2012-2014 Commercial Lighting Programs Impact and Process Evaluation Final Report

Contents:

This document contains Navigant's Commerial Lighting Programs Impact and Process Evaluation Final Report, and Puget Sound Energy's Evaluation Report Response (ERR). In accordance with WUTC conditions, all PSE energy efficiency programs are evaluated by an independent, third party evaluator.[1] Evaluations are planned, conducted and reported in a transparent manner, affording opportunities for Commission and stakeholder review through the Conservation Resource Advisory Group (CRAG) and reported to the UTC.[2] Evaluations are conducted using best-practice approaches and techniques.[3]

PSE program managers prepare an ERR upon completion of an evaluation of their program. The ERR addresses and documents pertinent adjustments in program metrics or processes subsequent to the evaluation.

Please note that this is an evaluation of the program as it operated during the 2012-2014 program years, and does not necessarily reflect the program as currently implemented, or measures currently deployed by the program.

This and all PSE evaluations are posted to Conduit Northwest. To view an electronic copy and to leave comments, visit **https://conduitnw.org/Pages/Welcome.aspx**

[1] (6)(c.) Approved Strategies for Selecting and Evaluating Energy Conservation Savings, Proposed Conditions for 2016-2017 PSE Electric Conservation.
[2] PSE 2016-2017 Biennial Plan, Exhibit 8: Evaluation, Measurement & Verification (EM&V) Framework, revised August 6, 2015.
[3] Ibid.

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Commercial Energy Efficiency Program Evaluation

Commercial Lighting

Business Enhanced Lighting
Business Standard Lighting
C&I Retrofit: Schedule E250

Final Report

Prepared for:
Puget Sound Energy

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February 11, 2016

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Executive Summary

This report describes the process and impact evaluation activities related to Puget Sound Energy's (PSE) four Commercial and Industrial (C&I) program delivery channels:

- Commercial Lighting
- Business Enhanced Lighting
- Business Standard Lighting
- C&I Retrofit: Schedule E250, G205

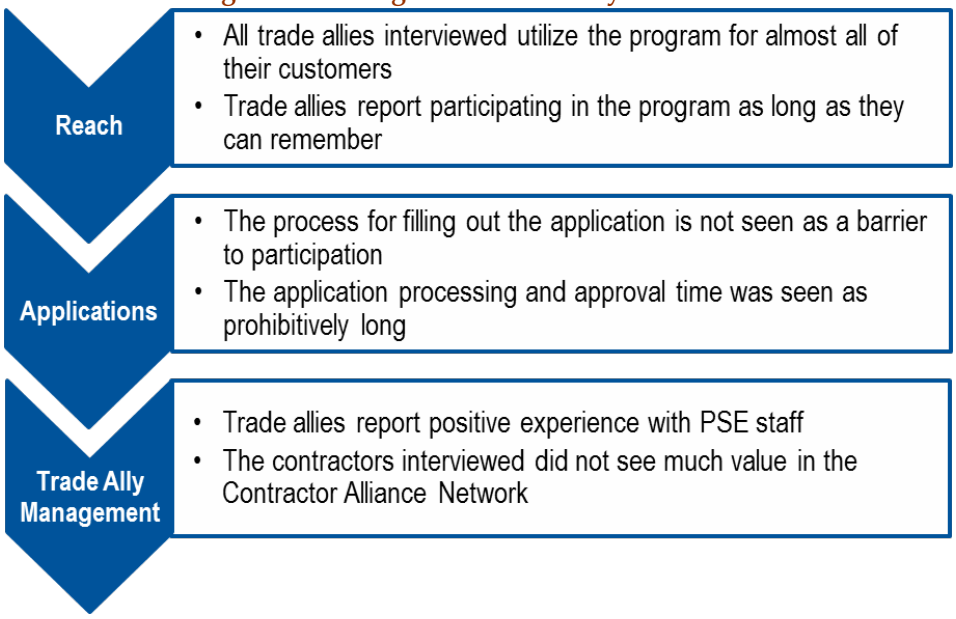
Evaluation findings serve to inform Program Schedule improvements anticipated for the 2016-2017 program cycle while also complying with the Washington Utilities and Transportation Commission (WUTC) filing requirements. This report presents the evaluation tasks completed and the corresponding final evaluation findings.

Process Evaluation

Key Process Evaluation Findings and Recommendations

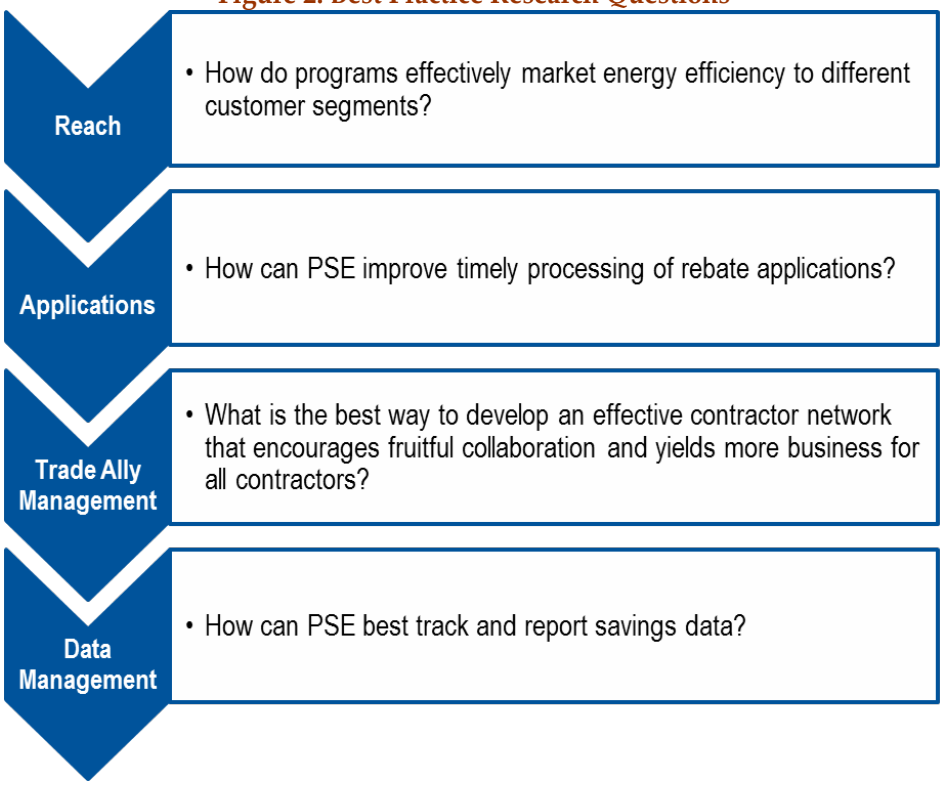
Findings from the process evaluation activities can be grouped into three thematic areas; reach – which includes customer and trade ally outreach and engagement, the application process, and trade ally management. Key findings from the trade ally interviews can be found in section 2.2.5 and include a discussion of the following:

Figure 1. Findings from Trade Ally Interviews



We used the impact evaluation findings, the logic modeling exercise and the trade ally interviews to direct our best practice research and aligned themes to explore the following questions in section 2.2.3:

Figure 2. Best Practice Research Questions



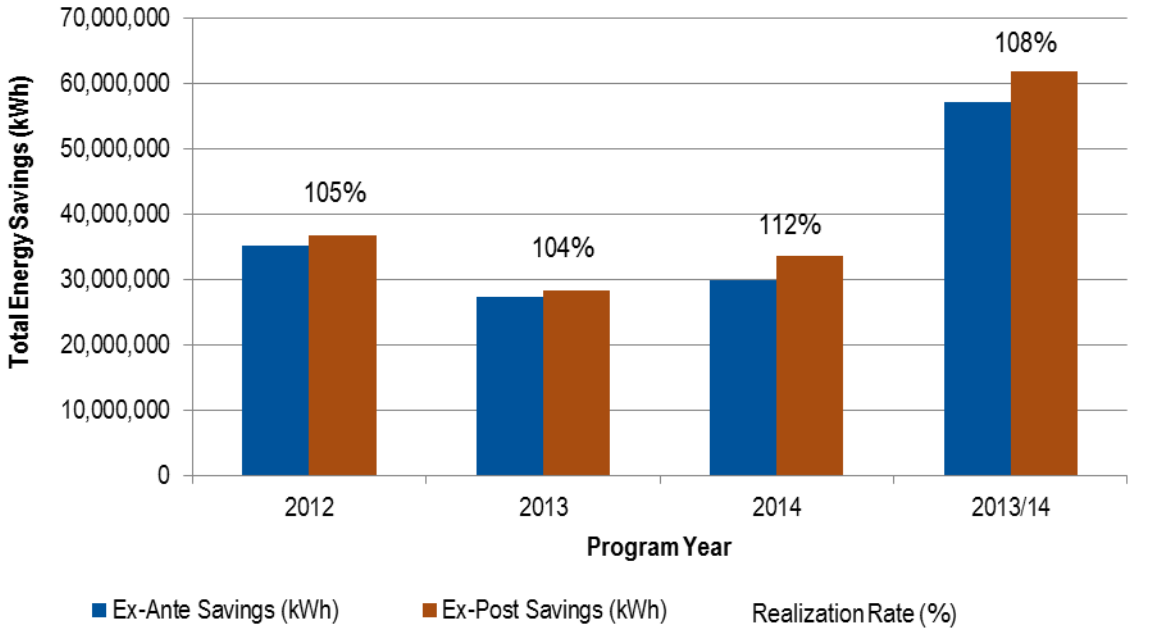
Impact Evaluation

Key Impact Evaluation Findings

Figure 3 shows the total C&I lighting *ex-post* gross program savings and realization rates for program years 2012-2014 and for 2013-2014 combined. Navigant and PSE determined that program years 2013-2014 were more representative of the future program, and thus the evaluation sample relied almost exclusively on projects from those program years.[1]

[1] The one exception was one very large project from 2012, accounting for 7 GWh of ex-ante savings, which was included in the sample.

Figure 3. Total Lighting Program Savings by Program Year



Source: Navigant analysis of M&V data

Overall realization rates were all slightly greater than 100%, indicating that PSE's tracking database is providing a reasonably good indication of lighting program savings, but tends to under-report. Program year 2014 showed a significantly increased realization rate over program years 2012-2013, and the combined 2013-2014 realization rate was also higher than 2012.

