference between baseline consumption and actual consumption. Questions 3a and 3b will enable the estimation of total market savings by calculating the total energy consumption for both the baseline and actual market scenarios, respectively.

Question 3a: What was the energy use when the Power Plan was written?

To convert the watts shipped (MW) in the baseline scenario to annual energy consumption in aMW, the research team used the following equation:

Equation 2. Lighting Consumption (aMW) for the Baseline Scenario

$$\text{Annual aMW}_{baseline} = \frac{MW_{baseline} \times \text{Annual Operating Hours} \times \text{HVAC Interaction Factor} \times \text{Busbar Factor}}{8760}$$

Table 7 summarizes the factors that comprise Equation 2.

---

[21] Since there were not significant changes in standards or program activity during the 2010-2012 analysis period, the team used a linear backwards extrapolation to estimate 2009 efficiency levels in the market.

Table 7: Inputs to Convert New Watts Shipped to aMW for the Baseline Scenario

Input	Value	Description
MW $_{baseline}$	Variable	Millions of Watts shipped in the baseline scenario (defined in Question 2)
Hours	4,062	Weighted average operating hours for non-residential lighting (defined in the Sixth Plan)
HVAC Interaction Factor	0.998	Weighted average interaction factor accounting for electric heating and cooling benefits and penalties (defined in the Sixth Plan)
Busbar Factor	1.09	Accounts for transmission losses to reflect savings at generation (defined in the Sixth Plan)

Source: Research team analysis

Question 3b: What was the energy use in the following years?

The research team used the same equation for calculating the lighting consumption in the actual market scenario, substituting watts shipped in the actual market scenario for watts shipped in the baseline market scenario. All other input values remained constant across both scenarios.

Equation 3. Lighting Consumption (aMW) for the Actual Market Scenario

$$\text{Annual aMW}_{actual} = \frac{\text{MW}_{actual} \times \text{Annual Operating Hours} \times \text{HVAC Interactive Factor} \times \text{Busbar Factor}}{8760}$$

The actual watts shipped are calculated by multiplying the total lumen demand by the actual market efficacy. The team estimated actual market efficacy for each year of the analysis based on market share data from the regional lighting stock model and distributor sales data, as well as, efficacy data from DOE and other secondary sources. The analysis steps for calculating actual market efficacy from lighting sales data in each year are as follows:

- **Step 1. Characterize the efficacy of lamp-ballast systems (Linear fluorescent and HID systems only)**. The research team used data from the most recent DOE lamp and ballast rulemakings to detail the typical system efficacy characteristics for all lamp-ballast combinations likely found in commercial and industrial buildings.[22]

  Output: A data table including detailed characteristics for all practical combinations of lamps and ballasts, including ballast type, lamp length, wattage, and quantity of lamps per fixture, available for installation each analysis year.

---

[22] Based on data from the 2009 General Service Fluorescent Lamp DOE rulemaking and from the 2011 Fluorescent Ballast DOE rulemaking. Navigant was the lead DOE contractor on many technical analyses for these rulemaking processes.

- **Step 2**. **Roll up sub-type characteristics to produce a representative efficacy for each technology and lamp type**. The research team rolled up the detailed lamp sub-type data into a single weighted-average efficacy for lamp type (T8, T5, etc.) and for each of the five lighting technology groups: Linear fluorescent, HID, LED, incandescent and halogen, and compact fluorescent. This roll up included, among others, analysis of the impact of various ballast systems, varieties in LED efficacy, and lamp counts per linear fluorescent fixture. For example, the linear fluorescent category has the following underlying weights:

  - Weights for individual lamp types: T8, T5, and T12

  - Weights for individual lamp sub-types: i.e., 25W T8, 28W T8, 700 Series 32W T8, 800 Series 32W T8

  - Weights within lamp sub-types for ballast efficiency shares and lamp counts per linear fluorescent fixture

Output: Representative efficacy for each technology type.

- **Step 3. Weight the technology-level efficacy data to reflect each technology's share of the market.** The research team used shipment estimates from the regional lighting stock model to estimate the distribution of sales by technology for the entire region.[23] This model, built to estimate the impacts of lighting standards on regional sales, referenced the distributor sales data collected as part of this assignment, as well as, DOE rulemaking shipment data. The team also checked the mix of technology in this stock model against the latest CBSA results to ensure consistency. The team then weighted the representative efficacy value for each lamp type using this distribution of sales, to calculate a single weighted-average efficacy value to represent all lamp sales in each year.

Output: A single weighted-average actual market efficacy value for each year of analysis.

  - The team then multiplied the total lumen demand (as calculated in Question 2) by the actual market efficacy (watts per lumen) to estimate the total actual market watts sold (MW_{actual}) needed in Equation 3 to estimate total actual energy consumption. Finally, the team subtracted the total actual energy consumption from the baseline energy consumption to estimate total market savings.

For a diagram of the lamp sub-type roll up steps, see Appendix E. Schematic Summary of Market Efficacy Calculation.

Question 4: What are the program savings?