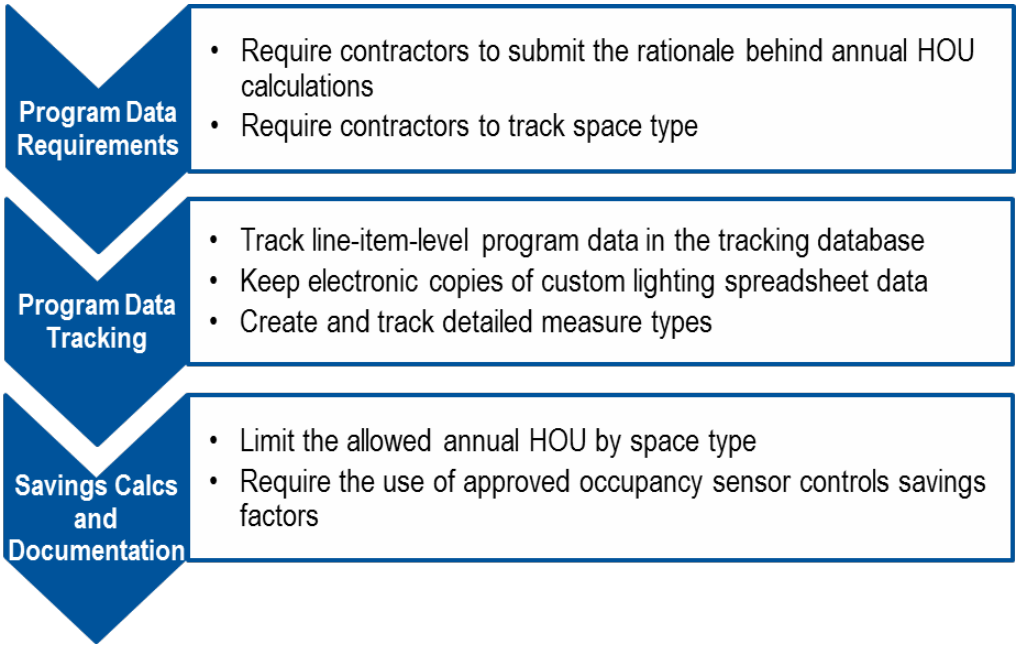
The main drivers of lighting realization rates were differences between reported and verified fixture counts and hours of use (HOU). Other minor drivers included cases where the project claimed installation of lighting controls but no controls were found on-site, and differences in the controls savings factor and the HVAC interactive effect factor values between the project file and what was verified.

Navigant developed the overall sample for this evaluation using the Stratified Ratio Estimation approach, with strata defined by program year and project size. The sample design targeted achieving 80% confidence and 20% precision or better at the stratum level, and 90/10 confidence and precision across the 2013-2014 program years. The final results achieved the desired precision at the program level and across all of the strata, with several of the strata achieving much greater precision than targeted.

Key Impact Evaluation Recommendations

Based on the study of the PSE C&I Program impacts, and lessons learned in the evaluation process, Navigant offers the following recommendations for PSE's consideration:

Figure 4. Recommendations from Impact Evaluation



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1. Introduction

1.1 Scope of the Evaluation

PSE offers an array of energy efficiency (EE) services to their electric and natural gas customers in all market segments. The Company is committed to ensuring that all customers have access to these services by offering a mix of programs that address all major end uses. Navigant evaluated the Business Enhanced Lighting Program, Business Standard Lighting Program, and the Commercial and Industrial (C&I) Lighting Program as part of its assessment of several PSE C&I EE programs in 2015.

The goal of these programs is to encourage existing C&I customers to use electricity more efficiently by installing cost-effective Energy-Efficient (EE) equipment, using energy-efficient operations at their facilities and adopting energy-efficient designs. Incentives are available for various lighting upgrades, including both fixtures and controls. Lighting system upgrades commonly include screw-in LEDs, standard and low-wattage T8 fluorescent lighting, and occupancy controls.

Navigant assessed the program energy savings impacts, implementation processes, and markets the programs interacted with during the 2012-2014 tariff years.

Table 1 shows the ex-ante performance of these programs during 2012, 2013, and 2014.

Table 1. Summary of PSE's C&I Lighting Retrofit Programs Performance, 2012-2014[2]

Program	# of Projects	Total Grants ($MM)	*Ex-Ante* Savings (kWh)
2012			
E250 C&I Retro (Lighting)	408	$6.237	35,133,581
2013			
E250 C&I Retro (Lighting)	372	$5.835	27,259,064
2014			
E250 C&I Retro (Lighting)	153	$2.407	11,572,383
Business Standard Lighting	281	$1.954	12,996,576
Business Enhanced Lighting	73	$1.455	5,389,287
Total	1,287	$17.886	92,350,891

Source: Navigant analysis of PSE tracking database.

PSE's C&I lighting programs are comprised of a mix of custom and prescriptive measures. Because custom measures make up the vast majority of total *ex-ante* savings, and have greater uncertainty in the resulting savings, this evaluation focused heavily on custom measures.

[2] Data provided by PSE in an Excel file: Clean commCSY.xlsx

1.2 Organization of This Report

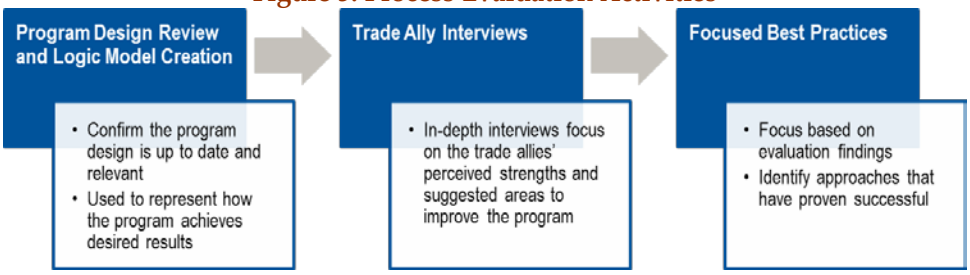
This report is divided into four sections:

- **Executive Summary:** Top line findings and key recommendations
- **Section 1: Introduction** (this section) frames the research undertaken by outlining the scope of the evaluation activities
- **Section 2: Process** evaluation covers the following activities; program manager interviews, document review and logic model creation, trade ally interviews and best practice research. Methodologies and findings of the process activities are presented within each section.
- **Section 3: Impact** evaluation begins with a discussion of the methodology employed in the review of the tracking data and project files, then continues with a description of the sample design and finally presents the on-site measurement and verification data collection and analysis approach. Next the impact evaluation findings are presented at the annual, stratum, and project levels. This is followed by a discussion of the drivers of the realization rates, and the statistical validity of the findings. The section concludes with recommendations for PSE based on the impact evaluation findings.

2. Process Evaluation

This section discusses Navigant's process evaluation methodology, findings and recommendations regarding the efficiency and effectiveness of PSE's Commercial Lighting programs. Process evaluation activities consisted of logic model creation, trade ally interviews and best practice research as shown in Figure 5.

Figure 5. Process Evaluation Activities



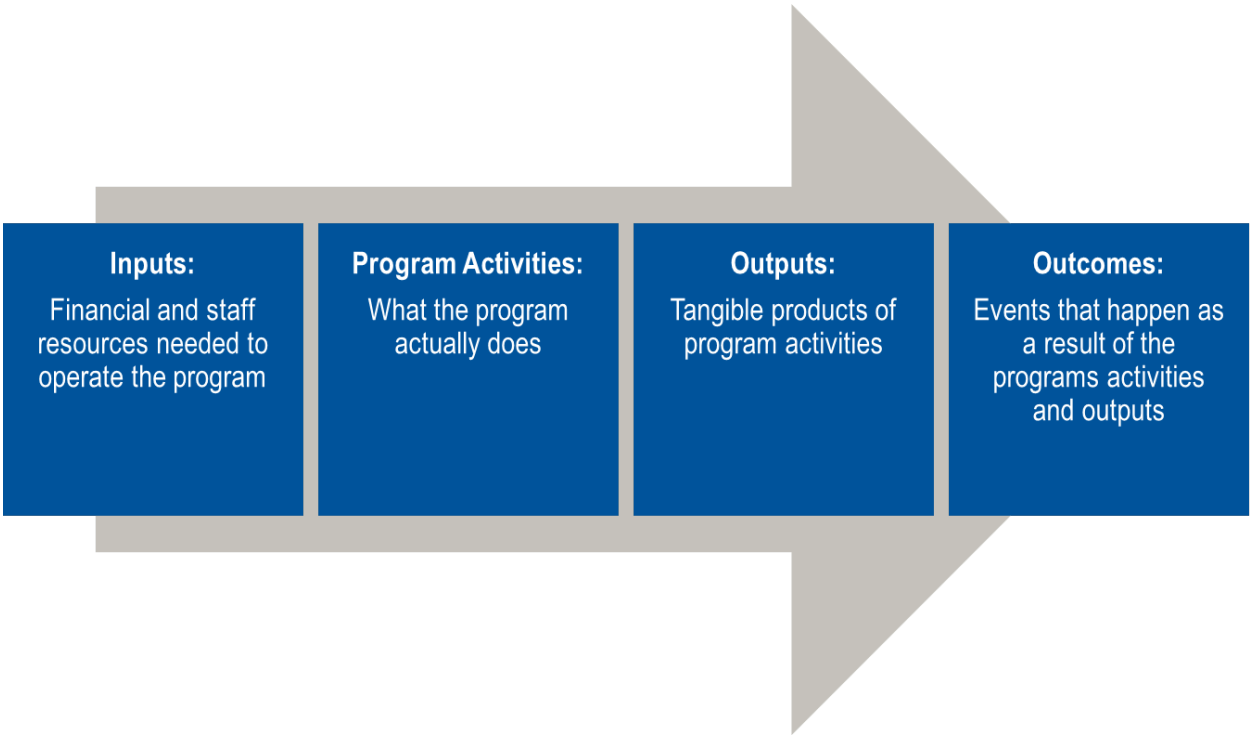
Findings from the process evaluation activities can be grouped into three thematic areas; reach – which includes customer and trade ally outreach and engagement, the application process, and trade ally management. The following sections present findings from the process evaluation activities.

2.1 Program Management In-Depth Interviews, Document Review and Logic Model Creation

Logic models are a specialized application of flow diagrams that map causal links from program activities to desired outcomes. The intention is not to illustrate a chronological sequence, as one might expect in a process flow diagram, but to disaggregate program components and evaluate their efficacy individually.

The nodes in a logic model represent a specific event, and arrows point from cause to effect. Nodes are typically arranged in four rows: activities, outputs, short-term outcomes and long-term outcomes, from top to bottom, and the causal logic flows downward. In this framework, an activity is any program component requiring allocation of the agent's resource. An output is a measurable consequence of primary programmatic activities. If a node describes an event that couldn't readily be enforced by contract, it's generally not an output. Outcomes describe the realized intentions of the program, and generally do not describe contractually enforceable events. A high level summary of the program aspects represented in logic model development are shown in Figure 6.

Figure 6. Logic Modelling



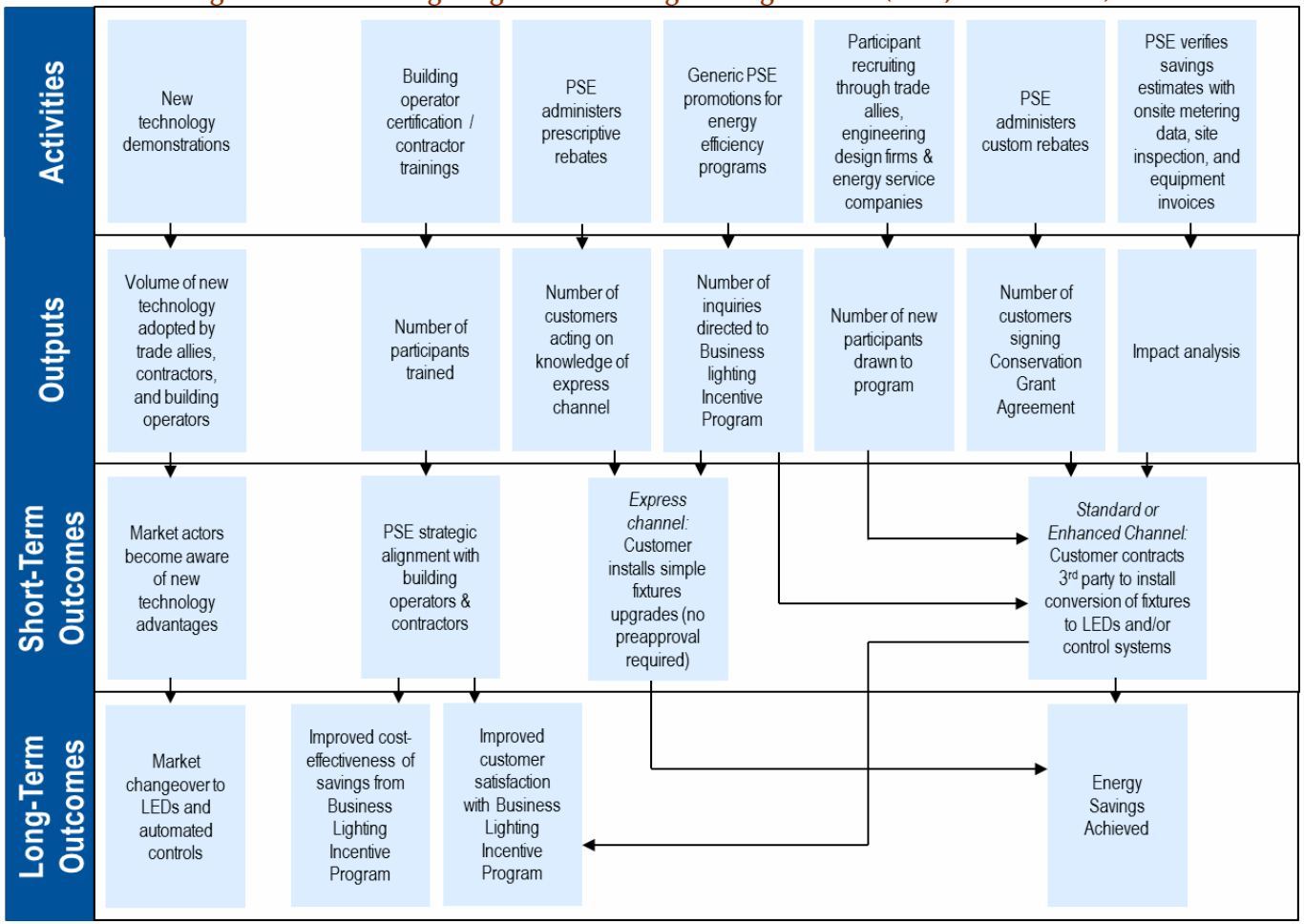
Navigant prepared a logic model to identify cost-effective interventions, the changes PSE should expect in targeted populations as a consequence, and the actors contributing to the desired outcome. Program documentation, marketing materials and application forms were reviewed to create the logic model. The draft was then reworked with program managers in a day-long meeting at PSE's Bothell facility to ensure it aligned with current program structure.

Logic models are useful both for the evaluator to develop a framework of a program holistically; and also for program administrators to scrutinize the contributions of individual priorities within a complex program. Collaboration between PSE and Navigant developing the Business Lighting Incentive Program Logic Model identified several specific interventions and opportunities for research, including:

1. Identification of information channels that lead 10% to 20% of new participants to contact PSE on their own initiative.
2. Improved technology demonstrations, and opening channels by which customers learn the benefits of LED systems with integrated controls.
3. Support of the Contractor Alliance Network in its central role of conducting surveys.

Figure 7 depicts the logic model developed in collaboration with PSE.

Figure 7. Business Lighting Incentive Program Logic Model (E250, C&I Retrofit)



2.2 Trade Ally In-Depth Interviews

The following subsections summarize findings from our in-depth interviews with program participating lighting trade allies.

2.2.1 Methodology

Navigant interviewed six participants in PSE's Business Lighting Incentive Program randomly selected from a list of sixteen trade allies. Following an interview guide approved by PSE program administrators, Navigant documented trade ally program experience and potential opportunities for improvement. In order to protect the accuracy of findings, interviewees were guaranteed anonymity, and that their comments are reported in aggregate. Although Navigant informed interviewees that a typical call need last only twenty minutes, trade ally dialogues were not constrained, and the average call was significantly longer.

Four of the six trade allies were large contractors servicing industrial and large commercial sites, one was a small contractor, and one was a lighting distributor. Contractors report their typical clients to be building owners rather than tenants. Every trade ally contacted by Navigant but one was happy to discuss PSE's Business Lighting Incentive Program.

Where possible, verbatim quotes have been provided to exemplify themes found through the interview process. Trade ally responses are grouped by theme. These passages represent prevailing views among interview respondents only; it is not possible to draw population-wide conclusions considering the small sample size.

2.2.2 Reach

Participating program contractors estimate that 90%-95% of their projects take advantage of the Business Lighting Incentive Program. Every contractor interviewed by Navigant integrates PSE's incentives into their standard business offerings. Only two reasons were offered for nonparticipation:

1. Program ineligibility, either because the site is located outside of PSE's service territory or the business is seeking a lighting system not approved by PSE. One contractor suggested that greater participation could be achieved if PSE were to reevaluate the benefit-to-cost ratio of rebates for costlier products.
2. The business requires immediate replacement of a relatively small installation, so the incentive amounts cannot outweigh the time cost of the application process. Only two contractors reported these cases having resulted in lost participation, and both qualified it as uncommon.

Standardization of PSE incentives is so entrenched in trade ally business models that only one could identify how they learned about the program. One speculated that a customer must have brought it to his attention years earlier, but two-thirds reported their employer's involvement with the program anteceded their employment. The one specific recollection of learning about the program came from a contractor who attended a PSE presentation.

Figure 8. Contractor Quotes; Program Reach

Lighting System Eligibility	Incentive Standardization	Program Discovery
"Look more at the savings and less at the cost of the fixture. Some products are ineligible for rebates because they're too expensive, but they're state-of-the-art going by total resource cost. Customers need more leeway in pricing to make the project work out."	"I always do it, unless they're really small and it's just not worth the paperwork. I've only ever discouraged one customer from using the program."	"I started working for [another company] about 4 years ago. They were doing a lot of projects for PSE, so I started to attend all the PSE programs. They had presentations on new lighting-whatever, and I attended all of them over the last 4 years."
	"If the customer is on a time schedule I advise her that the process can take months. Also if the building is small, it's not worth all the paperwork and effort. Also if their usage is really low it's not worth the effort."	

2.2.3 Applications

2.2.3.1 Application Management

Navigant did not interview any contractors who give responsibility of the application process to their customers, and only one even offers this option. Most volunteered that the paperwork would be too complex for their customers to manage, and that having experience with the process, it is easier to complete on the customer's behalf:

Although two-thirds of the interviewees commented that the process could be tedious, most implied resignation to the "necessary evil." One contractor with customers in several service territories remarked that PSE's process, while sometimes cumbersome, is the easiest to complete.

One-third of interviewees suggested that the application process could be improved if PSE were to internally standardize their expectations and eliminate superfluous requirements. Others expressed challenges keeping current with the most recent paperwork.

Figure 9. Contractor Quotes; Application Process

Trade Ally-Facing Applications	Simplify Requirements	Application Consistency
"I understand the utility is focused on the ratepayers, but I think that since PSE isn't actually installing the program it's just confusing for the end user to get through it. I found that by taking on that role makes it much easier. It would be better if PSE just catered to the contractors. The customers shouldn't have contact the utilities and tell them it's OK to disclose their usage data, or disclosing that information should be a simple check-the-box."	"Standardize what advisers want…I don't want to have to cater to different preferences anymore."	"A lot of projects we have to move to a new version of the workbook, so now I have to transfer it to the new form because PSE won't accept it on the old form. PSE isn't the only utility with that problem, but it's a time suck for me."
	"I have to get the document signed before I send the customer the package…it doesn't make sense to hold it up in the authorization step. It can take a solid week or two just to get a signature when PSE is involved in the rest of the process."	

2.2.3.2 Application Processing Timeliness

Every interviewee but one expressed frustration with the time it takes for PSE to approve applications for business lighting incentives. Contractors concerned about losing business sometimes integrate the incentive into their base price as a good-faith discount. When their payments are delayed, or if an application is for some reason not approved, the contractor incurs a real expense. However, the most dissatisfied contractors implied that delayed application approvals could be manageable with improved transparency:

Figure 10. Contractor Quotes; Application Processing Time

Program Timeliness	Contractor Liability	Transparency
"This program is slower to authorize than any utility I've ever worked with. It's really frustrating for the customers, who bite, and they get excited, but then they're waiting months to get something back."	"We started a project ten months ago, turned in the applications. They say we're supposed to get the paperwork back before we start the work in case the grant is smaller than expected. But in this case we only got the paperwork back in July, so we had to start the project anyway. Now we just have to live with the smaller incentive. We really can't wait more than a month or we could lose the job, and PSE says it only takes 2-4 weeks."	"More personal contact with program administrators would be nice…Most end users contact me when they don't know where the project is, and I don't know because PSE's system is not visible to me."
"It used to take just a business week to get an EME assigned to us, now it can take three weeks. That makes it really hard for us to sell the project to the customer. 4/5 of the projects go well, but it's that 1/5 that really creates the issue. PSE never tells me what the holdup is, so I have to keep the customer in a holding pattern, which is frustrating for them. And then in the end I never find out what was wrong with that one application, so I can't do anything to prevent it from happening in the future."	"Getting paid is another long process, 6-8 weeks. It costs me time to keep the customer engaged, and they get irritated waiting on something they're excited about."	"Sometimes PSE cuts the contractor out of the loop and sends the grant agreement directly to the customer, which can overwhelm them…and the contractor can't help…it's hard to know if a delay is with the utility or the customer.."
"I can submit a proposal and not get a response for 2-3 months. I have to order material and that takes planning."	"More explanation when new Smart Energy meter was installed. I had no idea what it was all about."	"PSE should acknowledge that they received a package and give an ETA, both on assignment to engineer and authorization. I don't know how much volume they have, so I can't communicate effectively with my customer about the status of the project. I shouldn't have to wait weeks and then call them to ask where we are."
		"Nothing. It was just to restrictive for me. I did not like being told when I should and shouldn't be using electricity."

Importantly, the trade allies able to quantify the frequency of application delays estimated timely approval in 95% of their cases. These findings suggest that the preponderance of complaints are focused on a small number of highly delayed applications, which may not represent the program as a whole, but nevertheless have a disproportionate impact on PSE's reputation.

2.2.4 Trade Ally Management

2.2.4.1 Contractor Sales Process

Every contractor interviewed reported the most significant motivator in technology selection is price, which is primarily driven by PSE's incentives. Every respondent specializes in LED installations, half sell LEDs exclusively, and one reported eliminating linear fluorescent offerings as a consequence of PSE's LED rebates. One-third of interviewees actively solicit customers with program offerings.

Three contractors report using PSE's materials during the sales process. Most interviewees would prefer marketing materials had more focus on savings potential and were generally more succinct.

Figure 11. Contractor Quotes; Sales Process

Program Solicitation	Relevance of Content	Simplicity of Content
"Most of our projects are existing customers. The outside sales guy will see the opportunity and bring it up to the customer."	"They could add the savings estimates that BPA has. Sometimes I wish they'd go back to their old form; it's so easy for customers to read. It's all there on one form…they have this multi-page things that people have to run though. Sometimes I'll use the old-fashioned form so my customers actually read what's going on."	"They could probably hire somebody to…simplify the materials. Most people don't want to look at that much stuff—what is the utility going to pay? It's not always obvious to look at the paperwork and see what they're offering. It's all legal jargon that confuses people."
"Once per year I might approach a customer and suggest that they update their lights. I lay some seeds and get them thinking about it."	"I wish they were a little clearer about the savings potential and stipulations."	"[The materials are] a little confusing... It was a mistake to make one workbook fit every program. Better to split it up, one workbook for Express program, one for Custom program…"

2.2.4.2 *Contractor Experience with the Contractor Alliance Network (CAN)*

Although every respondent was a member of the CAN, four out of five expressed doubts that its benefits could justify the dues.