Momentum Savings, by definition, exclude electricity savings achieved through efficiency programs in the region. The research team obtained estimates of programmatic savings from program data provided by BPA, NEEA, ETO, and non-BPA utilities. However, to subtract these programmatic savings from the total market savings, both values must be measured from the same baseline. This is not always the case for

---

[23] Bonneville Power Administration. *Non-Programmatic Savings from Appliance Standards*, August, 2014.
https://www.bpa.gov/EE/Utility/research-archive/Documents/Non-Programmatic%20Savings-%20Appliance%20Standards%20Report.pdf

lighting due to the following conditions:

- Most lighting programs claim savings from a pre-condition baseline: energy savings are calculated as the difference between the new system and what was previously installed.

- Since the Sixth Plan models natural turnover with average market efficiency levels for new systems, the Sixth Plan baseline is in effect a current practice baseline. Energy savings above the Sixth Plan baseline are calculated as the difference between the new system and the market average alternative product.

The result of this baseline discrepancy is that the program savings to be subtracted out of total market savings in the Momentum Savings calculation will be smaller than the program-reported savings, because they are measured against a higher baseline.

The research team determined how to adjust the program-reported savings to a current practice baseline by estimating the difference between 1) the baseline efficacy as estimated for 2009 in Question 2 above (i.e., a current practice baseline) and 2) the average efficacy implied in the 2009 CBSA stock mix (a proxy for the pre-condition baseline). The research team approximated the pre-existing condition baseline efficacy for programs using the 2009 CBSA stock mix of T8 and T12 linear fluorescents and the estimated average efficacies of each technology in 2009. The team then used this average pre-existing condition baseline for linear fluorescent (the bulk of program savings) to determine the share of program savings that accrued above and below the Council baseline. The team removed the portion of program savings below the Council baseline to calculate the final program savings needed in the Momentum Savings calculation. Figure 11 illustrates the relative magnitude of each type of savings over the analysis period.

Figure 11: Draft Momentum and Program Savings Relative to Sixth Plan (aMW)
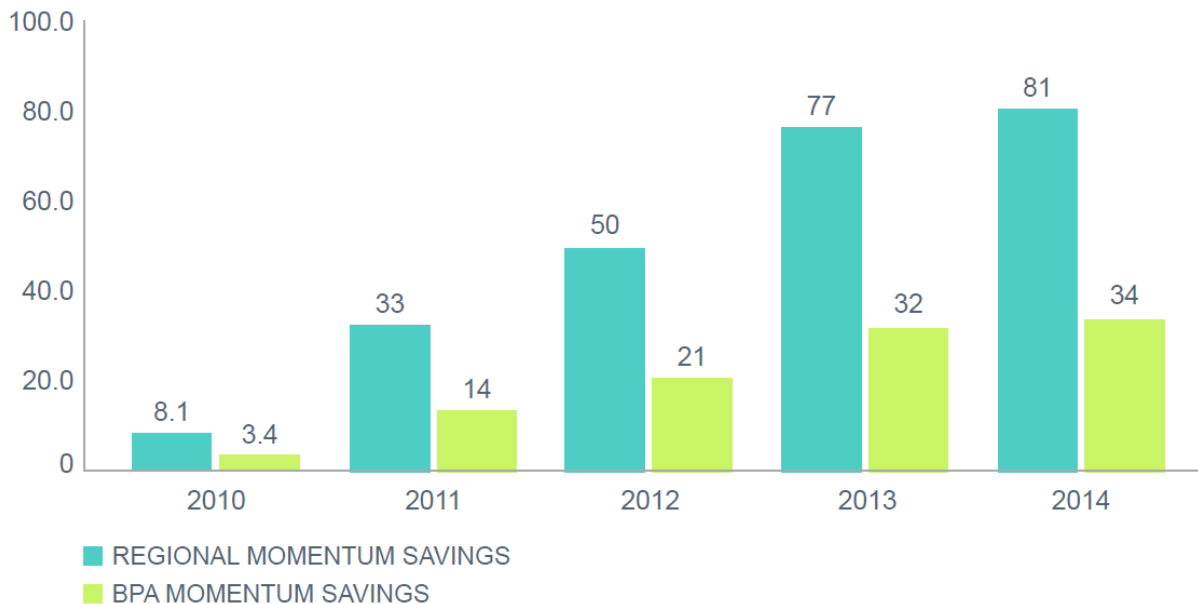
Source: Navigant and Cadeo analysis

Momentum Savings Results

Table 8 summarizes the draft Momentum Savings totals for the Northwest region and for BPA.

Table 8: Draft BPA and Regional Momentum Savings, 2010 - 2014

	2010	2011	2012	2013	2014	Total
Regional Momentum Savings (aMW)	8.1	33	50	77	81	**249**
BPA Momentum Savings (aMW)	3.4	14	21	32	34	**105**

Source: Navigant and Cadeo analysis

Upcoming Momentum Savings Methodology Development

The lighting research team is working with BPA to re-examine several aspects of this methodology. The objectives of this effort are to ensure that the next version of the model is more robust and transparent, and that it can produce sensitivity analyses to help stakeholders understand the uncertainty associated with Momentum Savings estimates. Elements the team will revisit include:

1. The assumption of constant lumens between the baseline and efficient lighting cases and implications of improvements in fixture efficacy

2. Lamp and system turnover rates

3. The modeling approach for both the natural replacement and maintenance markets, as well as treatment of lamps turning over multiple times within the analysis period

4. Incorporation of lighting controls

5. Specific characterization of the outdoor and industrial sectors

6. Options for gathering additional data sources to support market size estimation

Key Findings and Recommendations

This section presents the key research findings from this study and makes recommendations to BPA and other program planners based on the research.