Figure 12. Contractor Quotes; CAN

"I don't think it's worth it for me. I'm not a huge contractor, and they give everything to the people that do a lot. They give very little to the person that only does a few per year… it would be nice if jobs were assigned by geography."	"Nothing ever really pans out... we get some referrals but the customers never meet the TRC criteria so it turns out not to be viable… we're thinking of getting out of the program."	We thought it would be beneficial, being able to use their logo and whatnot, but people don't really care if we're affiliated with the utility.

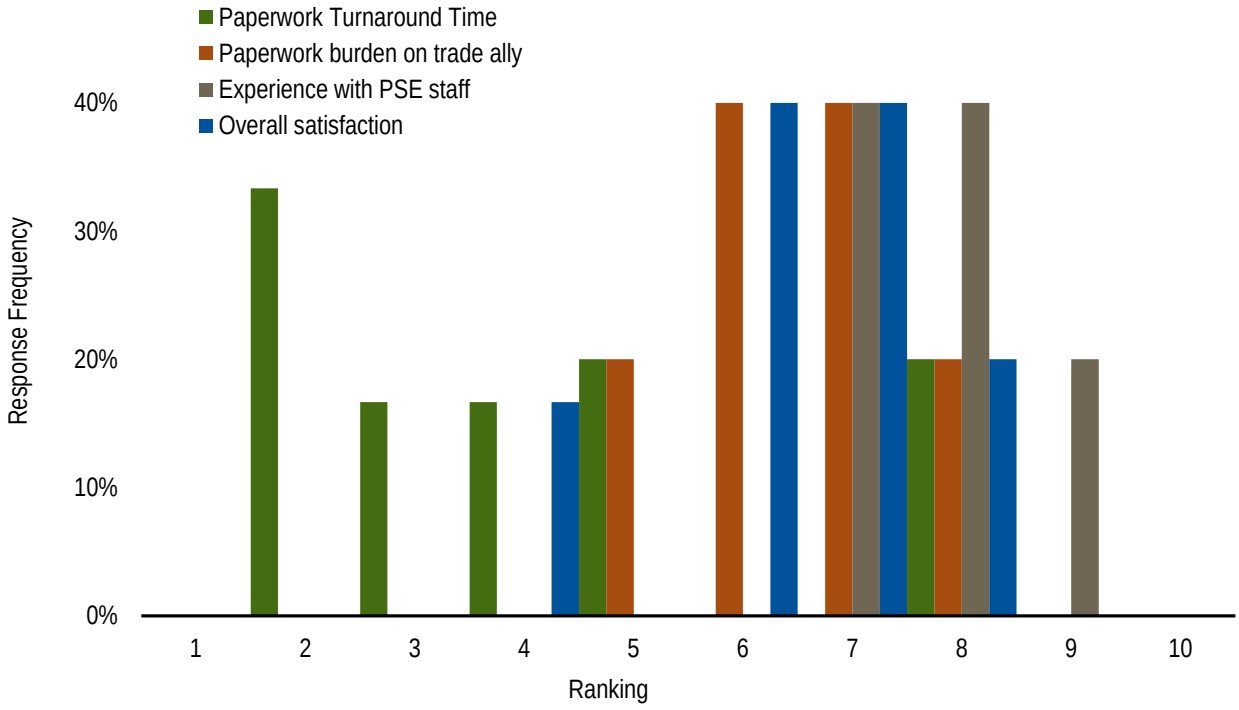
2.2.5 Trade Ally Interview Conclusions

1. PSE's lighting incentives are integrated into trade allies' business models, and nearly all their customers participate in the program.
2. Trade allies find PSE's application relatively convenient, but most would benefit from an application targeted at clearly partitioned channels. PSE might improve the trade ally experience by merging incentive channels in the application where they are comparable, and otherwise using a separate application where they are not similar. These findings support PSE's decision to move screw-in LEDs to their business incentive program, which might also have the benefit of reducing double counting of savings.

3. Trade ally satisfaction would be most improved if PSE were to ameliorate delays in the application approval process and to improve transparency into the application progress. These findings support PSE's decision to implement an application tracking system.
4. Price is the most important consideration in the contractors' technology selection, and customers generally follow the contractors' recommendation for lighting systems. These findings imply that PSE's Business Lighting Incentive Program has low free ridership.
5. Most contractors are having difficulty finding value in their continued CAN membership. PSE should reevaluate the purposes and implementation of CAN.

Figure 13 below summarizes the interview response frequency and the trade ally ranking of the key aspects asked about in the interview.

Figure 13. Frequency of Trade Ally Program Ratings by Category



2.3 Best Practices of Commercial Lighting Programs

2.3.1 Methodology

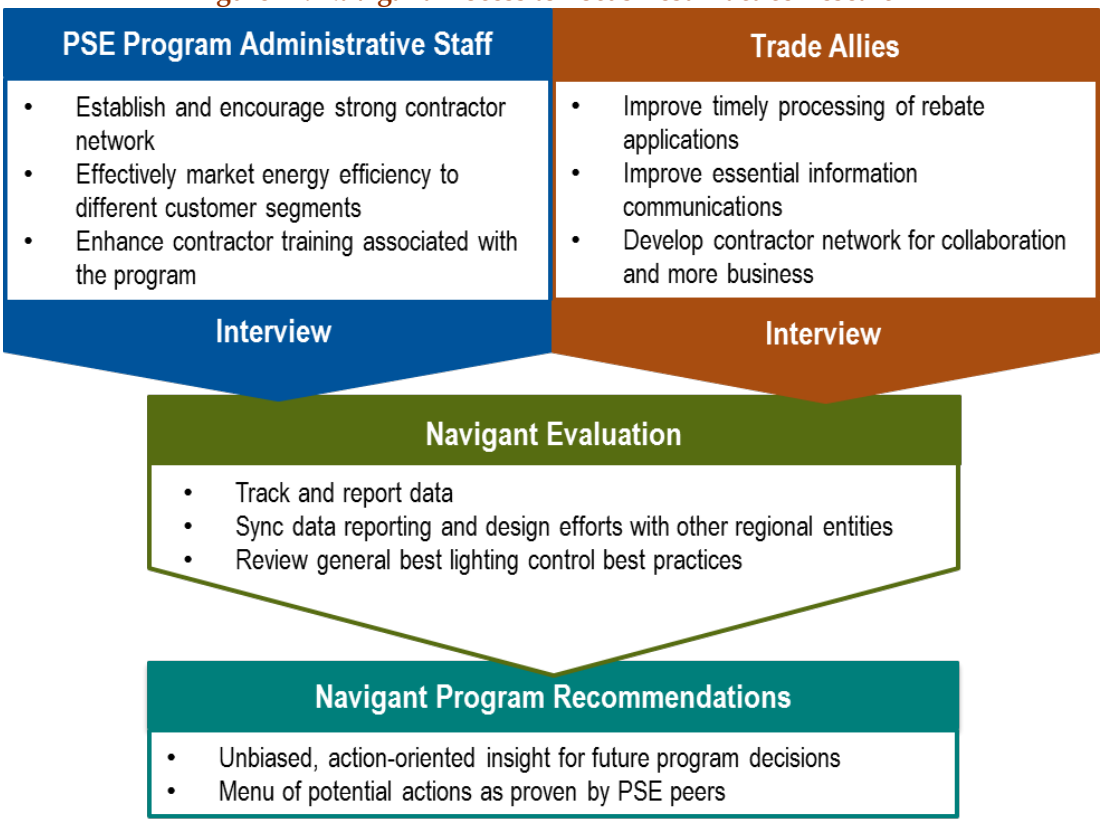
This section presents the commonalities and unique approaches identified among best practice programs that were deemed applicable to the PSE programs being evaluated. Navigant's review of industry best practices focused on program efforts that effectively contribute to PSE programs' desired outcomes as articulated in the Program Logic Model.

We used the impact evaluation findings, logic modeling exercise including program manager interviews and trade ally interviews to direct our best practice research and aligned themes to refine the area of inquiry. The successful approaches and recommendations presented here were derived primarily from interviews with marketing consultants, implementation contractors, and evaluators and were supplemented by a literature review of similar programs to inform the interview topics.

Navigant's program recommendations are provided as items for PSE's consideration. Our goal is to provide PSE with unbiased, action-oriented insight for future program decisions. The intention of this section is not to dictate explicit actions that PSE should take regarding these programs, but to present a menu of potential action items that have proven successful among some of PSE's peers.

Interviews with the groups shown in Figure 14 informed the scope of the best practice review:

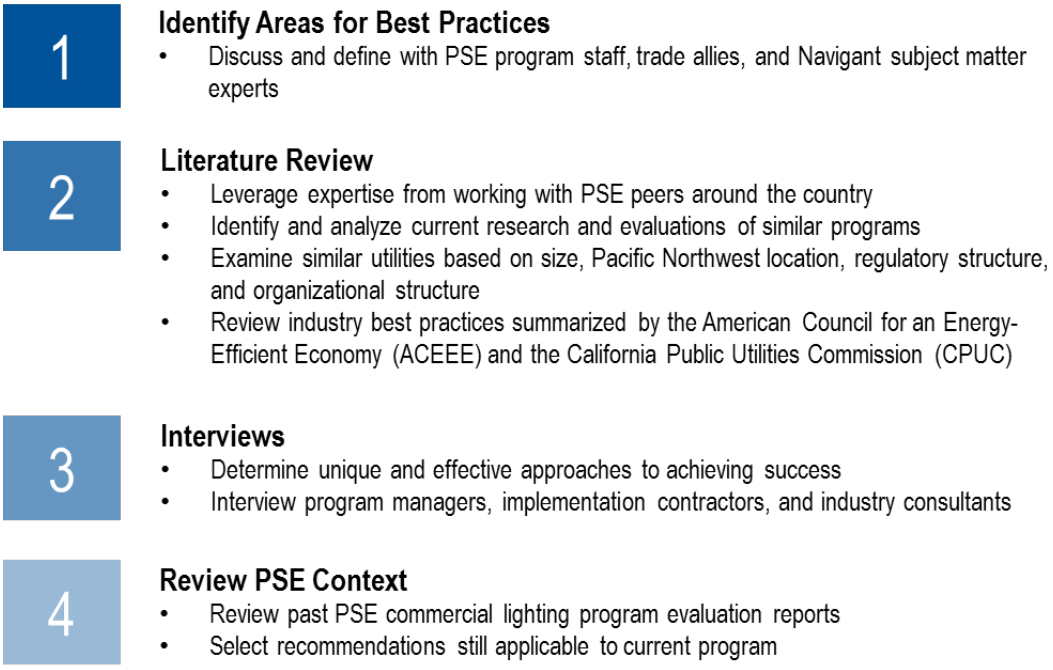
Figure 14. Navigant Process to Focus Best Practice Research



2.3.1.1 Research Approach

This section presents an overview of Navigant's approach to identifying and reviewing best practices among similar commercial EE programs, along with discussion of several key issues uncovered in the process. Navigant relied primarily on practitioner and subject matter expert interviews supplemented with a review of secondary data sources (Figure R). To identify other exemplary programs from across the country, the team referred to Navigant's library of relevant research articles and evaluations of commercial lighting programs, and reviewed resources made available by the American Council for an Energy-Efficient Economy[3,4] (ACEEE) and the California Public Utilities Commission (CPUC)[5].