Key Findings

The team offers the following key findings from the study:

1. **The LED market's rapid development offers many efficiency opportunities and challenges.** Price declines, efficiency improvements, and rapid product development have created tremendous energy savings opportunities, while also challenging the timely management of savings estimation, baselines, rebate levels, and qualified product lists.

2. **Lighting will increasingly be about complete systems, not light bulbs.** The technical nature of LEDs enables a variety of new features, controllability, and form factors. As longer product lifetimes result in fewer replace-on-burnout 'widget' sales, it becomes increasingly important for manufacturers to shift to full system products as opposed to lamps and ballasts.

3. **The LED transition is changing the points of influence in the lighting distribution chain**. Fixture manufacturers and their sales representatives in the field will likely have more influence as the market becomes more project-based and shifts from bulbs to lighting systems. This shift will reward those market actors with expertise in lighting controls and lighting design as well as those who can communicate both the energy and non-energy benefits of advanced lighting systems to potential customers.

4. **Regulatory 'loopholes' and the uneven adoption of LED technology across all applications means some pieces of the lighting market have more efficiency potential than others.** Many of the recent lighting standards do not apply to the full range of products they appear to cover. These 'coverage gaps' create significant efficiency opportunities within product categories. Additionally, as LED systems penetrate the major renovation and new construction market, the maintenance market, particularly the large installed base of 32W T8 linear fluorescent lamps and HID lamps, remains a ripe savings opportunity.

5. **Linear fluorescent lamps still dominate the non-residential market**. The linear fluorescent lamp measure category represents a savings opportunity; savings will increase as 28 and 25 Watt replacement lamps make up a greater portion of program activity. These savings are particularly important since they fall within the often-overlooked maintenance market segment.

Recommendations

The team recommends the following actions for program planners in the Northwest region:

1. **Monitor LED cost, performance and sales trends frequently to keep cost-effectiveness estimates up to date**. Programs have rightly targeted A-lamps—the most common general purpose lamps—for replacement. However, those same lamps are the most thoroughly regulated by EISA and continue to be the target of LED manufacturer R&D efforts. The result is a narrowing

incremental cost for LEDs, which should increase natural adoption practices. Programs should ensure baselines and incentives are continually adjusted for this bellwether lamp and other LED technologies. On the non-residential side, market actors reported a two-year payback as the sweet spot for convincing end-users to adopt efficient lighting upgrades across applications. Incentives that lower the payback below two years may not be necessary.

2. **Adopt baseline frameworks that represent the changing market and that can easily be updated with more recent sales data**. If baselines are meant to represent current market practice, the rapid penetration of LEDs into the sales mix means baselines should reflect the flow of sales, not the installed stock. The research team recommends updating baselines annually because longer update cycles may lag the market, risking inaccurate baselines and potentially misallocating program resources. Flexible upstream program models can reduce the risk of misallocating resources, increase regional savings, and improve cost-effectiveness.

3. **Collect full category lighting sales data**. Because the product mix is changing so rapidly, full category data is essential to accurate baselines. At present, lighting baselines cannot be addressed with good engineering assumptions alone—they need market data. Data from program partners is a must, but BPA and NEEA should also continue broader efforts to collect from as many market actors as possible. This data collection will allow program planners to understand the entire market, not just the portion participating in programs.

4. **Focus on "measure-market fit" with targeted approaches.** Programs could focus on market actors with outsized influence in the particular market segments they hope to influence. For example, programs seeking the accelerated deployment of integrated controls should focus marketing and education on trade allies and market actors active in major renovation and new construction projects, where integrated controls are most effective. For the lighting maintenance market, where new, complex systems are less likely to be employed, the focus should be on upstream programs for the distributors and manufacturers, encouraging them to stock and push high efficiency replacement options.

5. **Develop guidance for trade allies for specifying advanced lighting systems**. The confluence of hardware, software, new lighting performance metrics, and user-experience will be dynamic and ever changing, placing a premium on trade ally education (e.g., installing LED troffers with integrated controls is more complicated than lamp and ballast change outs.). Especially for controllable lighting systems that offer deeper savings and non-energy benefits, programs could help trade allies become confident in offering advanced systems to their customers.

6. **Tailor transition strategies by measure.** Transition strategy doesn't have to mean dropping measures entirely: changing incentive levels and structures can also provoke shifts in the market. For example, as screw-in LEDs become standard practice in the commercial sector, consider moving from dollar per unit incentive structures to more creative arrangements that reward partners for other metrics such as increasing market share or average product efficacy. More broadly, programs should continually revisit the theory of their market transformation efforts. As more non-energy related bells and whistles are added to lighting systems, lighting programs will need to think critically about what features and benefits they are willing to pay for. Manufacturers will seek ways to add value (and maintain prices) in the face of significant cost pressure that are often unrelated to, or even detrimental to, efficacy.

7. **Support and follow the development of performance test methods for LED systems.** Common methods of LED testing for various performance characteristics—including reliability and lifetime—are still evolving. Programs should monitor their progress and when appropriate require their use for product qualification purposes.

8. **Promote the "interoperability" of controls and technologies**. Interoperability is the ability of separate technologies to speak to one another and work seamlessly together. Compatibility issues have frustrated some early adopters of LED technologies, particularly around dimming capabilities.

Appendix A. Northwest Electrical Distributors Interview Guide

Introduction

Thank you for participating in the Second Annual Survey of Northwest Electrical Distributors!

About Us. *This study is centered on the non-residential lighting market in the Northwest (NW), with a particular focus on the LED market. To quickly get on the same page, a couple of definitions:*

- *"Northwest" – WA, OR, ID, and MT*

- *"Non-residential market" – lighting products intended for use commercial and industrial buildings, including exterior lighting*

About you. *We understand distributors have highly variable service territories and may have parent companies or subsidiaries with various internal divisions, so it is important for us to understand the perspective you'll be providing today.*

a. What is your role within <Company>?

b. From which perspective will you be speaking today: Your entire company? Your company's NW operations (preferred)? A specific division within your company (e.g., energy efficiency division, projects, etc.)? A specific branch?

c. Please provide an overview of your company's role in the Northwest lighting market. Consider any market segments or niches you specialize in, or specific geographical areas where you have a relatively strong presence.

d. Do you specialize in lighting, or is lighting one of many product categories you cover? What percentage of your business is lighting?

Programmatic and Non-Programmatic Activity

a. Are you signed up as a "trade ally" for any energy efficiency programs?

b. What percentage of your total LED unit sales would you estimate do not go through utility incentive programs?

c. What percentage of your low wattage T8 products (28W and 25W) would you estimate do not go through utility incentive programs? Has that share changed in recent years?

d. Are there any specific efficient lighting products not currently incentivized in particular programs that you would like to see incentivized?

Supply Chain and Market Actors
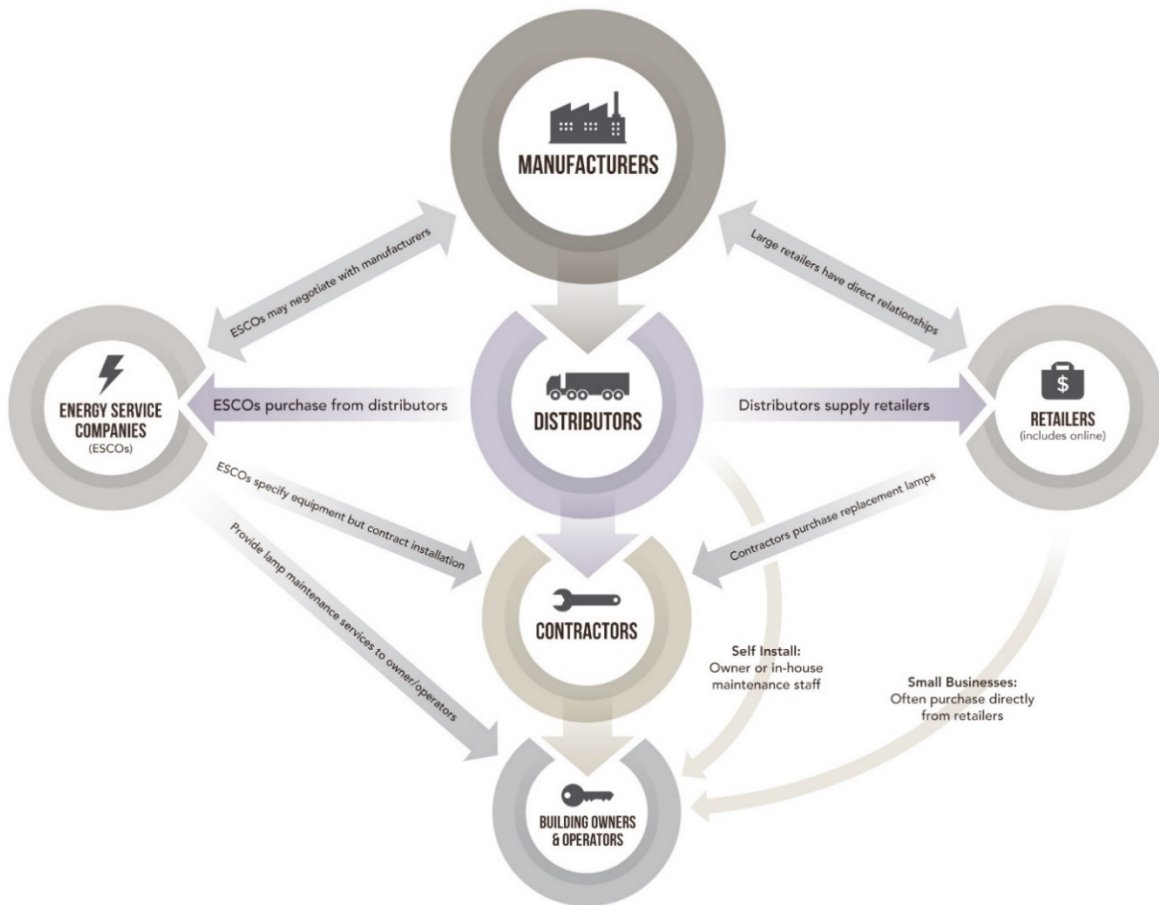
Last year, we developed the above map of the non-residential lighting supply chain. We learned the vast majority of HID and LFL lamps flow through distributors to contractors and ultimately the end-users. We are interested in learning how the supply chain for LED systems may differ.