Figure 15. Navigant Process to Identify Best Practices Specific to PSE



The team sought out programs reflective of PSE's relative size, experience and vision, and programs that might have transferable methodologies or lessons that could contribute to PSE's goals for this evaluation.

[3] Nowak, Seth, et. al. "*Leaders of the Pack: ACEEE's Third National Review of Exemplary Energy Efficiency Programs*". American Council for an Energy-Efficient Economy. June 2013.

[4] York, Dan et. al. *"New Horizons for Energy Efficiency: Major Opportunities to Reach Higher Electricity Savings by 2030"*. American Council for an Energy Efficient Economy. September 2015.

[5] The team reviewed the material compiled in the Energy Efficiency Best Practices study managed by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission in association with the California Energy Commission, San Diego Gas and Electric, Southern California Edison, and Southern California Gas Company. http://www.eebestpractices.com/

Table 2 lists the programs that were selected for this evaluation's best practice review.

Table 2. Programs Included in Best Practice Review

Utility	Service	Reasoning
Salt River Project	Electric	similar size to PSE, reputation for innovation
Seattle City Light	Electric	local, enhanced incentives for demonstration technology
Energy Trust of Oregon	Electric and Gas	local, quick start guide for quick lead generation
BC Hydro	Electric	local, online energy audit tool
Cascade Natural Gas	Gas	local, strong website, gas company
Duke Energy Indiana Inc.	Electric	similar size, innovative "savings store"
South Carolina Electric & Gas Co	Electric	similar size, comprehensive exterior lighting program
Snohomish PUD	Electric	local, energy savings recommendations segmented by cost
Avista	Electric and Gas	local
MN Center of Energy and Environment	Electric	Featured by ACEEE-one stop efficiency shop
United Illuminating (CT)	Electric	Featured by ACEEE-great on bill financing
National Grid	Electric	Featured by ACEEE - turnkey approach, strong incentives/financing
NICOR Gas of Wisconsin	Gas	Featured by ACEEE- leveraged relationships with outside organizations
Efficiency Nova Scotia	Electric	Very innovative small business marketing practices

The team researched each of these programs with a variety of efforts including phone interviews and reviews of available reports and evaluations. Furthermore, program reports and evaluations from other utilities were examined for the purposes of benchmarking PSE's program performance.
In addition to comparisons with distinct programs, the team interviewed marketing and program implementation experts that work across utilities. These interviewees and their organizations are listed in Table 3.

Table 3. List Cross-Program Interviewees

Interviewee	Organization	Expertise
Roy Barnes	Blue Space Consulting	Customer experience, customer satisfaction, JD Powers scores
Suzanne Shelton	Shelton Group	Marketing strategies for sustainable businesses and utilities
Lee Ann Head	Shelton Group	Marketing strategies for small business programs
Mana Haeri	PECI	Co-developed innovative commercial marketing campaign with the Energy Trust of Oregon
Bill Biesemeyer	Navigant (formerly DNV KEMA)	Streamlining applications, rebate processing, and databases
Steve Hastie	Navigant	Extensive experience with best practice reports and assessment criteria
Jessica Rivas	Navigant	Broad experience in the commercial lighting sector and leader of Navigant's internal lighting efficiency Center of Excellence
Mark Bielecki	Navigant	Expert on lighting controls and how innovative utility programs are considering controls as part of their program offerings
Laura Tabor	Navigant	Commercial lighting expert with experience in the Pacific Northwest region
Andi Nix	Navigant	LED field impact evaluation operations for this evaluation, conveyed insights from customer interactions

We used the impact evaluation findings, logic modeling exercise and trade ally interviews to direct our best practice research and aligned themes to explore the following questions Findings are presented by focus areas in the following subsections.

2.3.2 Reach

How do programs effectively market EE to different customer segments?

The most effective programs are those that increase customer awareness and engagement. We identified several methods that PSE can employ to increase program visibility and promote customer involvement. Moreover, these methods can be used to develop customized messages to market the program to customers according to specific demographics such as customers with high energy bills, service offered, business size, as well as location, community, and cultural factors. Reaching out to customers requires market research to understand customer needs, customer profiling to identify target customers, customizing messages and offerings to customers, and engaging them over the long term.

2.3.2.1 Market Research

Know the target audience, and use segmentation to optimize the effectiveness of your message. Mass marketing typically produces low response rates. In the digital era, customers come to expect that companies know their needs, and will design a message to appeal to them personally. The message of "energy efficiency" does not resonate equally with all PSE commercial customers. Targeting specific

customer segments and engaging them with appealing messages at multiple touchpoints can increase marketing effectiveness. Rather than sending bill inserts to all eligible customers, many well-marketed EE programs segment their customer base, define motives by segment, and target those most likely to be interested in program offerings. Tracking the results of these efforts is important for refining the segments and obtaining an impression of which segments will readily respond to marketing efforts.

Table 4 summarizes some segmenting strategies undertaken by other successful programs:

Table 4. Potential Marketing Strategies to Target Various Customer Segments

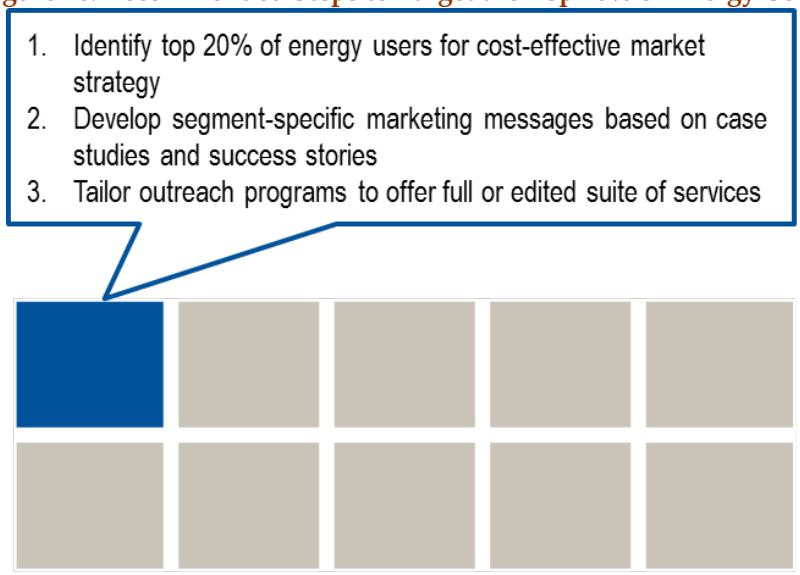
Segmentation Strategy	Customer Characteristics	Marketing Strategy
High energy bills	Energy is a priority for them	Targeted bill inserts, phone calls, emails, appeal to non-energy benefits of EE
	Energy cost may be a significant financial motivator	
Business type, service offering	Varies by type: similar businesses share similar priorities. Best practice is to determine predominate business types within a service territory	Use case studies to target successful projects in target business types
		Depending on the program, target business types that historically participate, or tap new markets
Business size (small)	May not qualify for financing	Target with a DI program through community blitz events in strategic "empowerment zones"
	Cash flow is important	
	Energy is not a high priority	
	Overwhelmed	
Business size (large)	Financing options available	Target with a custom program, initiate one-on-one interaction with a qualified PSE engineer
	Dedicated facility staff	
Geographic, cultural, or other community factors	Customer comes from a distinct cultural background	Leverage connections of trade ally organizations
	Customer is doing business in a geographic area with certain criteria (e.g. Downtown)	Present case studies that address their particular point of view, make use of community groups and associations
	Customer is a member of a certain business/trade organization	

2.3.2.2 Customer Profiling

The primary goal of segmentation is to target marketing efforts that are limited by time and financial constraints. Sending bill inserts to the top 20% of energy users in a particular rate class, rather than blanketing all customers, is a cost-effective method of segmentation as shown in Figure 16 below. More sophisticated methods include developing nuanced segments using a variety of data sources and

analytics, and targeting each with segment-specific marketing messages. Performing data analytics on current program participants allows some programs to target efforts toward customers most likely to participate. These customers are assigned a "propensity score" based on their business type, history of program participation, billing data, location, membership in community organizations, and other factors. Other possibilities for application of this strategy include targeting DSM program efforts where there are transmission and distribution constraints. Deferring T&D upgrades is highly valuable and changes the cost effectiveness of DSM solutions. "Geotargeting" DSM efforts in this way is a strategy under development in a number of utilities around the country. This approach falls under the category of "Big Data" or advanced data collection and analytical methods.

Figure 16. Recommended Steps to Target the Top 20% of Energy Users



Once a business-type segment has been defined, it is effective to market toward that segment with case studies and other approaches which highlight strategies of similar businesses that have experienced success through past program participation. Not all segments will be eligible for or interested in the entire suite of program offerings, so outreach efforts need to be further tailored to the subprogram or even measure level. For example, a direct install program is a good fit among customers with little time, minimal financial flexibility and a lack of intrinsic motivation for EE upgrades. As one of our interviewees said, "Direct install is like giving someone a fish rather than teaching them to fish," meaning the DI program may not perfectly match the utility's goals, but is an appropriate program offering for certain segments.

2.3.2.3 Measuring Engagement

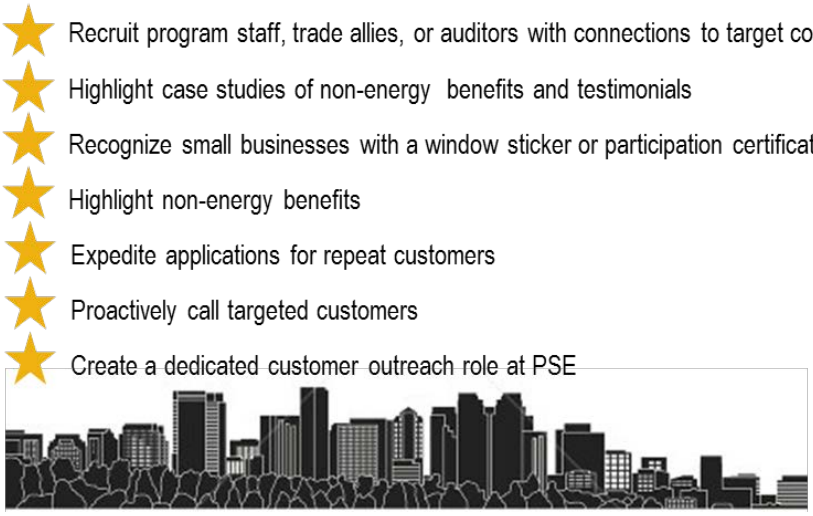
Besides performing market research with customer data, PSE can continue data analytics in order to measure customer engagement. For example, PSE can gain insight into the percentage of commercial real estate stock that participates in EE programs by comparing program data to municipal records, the Commercial Building Stock Assessment (CBSA), Commercial Building Energy Consumption Survey

(CBECS), and other databases. It can identify specific geographic areas with a high concentration of low income small businesses, which make good candidates for community blitz events, or door-to-door direct install campaigns.

2.3.2.4 Maintaining Engagement

Utilities can personalize their interactions with customers on several levels, as shown in Figure 17 below.

Figure 17. Recommended Best Practices to Engage and Recognize Customers



Recruit program staff, trade allies, or auditors with connections to target communities. Several urban utilities we spoke with actively recruit bilingual and/or bicultural trade allies or auditors. This effort can be as simple as identifying and recruiting non-participating contractors that could provide inroads into these target markets, or directly recruiting qualified staff from community colleges. Targeting members of bilingual and bicultural communities within cities can yield significant increases in program participation even after only one community member participates, as word of mouth often spreads quickly through these communities.

Highlight case studies of non-energy benefits and testimonials. Have PSE staff think of one customer that provided positive feedback about the program last year. Ask if the customer would be willing to be featured on the website. The feature could be anything from a simple quote to a fully-articulated case study and video documentary. Recognizing existing customers improves customer satisfaction, enhances PSE's reputation, provides positive publicity for stakeholders, and converts program participants into program ambassadors. In Navigant's survey of best practices, we uncovered many different strategies for making the customer feel good about their continued participation in the program. The key to success with these programs is to make the customer feel unique and valuable to the utility. The goal is to convert program participants into program ambassadors, who enthusiastically recommend the program by word of mouth. Few sales pitches are more effective than those delivered to a colleague or neighbor by a satisfied and excited customer.

"Many businesses are risk-averse, no one wants to be the first, so a case study can go a long way in demonstrating program effectiveness" - Shelton Group

Recognize small businesses with a window sticker or participation certificate. Window sticker advertising is common in the small business sector, used effectively by companies like Yelp, Zagat, TripAdvisor and many others. A PSE-branded window sticker could potentially include lifetime energy savings, carbon mitigation, and payback period estimates. A certificate or plaque, such as that used by LEED, may be more appropriate for larger facilities such as schools and municipal offices. In the EE sector, the EPA Energy Star™ program has been very effective at distinguishing products, homes, and businesses with their labels, yard signs, and certificates.

Highlight non-energy benefits with case studies. Advertisement of non-energy benefits of the program is currently a priority for PSE staff. A case study is a great way to highlight water savings, better lighting quality, increased comfort, indoor air quality, free publicity, or other non-energy benefits of the program.

Expedite applications for repeat customers. As with customer loyalty programs utilized in other industries, customers that participate in the program multiple times and/or across multiple business locations should receive special treatment. Having an account that tracks their participation would allow rebate forms to be pre-populated and expedite processing. Reliable customers could qualify for enhanced rebate offerings, special financing options, or other perks.

Proactively call targeted customers. Most customers only talk to their utility company when they have a problem. A best practice is to find a positive reason to call a customer. Because of high turnover in commercial real estate, there are many new customers each year. An informational, proactive phone call during the first three months of service can improve customer satisfaction and increase program participation. On the call, the PSE representative can ask the customer if they have any questions about their service, or are interested in knowing which rebate programs they may qualify for. For repeat customers, make it a policy to personally call and thank customers that achieve a certain amount of savings for the program.

"We only reached one-third of the business owners, but the tone of the call was very friendly once we were speaking to each other." - Avista staff

Create a dedicated customer outreach role at PSE. Consider a pilot program with an intern or university student dedicated to discovering the energy needs of a small business segment and advertising directly to that segment. This program could be similar to the Resource Conservation Manager (RCM) program, but rather than targeting a single company or building, they are dedicated to achieving savings within a particular small business segment. This SB-RCM could work to develop case studies, perform market penetration analyses, or implement any of the other recommendations mentioned in this section.

2.3.2.5 New Measures: Advanced lighting Controls

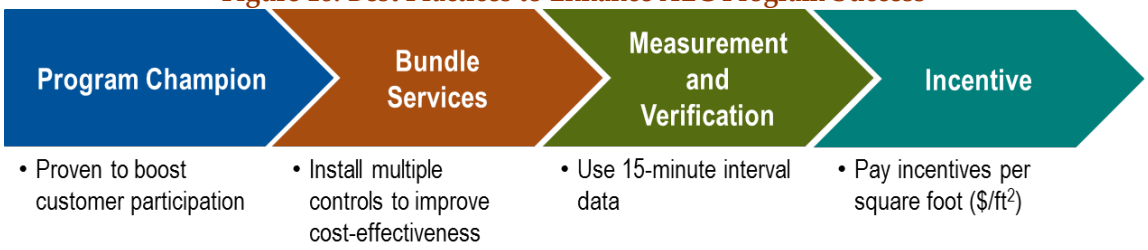
Program administrators throughout the country are considering including advanced lighting controls (ALC) as part of their program offerings to obtain deeper savings in the commercial lighting sector. However, the market for ALC as a utility offering is still in its infancy, with many of the leading programs still midway through initial pilot stages. While many existing programs are not operated to be strictly cost-effective, they are designed to obtain a sense of the magnitude of savings achievable through ALC offerings. In Figure 18 below, we present some emerging best practices for PSE's consideration, if ALC is something that PSE is considering for the future.

Program champions are key to success. Because ALC are complicated, unorthodox, unproven, and sometimes confusing to customers, a specific program manager dedicated to ALC is crucial for success of the program. In the past, the Sacramento Municipal Utility District (SMUD) had a dedicated ALC program champion, then when they rolled ALC into their other program offerings, participation significantly declined.

Pay incentives on an energy use intensity ($ per square foot) basis. Pilot programs in Ohio and Michigan experienced the most success by using a savings calculator tool that determined savings on a square foot basis. Near real-time measurement and verification of savings validated the tool using 15 minute interval billing data.

Bundle ALC with fixture retrofits and/or energy management system (EMS) installation. Controls on their own are usually not cost effective. Take advantage of timing by installing controls along with a more comprehensive lighting fixture overhaul. The most cost-effective applications of ALC involve basic scheduling and dimming using an EMS.

Figure 18. Best Practices to Enhance ALC Program Success



Engage customers and educate the market to build momentum for ALC programs. Successful execution of ALC programs requires significant customer engagement. The customer needs to be "sold" on the capabilities of ALC, and educated about how to successfully implement ALC after installation. At the moment, the market is so young that education efforts upstream are also useful to utilities. There is a lack of understanding of ALC in the industry—vendors don't have standard nomenclature for referring to ALC capabilities, and do not have any benchmarks for pricing their products. The DesignLights Consortium is working to address this issue by developing industry standards and product quality definitions.

Program administrators seeking to implement ALC should look to the DesignLights Consortium for technical guidance on which products to feature.

2.3.3 Applications

How can PSE improve timely processing of rebate applications?

Utilities increase trade ally satisfaction and reduce cost by leveraging web-based tools to the greatest extent possible. Existing best practices include programs that feature fully automated application processing systems that include real-time tracking, automated reporting and large batch submissions. For example, Xcel Energy Minnesota uses an online database for their One Stop Efficiency Shop program, where program staff and trade allies can track the progress of an efficiency retrofit, see the status of rebate processing, add customer-specific comments, and even provide feedback about the propensity of the customer to participate in other DSM programs. Effective dissemination of information through the internet can reduce the amount of time PSE staff need to spend with each program participant. Furthermore, publishing program information and applications on the web can reduce the costs of printing and mailing physical forms and brochures. Electronic tracking of program documents can save valuable time searching for customer-specific records. Online applications can check themselves for errors and flag inaccuracies automatically, so a participant can correct errors before the application is reviewed by a PSE staff member[6].

Successful programs systematize repetitive tasks to ensure forms are processed quickly yet carefully, so each form only needs to be touched once by a staff member. A best practice is to create a checklist that an administrator can use when reviewing each form. Ongoing, regular communications between and among all staff supporting a program helps to maintain consistency, allow for adequate planning, address unexpected events efficiently, and reduce the risk of problems due to lack of coordination. This not only increases operational efficiency at PSE, but also increases trade ally satisfaction because they are paid more quickly and need to spend less of their time on administrative overhead.

Assign staff to specific roles to capitalize on their skillsets. Often highly-qualified utility program staff spend considerable time processing and reviewing rebate applications. Ideally, administrative staff can process simpler prescriptive rebates, which will give the qualified engineers an opportunity to perform quality control on custom projects and field inspections on projects that lack sufficient documentation.

Establish checklists for paperwork review. Standardized checklists will expedite quality control and rebate application review, and improve the program's consistency. Having a checklist for every step of application review ensures that each application only needs to be touched once by a particular staff member, and reduces the likelihood that an application will be delayed or need to backtrack through the process.

[6] Nexant. *A Guide to Best Practices for Energy Efficiency in Locally Governed Electric Service Areas in the State.* Houston, TX: Nexant, 2011.

Request that the rebate processor provide monthly metrics about average processing time, the number of applications processed, and any notable issues with the applications. Demonstrating an interest in the rebate processor's progress will motivate their staff to be quick and thorough. Customers rarely know the difference between a utility and an implementation contractor, so oversight of the rebate processor is important to ensure customer and trade ally satisfaction. The mere act of reporting and tracking rebate processing metrics can help improve the rebate processor's efficiency and attentiveness to process improvements.

Establish internal limits on rebate processing time, and provide employee incentives for process improvements. Provide incentives to PSE or the rebate processor's employees (formal recognition, competitions, bonuses, etc.) to expedite paperwork processing time. Set firm and realistic deadlines for batches of paperwork to be fully processed.

One of the most common sources of dissatisfaction among trade allies and participants is the amount of paperwork associated with obtaining an incentive. Approval and documentation of measures subsidized by the program is necessary for a number of reasons--from tracking budgets to assisting with measurement and verification efforts. However, the paperwork should not be a substantial disincentive for customers to participate, and the best programs consistently work to improve the customer experience in this regard. Furthermore, streamlining the paperwork allows for a better relationship with vendors and contractors, and increases PSE employee satisfaction as they spend more time on the important and creative aspects of program administration.

Consider implementing an online application. Online applications have the potential to be very convenient for program staff, expedite rebate processing time, and reduce errors[7]. However, a complex measure may not be appropriate for an online form, as customers can experience dissatisfaction due to browser time-out or refresh errors. Automatic error checking should not withhold information from those filling out the form, nor prevent them from filling in a certain portion of the form. Instead, error checking is most effective as "flags" that warn participants of missing information, unrealistic numbers, or other potential flaws. This system is best piloted with certain programs before attempting a portfolio-wide rollout. In any case, customers should always have a paper alternative to the online form.

Consolidate all forms on a single web page to simplify the customer's process. The customer-facing website should make it easy to compare rebate applications. Some programs even have "universal applications" that are not measure or program specific to simplify the customer experience. If a universal application necessitates a costly process redesign, a least-cost method for simplifying the customer experience is to consolidate all the forms needed for any rebate application onto a single web page.

Create a roadmap of the customer experience. Determine time spent on the various tasks and review the flowchart for bottlenecks. Make an effort to see the program from the customer's perspective. Work with a customer through the rebate process from start to finish, and record their feedback in real-time. Consider web site usability testing—a type of research that observes customers using the website while

[7] Harvey, C. *BEST PRACTICES IN SMALL COMMERCIAL HVAC PROGRAMS AT CALIFORINA UTILITIES.* UNIVERSITY OF CALIFORNIA, DAVIS, 2013.

they vocalize their thought processes. Physically draw a map of the customer experience, identify the number of discrete actions they need to take to participate in the program, and determine if it is possible to eliminate or streamline some of those actions. This process has proven successful among many private-sector companies offering complex services to customers, including utility companies.[8] If this proves to be a successful exercise, map the experience of a company attempting to join the CAN, a partnering vendor, a trade ally submitting a batch of applications, or the experience of any other crucial member of the program's ecosystem. Understanding how these parties interact with the program on a practical and everyday level can lead to numerous insights about how to streamline the overall program operations.