   a. Is the LED supply chain different from that for traditional lighting products?   Are there different paths to market? For example, is a larger share of direct from lamp manufacturers, fixture manufacturers, etc.?

   b. Does your answer change depending on whether we are referring to a lamp versus a luminaire?

   c. What is your business relationship with fixture manufacturers? Do they sell to you? Do you sell to them? Are they competitors?

        i. Is this different in the LED market than for other technologies?

   d. For commercial and industrial lighting products, who are your biggest customer types, both for LED products and for all other non-LED products?

Customer type	% share of revenue: LED lighting products	% share of revenue: Non-LED lighting products
Contractors		
End-user (Building Owner)		
Builders		
Retailers (e.g., Small hardware stores)		
ESCOs		
Fixture manufacturers		
Total	100%	100%

e. Which, if any, of your customer segments sell lighting products to residential end-users? Probe: Small retailers, hardware stores?

ii. What percentage of your company's lighting product unit sales would you estimate are non-residential versus residential?

	Traditional	LED
Residential (% of units sold)		
Non-residential (% of units sold)		
Total	100%	100%

Next, we'd like to ask you next about a few non-traditional channels in lamp distribution.

f. Do you view any of the following *newer* distribution channels as a growing competitive threat with respect to LED lamp distribution (they are taking an increasing market share)? If so, what makes each of them competitive?

i. Online-only channels like 1000bulbs.com

ii. Amazon Supply or Google Shopping for Suppliers
iii. So called "trunk slammers"—small LED manufacturers selling direct to customers

g. How much of the wholesale lamp distribution market would you estimate these non-traditional channels make up?

Sales

Next, we'd like to learn about sales practices in the lighting industry. The next set of questions will cover the sales channels you use, pricing, and your customer profile.

Sales Channel	% of units sold
Online	
Phone	
In-person	
Other (please specify)	

a. Through which channel does your staff have the greatest opportunity to influence the customers' purchase decisions? Where does your staff have the least opportunity to influence the customers' decisions?

b. Are you more of an influence in project-based work or routine maintenance sales? Why?

c. Who are the typical customer types for the various sales channels? Does this vary based on whether the sale is for a specific project or if it is maintenance work?

Sales Channel	Typical Customer Type	Project or maintenance?
Online		
Phone		
In-person		
Other		

d. What portion of your lamp sales are contracted/recurring orders? Do these tend to be online, phone, or in-person orders?

    i. Do you have any chance to influence the product selection in these? If so, how?

    ii. Who are the most typical customers to use this method?

e. Do you support any national accounts? What is the nature of those relationships?

    i. Are these agreements negotiated at a national corporate level? Between whom (i.e., is the product manufacturer or is the distributor the primary negotiator with the client)?

    ii. What is the distributor's role in these agreements?

    iii. Who determines which product types are sold?

f.   Who is your biggest competitor?

g.   How do you determine price for a given technology? Do you typically earn a higher margin on high efficiency equipment?

h.   On average (ballpark estimate), how much have LED prices fallen on average over the last:

Months	% change in price
12	
24	
36	

i.   Typically, how many brands do you sell in your lighting product portfolio? How do you choose which brands to market?

j.   If applicable, when you say you "stock" a product, does that mean you stock it at the branch or at the central warehouse?

k.   Do you market various lines based using a "good-better-best" concept? If so, what is the typical percentage price difference between product tiers? Five percent, 10% or 25%?

l.   Generally, what are the main markets your customers are supplying when they purchase LED product from you? (i.e., Are they primarily for new construction? Retrofits for energy-saving purposes? Renovations for non-energy saving purposes? Maintenance?)

Reason for purchase	% of LED units sold
New construction	
Retrofits*	
Renovations**	
Maintenance	
Other	
Total	100%

*Often for energy saving purposes, may be just lighting
**I.e. tenant improvements, lighting is one part of a larger project

m.   Do you supply any contractors that specialize in serving particular sectors of the market, such as the agriculture sector?

n.   [If yes to agriculture] My colleague is conducting research for BPA to better understand ways to support energy efficiency in the agriculture sector. If you could provide some names of contractors who serve the agriculture market specifically, that would be very helpful.

o. Where are the majority of your customers located? Are most of your customers urban, rural, or a mix of the two? Do you sell products across multiple states? Which ones?

    i. Has there been greater interest in LEDs in rural or in urban areas? Which regions/states have shown the greatest interest in LEDs? Why?