2.3.4 Trade Ally Management

How can we establish and encourage a strong contractor network?

All utility efforts are a complex interaction of different entities with different incentives, interests, and expectations. The utility is at the center of this ecosystem of potential discontent, and usually assumes the blame (or recognition) as the responsible party. This contributes to utilities' tendency to be rather conservative and risk-averse. However, everyone in a DSM program ecosystem has something to gain through a partnership with the utility, and vice-versa. Innovative programs actively look outside of the organizations currently associated with the program to find allies in occasionally unexpected places—such as trade organizations, religious groups, local banks, cultural centers, and environmental advocates.

Contractor networks are a key element of this community outreach, as the contractor is "the face" of the utility to the customer (and indeed often the customer conflates the contractor and utility as being the same organization). Furthermore, in the commercial sector, contractors and facility managers may have a better understanding of the customers' needs than the utility does, and are therefore essential partners for driving program participation.

Educate PSE call center employees on the status of the program. Organize meetings between call center staff, key account reps, and implementation contractors. Be sure program information is passed to new employees in areas of high turnover. Ultimately, trade allies, account representatives, utility staff, call center staff, and implementation contractors should all be trained to assist the customer (at various levels of detail) with technical or program information. At a minimum, each party should have a clear idea of where to direct a customer if they themselves do not have an immediate answer.

Add value and build trust among trade allies by offering classes and trainings to educate them on program offerings and new technologies. In interviews, PSE staff expressed a specific interest in cultivating interaction among other PSE DSM programs. PSE could host events where staff from other programs join members from the CAN to learn about program offerings, technical best practices, or new technologies. Contractors, equipment dealers, and installers acting as program partners can serve as highly effective ambassadors for all DSM programs, not just the programs they represent.

[8] Rawson, Alex, et al. *The Truth about Customer Experience: Touchpoints Matter, but it's the Full Journey that Really Counts.* Harvard Business Review. September, 2013.

"We see our trade allies as our customers too." – CEE MN staff (Xcel MN)

Consider organizing a yearly trade ally conference to recognize successful projects and assemble case studies. Provide awards for the most savings per trade ally, meet with trade allies on a quarterly basis to share ideas, convert them to program ambassadors, and obtain frequent feedback from the field.

How can we enhance training offerings for contractors associated with the program?

Make training useful to contractors. The first step in designing an effective training program is to issue a short survey, or informally ask trade allies what type of training they would find most useful. In past evaluation reports PSE trade allies have requested more training in marketing techniques, and design of "plug and play" spreadsheets that will minimize the trade allies' time behind a desk.

Develop training materials. If contractors desire more marketing training, create prefabricated marketing materials that they can use "off the shelf" with the credibility of PSE's name backing their sales pitch. If contractors are seeking more technical expertise, create "cheat sheets" for use in the field, that contain all the essential checklists a field technician should review before leaving a job site. These materials should be developed in conjunction with contractors whenever possible, to ensure that the design of the materials caters to their interests and needs. In interviews, multiple respondents stated they prefer materials catered to each program type—the one-size-fits-all materials are too overwhelming. They also prefer simplified materials that clearly state what the utility will pay, without building unrealistic expectations.

Have frequent contact with participating contractors with in-person mini conferences and events. Many contractors with moderate program activity would like to have more direct contact and a better relationship with PSE; more active contractors with such relationships are often more satisfied with and better informed about PSE's programs. A best practice is to hold meetings with participating contractors on at least a quarterly basis. Meetings don't always need to be structured around program updates or changes to incentives; the network can meet to share customer experiences, technical approaches, update the network on market trends, or simply have a holiday gathering.

How can PSE best communicate essential information to trade allies?

Develop a system to share incentive application status with trade allies. One significant frustration trade allies expressed with the program is the inability to quickly understand the status of their incentive application with PSE. Trade allies suggest that PSE should improve timeliness and transparency of incentive approval processes and rebate returns. Of course, all rebates need to be vetted and reviewed before being issued. Programs with the highest trade ally satisfaction communicate every step in the process of application review to the trade allies and customers in a simple visual process flow diagram. The most sophisticated program administrators will issue project tracking numbers to each rebate, provide those numbers to the customer and the trade ally, and allow anyone to log in to an online portal at any time to track their application progress (similar to a UPS package tracking number). Many trade allies expressed that not knowing the status of the rebate leads to customer dissatisfaction that is

misattributed to the contractor. This frustrates both the contractor and the customer, because the contractor is unable to satisfy customer inquiries about the status of the rebate. Even if rebate processing time is not substantially increased by introduction of a tracking system, simply making the information accessible will greatly improve trade ally and customer satisfaction.

What is the best way to develop an effective contractor network that encourages fruitful collaboration and yields more business for all contractors?

80% of contractors interviewed for this evaluation have trouble articulating the value of the CAN. Almost all contractors think it should be a lead generation tool, and are dissatisfied because the CAN does not generate high quality sales leads.

Develop a method for pre-screening customer referrals through the CAN. One trade ally mentioned that customers referred through the CAN "never meet the TRC criteria." Convene a meeting of the CAN to talk about this issue. Is there a simple pre-screen of customers that could be implemented (such as a brief survey or online audit) that would greatly increase the likelihood that a referral through the CAN is an eligible participant?

Develop a system for fairly allocating referrals across all contractors in the CAN. Track referral metrics from the CAN. Are most or all of the jobs going to the largest contractors? Is there a better way to geographically allocate these referrals to the closest contractor? Contractors are less likely to join the CAN if they perceive unfair or preferential treatment of certain contractors over others. Work with the CAN to devise a fair, mutually agreeable system for allocating leads, and most importantly, be transparent about how the system works and track the results.

Create a contractor network that is about more than just lead generation. Contractors are likely unsatisfied with the CAN because they are not aware that there are potential benefits to CAN participation outside of simple sales lead generation. By implementing some of the recommendations described above (quarterly trainings, industry events, sharing customer experiences, community gatherings, etc.) contractors may begin to see value in the network for technical education, career development, and professional networking.

2.3.5 Data Management

Tracking and reporting data

Navigant staff gave good feedback on the condition and clarity of the new program database. Old data in scanned pdf files made the impact evaluation difficult, due to the need to enter significant quantities of data by hand. However, this should no longer be an issue for future evaluations.

Collect realistic and relevant data to streamline evaluation efforts. Currently, program documentation includes the option to record HOU for every fixture in the building. It is unrealistic to expect contractors or site contacts to record HOU on a fixture-by-fixture basis. It is more appropriate to allow five different spaces

in a building, and record HOU and fixtures by space. Then, all fixtures within a certain space will have the same HOU, which will simplify both the rebate application and program evaluation processes.

Similarly, many of the site contacts listed on the rebate application are corporate contacts, based in the corporate headquarters of the business (often off site and frequently not in the same time zone). It is important to have a local contact somewhere in the project documentation. This does not need to be a technical contact, just someone to unlock the door for field technicians evaluating the project, and speak broadly to the scope of the project.

Syncing data reporting and program design efforts with other regional entities

PSE is fortunate to be in the Pacific Northwest, where there is significant regional support for EE programs from organizations like the Northwest Energy Efficiency Alliance (NEEA), Bonneville Power Administration (BPA), the Northwest Power and Conservation Council (the Council), and the Regional Technical Forum (RTF). All of these organizations are dedicated to sharing resources and best practices with other program administrators in the region. Specifically, PSE can benefit from these resources in the following areas:

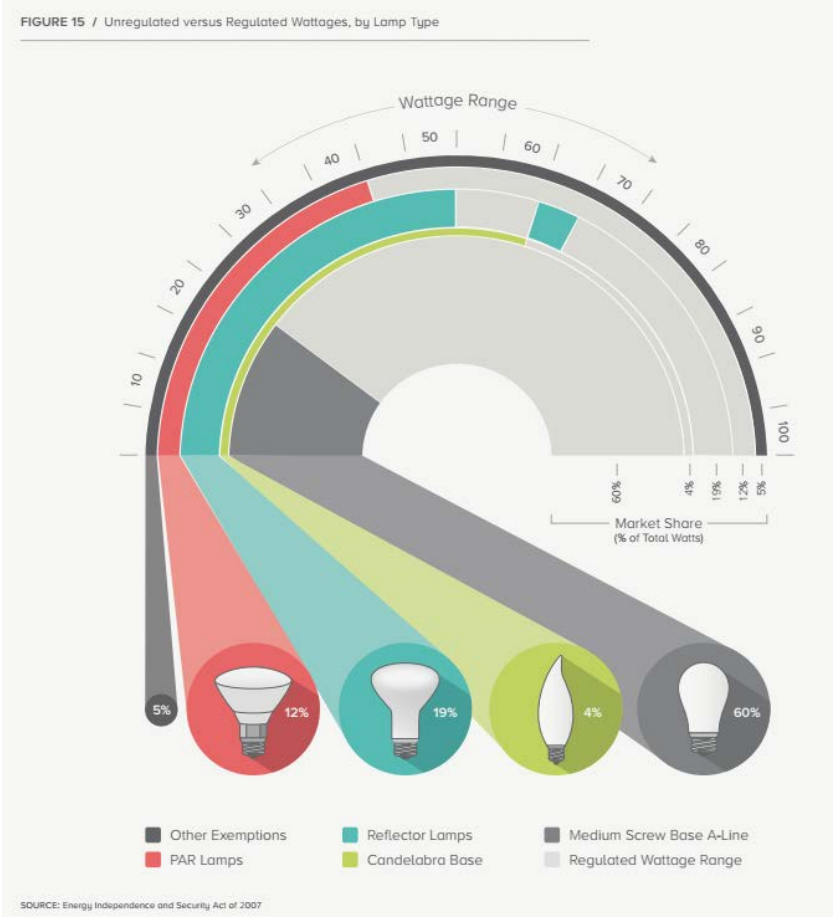
Data reporting. BPA is spearheading an effort to standardize program tracking data throughout the region, and measure all program savings against a consistent baseline. This will allow regional programs to make an apples-to-apples comparison of their program performance to other programs, and to savings in the market tracked by BPA and NEEA (known as Momentum Savings), and rely on technical material developed by the RTF and BPA (e.g. savings calculator tools, HVAC interaction factors, and data management best practices). Synchronizing data reporting is the first step for regional utilities to act together to transform the market. Programs have more leverage over manufacturers and distributors as a regional entity rather than individual programs. Distributors can easily ignore a single utility service territory, but they will pay attention when the entire four state region design a data-driven market transformation program. Collecting and standardizing that data is the first step in the process.

Program design. PSE can look to regional entities for best practices in program design. For example, there is a lot of activity in the region at the moment among program administrators and NEEA working with midstream distributors of commercial lighting. At the moment, midstream programs focus on "easy targets" such as screw-in LEDs, reflectors, and A-line lamps. Regional programs are seeking to evolve beyond bulbs that are easily installed by customers and achieve deeper savings through complete retrofits involving LED luminaries and rewiring of entire fixtures. Outdoor lighting retrofits are also an emphasis within the region, due to their high HOU, low efficiency in the current building stock according to the latest CBSA, and the fact that they are often overlooked by typical consumers.