Supplier Evaluation

a. Next, we'd like to ask you about your experience with LED suppliers. Who are your top three LED suppliers by volume? Based on your experience working with them, please rank these suppliers (1-3) in each of the categories shown in the table below?

	Supplier Name	Product Performance	Timeliness	Responsiveness	Overall Satisfaction
	Ex. Company A	Rank (1-3)	Rank (1-3)	Rank (1-3)	Rank (1-3)
1					
2					
3					

b. Approximately how many LED product suppliers have you had in the last two years?

c. What criteria do you use to select your suppliers?

d. When recommending a product, how do you evaluate the quality of a particular LED?

    i. Probe: Is it based on the lifetime of the lamp? Lumen output? The brand's reputation?

e. Return rates:

    i. What is a "typical" return rate for non-LEDs? What is it for LEDs by comparison?

    ii. Do any particular LED products have higher return rates? How high?

    iii. Have you experienced higher returns rates with any specific brands?

f. What are the most common types of customer feedback you receive for LEDs? Is this feedback different from other technologies?

Technologies

a. Which LED lamp types do you stock regularly? Are there any you are considering stocking soon? What considerations determine whether you choose to stock it or not?

b. When C&I customers are considering LED options compared to traditional technologies, what are the major factors in their decision? Please assign a score to the factors below from 1-5, with 5

being most important to customers.

Decision factor	New construction (Score 1-5)	Retrofit (Score 1-5)
Lumen Output		
Energy Consumption		
Lifetime		
Lumen Maintenance		
Color Maintenance		
Directionality		
Non-Technical Factors		

c. In which lighting applications are LEDs failing to gain traction? Which energy saving applications most need utility program incentives? Which need incentives the least?

d. Can you describe customer reaction to and interest in dimming products?

e. What is the customer reaction to and interest in integrated digital controls?

f. How educated are your customers about integrated digital controls?

g. What percentage of LED lamp or LED fixture unit sales include controls components? (i.e. occupancy and/or daylight sensors)

h. What do you see as the most significant barriers to digital controls adoption over the next three years?

i. What do you see as the most significant **drivers** of digital controls adoption over the next three years?

Marketing and Business Practices

a. What do you do to sell more lamps/LEDs? What do you wish you could do more of? If you had a doubling of your marketing budget, what would you do first?

b. Who do your marketing materials target? Retailers? Contractors? Fixture manufacturers? End-users? Other?

c. What do you see as the most significant barriers to greater LED adoption over the next three years?

Follow-Up and Closing

a. What do you think your organization needs from the utility efficiency business to help push efficiency in the Northwest market over the long term? What kind of tools, resources, rewards, or incentives can help? Please be specific.

b. Do you have any additional thoughts on the LED market in the Northwest that we did not discuss today, but you feel are important for our efforts?

c. What questions should we ask next year for this survey? What other metrics or topic areas would be helpful or interesting for you to compare your business against your peers?

d. Is there anyone else you would recommend we speak to in reference to some of the questions we have asked here today?

e. Do you have any questions for us?

Thank you for participating in the Second Annual Survey of Electrical Distributors in the Northwest.

Appendix B. Data Collection Tool

Navigant and Cadeo initially sought a complete census of electrical distributors in the Northwest to interview and collect data from. The data collection efforts centered on a shipment data request (Excel workbook) sent to those distributors in the region that participated in the survey. The data collection tool had line items for all major product lines in the fluorescent, CFL, incandescent, HID and LED technology families for 2010 to 2014.

LEDs are particularly challenging due to the lack of standard product categories and descriptions. The team consulted with Navigant's solid state lighting team, which performs large market analyses for DOE, to reduce the chance of distributors misinterpreting the product lines in the data collection tool. Working in tandem with BPA and NEEA staff, the team was able to collect full category sales data for 2010-2014 from 16 electrical distributors serving the commercial market in the Northwest

		2010 Qty (# of units)	2011 Qty (# of units)	2012 Qty (# of units)	2013 Qty (# of units)	2014 YTD Qty (# of units)	Sales Forecast — In the next 12 months, how do you think sales will change compared to the previous 12 months? [Answer for each lamp type (e.g., T12)]			
4ft	**T12**						Please select:	increase	by	%
	34W						General Comments:			
	40W									
	Other									
	Total	0	0	0	0	0				
	T8 - Standard 700 Series						Please select:	increase	by	%
	32W						General Comments:			
	T8 - High Performance 800 Series or Better						Please select:	increase	by	%
	25W									
	28W						General Comments:			
	32W									
	Other									
	Total	0	0	0	0	0				
	T5						Please select:	increase	by	%
	Standard Output - 28W									
	High Output - 54W						General Comments:			
	Other									
	Total	0	0	0	0	0				

Source: Navigant and Cadeo

The data collection tool itself consisted of an Excel workbook with 9 tabs:

Tab 1: Cover sheet with instructions.

Tab 2: General information. This tab requested basic information on the company itself, where it was located, which branches the data represented and in which states.

Tabs 3-7: Lamp category tabs. Tabs in this group were each dedicated to a specific lamp category, and were the most important for the project's purposes. These tabs requested complete sales data (in terms of units sold) for the years 2010-2014 for the following lamp categories:

   a. Linear Fluorescent

   b. HID

    c.   LED

    d.   Screw Base

    e.   Pin-Base CFL

Each of the lamp category tabs also asked distributors to project sales growth in 2015 (as a percentage of 2014 sales) for each broader product family (e.g. 4ft T12, 4ft High Performance T8s, 4ft T5s, etc.).

Tab 8: Controls. This tab requested complete sales data (in terms of units sold) for the years 2010-2014 for 18 types of controls. The "Controls" tab also asked distributors to project sales growth in 2015 (as a percentage of 2014 sales) for each broader product family (e.g., dimmers, timers, daylight sensors etc.), differentiating between networked and non-networked controls.
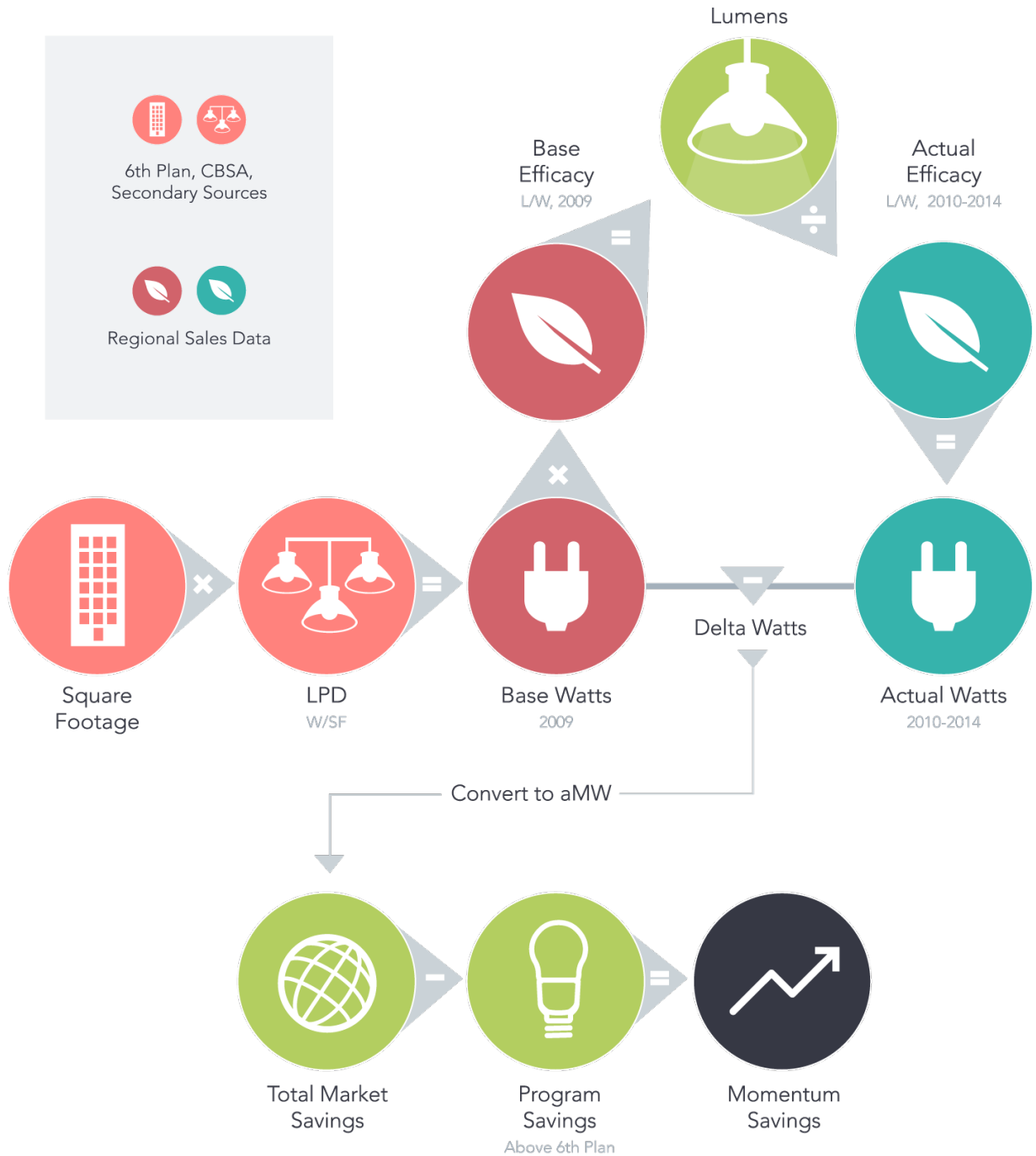
Tab 9: LED Replacements. This tab asked distributors to enter what they would recommend to their customers for an LED replacement, and a ballpark price, for 10 product lines.

Appendix C. Interviews Conducted

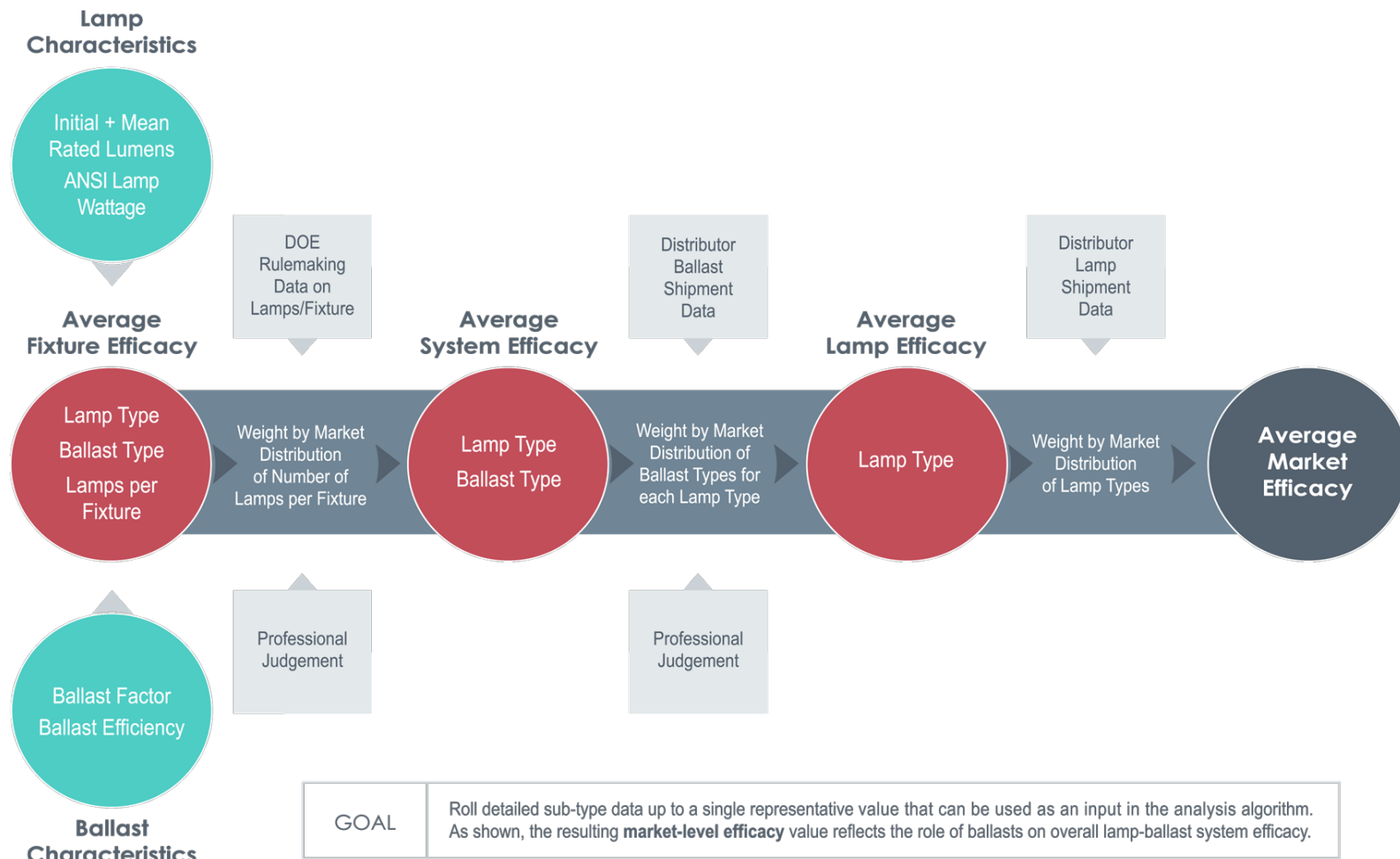| Interviewee	In-depth (>30 minutes)	Short (<30 minutes)
Distributors	18	0
Manufacturers	3	4
Regional lighting specialists	4	0
Utility program managers	4	0
Manufacturer representatives	0	20
Internal Navigant lighting experts	2	0
Total	**31**	**24**

Source: Navigant and Cadeo

Appendix D. Schematic Summary of Momentum Savings Methodology

Source: Navigant team analysis

Appendix E. Schematic Summary of Market Efficacy Calculation

Lamp Characteristics
- Initial + Mean Rated Lumens
- ANSI Lamp Wattage

Average Fixture Efficacy
- Lamp Type
- Ballast Type
- Lamps per Fixture

DOE Rulemaking Data on Lamps/Fixture

Weight by Market Distribution of Number of Lamps per Fixture

Average System Efficacy
- Lamp Type
- Ballast Type

Distributor Ballast Shipment Data

Weight by Market Distribution of Ballast Types for each Lamp Type

Average Lamp Efficacy
- Lamp Type

Distributor Lamp Shipment Data

Weight by Market Distribution of Lamp Types

Average Market Efficacy

Ballast Characteristics
- Ballast Factor
- Ballast Efficiency

Professional Judgement

Professional Judgement

GOAL — Roll detailed sub-type data up to a single representative value that can be used as an input in the analysis algorithm. As shown, the resulting **market-level efficacy** value reflects the role of ballasts on overall lamp-ballast system efficacy.

Source: Navigant and Cadeo analysis. For linear fluorescent and HID lighting systems.

BONNEVILLE
POWER ADMINISTRATION