There are a variety of regional resources such as the CBSA that can be very useful to PSE when designing programs. As utilities across the country move toward influencing markets, codes and

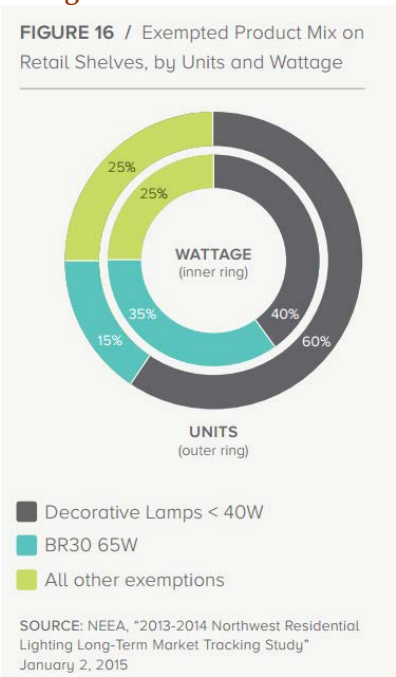
standards, and consumer behaviors, resources like BPA's LED Market Intelligence Report[9] can be particularly useful. Figure 19 presents an example of the type of visually-appealing technical information contained in BPA's report. The report also contains recommendations for program managers, and a wealth of regional market data (Figure 20). BPA also anticipates they will release a similar booklet on the HVAC market in early 2016.

Figure 19. Example Technical Figure from the BPA LED Market Intelligence Report



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

Figure 20. Example Market Figure from the BPA LED Market Intelligence Report



3. Impact Evaluation

This section presents the methodology, findings and statistical validity of the impact evaluation of PSE's C&I Lighting Programs. Specifically, the impact evaluation aimed to characterize program-specific energy savings impacts for commercial lighting retrofit measures by:

- Quantifying the impacts of all projects on annual gross energy consumption.
- Establishing post-implementation performance for installed projects.
- Defining realization rates between *ex-ante* assumptions and *ex-post* findings
- Explaining discrepancies between the results of this study and the *ex-ante* savings estimates.

Results are presented at the annual level, as well as at the level of the sampling strata and the individual projects that were included in the sample.

3.1 Impact Evaluation Methodology

3.1.1 Review of the C&I Program Tracking Database

Navigant completed a thorough review of PSE's Program Schedule Databases which store contextual project data along with *ex-ante* project savings estimates. In addition to verifying the consistency/quality of the information within these data files, the data was used to prioritize projects by their *ex-ante* savings. Navigant reviewed all of the projects in the lighting programs during the 2012-14 program years, and worked closely with PSE to determine which lighting programs and measures to include in the evaluation. Navigant then employed a detailed QC process to screen out non-lighting measures and projects from other programs, and to standardize the measure categories across all C&I lighting programs. A summary of the lighting projects by measure category is presented in Table 5.

Table 5. Lighting Projects by Measure Category

Measure Category	Number of Projects	*Ex-Ante* kWh Savings	Avg. kWh Savings per Project
Lighting Enhanced	222	28,092,032	126,541
Lighting	315	16,688,285	52,979
Lighting Fixtures + Controls	211	14,718,197	69,754
Lighting Standard	230	10,303,618	44,798
LED Lighting	147	5,691,387	38,717
Lighting Enhanced with Controls	56	4,274,401	76,329
Fluorescent Luminaires	60	4,107,712	68,462
Lighting Standard with Controls	50	2,366,327	47,327
Screw-In LEDs	275	2,084,730	7,581
Lighting Controls	32	1,095,297	34,228
Screw-In CFLs	105	913,291	8,698
HID Luminaires	16	836,799	52,300
Low-Watt T8s	96	635,999	6,625
T12 to T8	5	268,701	53,740
LED Exit Signs	100	158,898	1,589
Screw-In CMH	6	115,214	19,202

Source: Navigant analysis of PSE tracking database.

The original evaluation objective was to provide verified savings at the program level and for certain measure technologies (e.g., low-watt T8s, Screw-In LEDs, etc.). ***However, a review of the data available in the tracking database indicated insufficient measure-level detail to accurately stratify the sample based on measure categories.***[10] As a result, Navigant was unable to isolate and set statistical boundaries around these measure technologies. The final sample framework agreed upon is described in the next section.

3.1.2 Impact Evaluation Sampling Framework

Navigant developed a sampling framework that provides a realistic level of statistical accuracy, effectively address impact evaluation objectives, and made most efficient use of evaluation resources.

[10] For example, the top four measure categories in 2012-2014 in terms of reported energy savings are Lighting Enhanced, Lighting, Lighting Fixtures + Controls, and Lighting Standard. Within any one of those categories, several measure technologies could have been installed as part of the project. There is no direct way to know precisely the number of installations of each measure technology. Discussions with PSE program staff concluded additional data are not available to disaggregate the installed technologies in these measure categories.

Furthermore, feedback from PSE staff ensured that the subsequent sample design was consistent with both industry[11,12] and PSE's internal standards of statistical veracity.

Navigant developed the overall sample size using the Stratified Ratio Estimation approach.[13] Stratified ratio estimation sampling can achieve increased precision and reliability by taking advantage of a relatively stable correlation between an auxiliary variable and the variable of interest. Navigant will sample on the estimated realization rates (i.e., the ratios) rather than the estimated savings for each project. The method achieves efficiency compared to simple random sampling, because the variability of the estimated realization rates is generally lower than the variability of the estimated project savings. For example, two projects in the population may have savings reported of 1,000 kWh and 1,000,000 kWh, respectively. The expected savings for those projects has a large range, as their savings will be several orders of magnitude apart. The realization rates, on the other hand, generally fall between 70-100%, a difference well within one order of magnitude.

Per the 2004 California Evaluation Framework[14], sample sizes developed using the Stratified Ratio Estimation approach comply with the following equation:

$$n = \frac{\left(\frac{Z * \varepsilon}{rp}\right)^2}{1 + \left(\frac{Z * \varepsilon}{rp}\right)^2 / N}$$

Where:

n = Sample Size
Z = Z-value for Desired Confidence Level
ε = Assumed Error Ratio of the Realization Rates
rp = Desired Relative Precision
N = Population Size

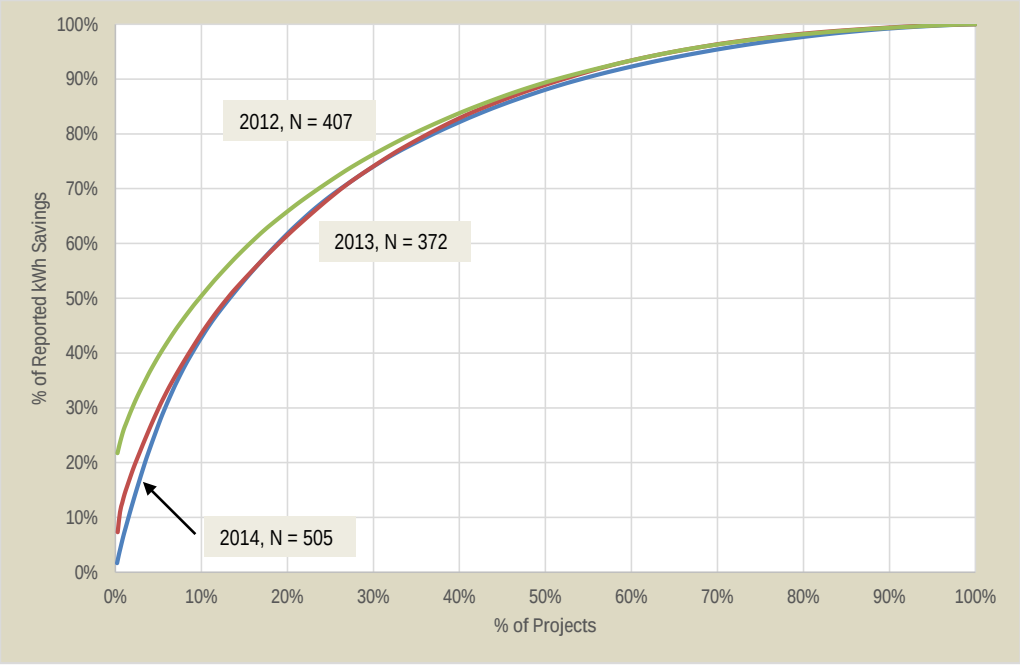
Navigant proportionately stratified the sample by program reported savings. Under this approach, the sample population is divided into subgroups (i.e., strata) and sample units are chosen equal to the portion of the population in the strata. This strategy ensures that the largest contributors to program performance are evaluated, while also addressing a sufficient number of smaller projects that may inform future program design efforts (e.g., providing information about savings opportunities at the smaller sites).

[11] TecMarket Works Team. *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*. April 2006.
[12] National Renewable Energy Laboratory. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 11: Sample Design Cross-Cutting Protocols*. April 2013.
[13] The data meet the two primary requirements for stratified ratio estimation: (a) there is substantial variation in the size of the projects in the program, and (b) the tracking system provides fairly accurate estimates of the savings of each project.
[14] TecMarket Works. *The California Evaluation Framework*. June 2004.

As discussed above, the original intention was to stratify by measure type, but there was insufficient detail in the tracking database to do so. However, the approach that Navigant employed — stratifying on program year and project size rather than measure — better met another goal of this evaluation (beyond determining *ex-post* savings), which was to inform *ex-ante* savings estimates for future program years. The chosen sampling approach better met this objective due to its focus on more recent projects.

Navigant determined the evaluation sample using unique projects, as defined by the Project Number in the tracking database, as the sampling unit. Figure 21 shows the project distribution of reported savings for program years 2012, 2013, and 2014. An examination of the distribution curves confirmed that a few large projects accounted for over half of the annual energy savings, while the small projects, though many, accounted for a much smaller proportion of the savings. As a result, Navigant gained efficiencies in the sample design by stratifying the program years by project size and evaluating projects within each stratum. Of particular note, the largest project in terms of energy savings was in 2012 with over 7 GWh reported. This project alone contributed nearly 22% of the total reported savings in 2012. Similarly in 2013, two projects of 1 GWh and 2 GWh respectively combined to account for over 10% of 2013 reported savings. Program year 2014 did not include any projects that fell into the very large stratum, yet the general distribution outside of the very large projects follows the same trend as 2012 and 2013. Figure 21 shows the similarity of the distribution curves, particularly for 2013 and 2014. That is, the slopes along the curves are approximately equivalent despite the absence of very large projects in 2014. Stratification by project size ensures the realization rate for 2014 was independent of the large projects in 2012 and 2013.

Figure 21. Distribution of Reported kWh Savings for 2012-2014 C&I Lighting Projects



Source: Navigant analysis of PSE tracking database.

3.1.3 Stratification Method

Navigant developed the stratification method using the following levels:

- **Level 1: Program Year**. Data are available in the program tracking database for program years 2012, 2013, and 2014. As mentioned above, Navigant and PSE agreed that the more recent projects are most representative of the future program, thus the evaluation sample reflected only program years 2013 and 2014. The evaluation determined a program-level realization based only on 2013 and 2014 projects, and Navigant assigned the most representative realization rate to the 2012 reported savings.[15]
- **Level 2: Project Size**. Based on the analysis of the tracking database, Navigant set project size thresholds to reflect the distribution of the savings. Navigant set the thresholds to ensure both the largest contributors to the program as well as medium sized projects were adequately sampled.[16] In doing so, Navigant prioritized cost effectiveness of the field work while achieving the targets of the evaluation. Table 6 presents the stratification boundaries used to determine the strata populations and the sample parameters. Navigant drew samples within each stratum except the Very Small projects. Common practice suggests withholding those projects that account for 5% of less of the total program savings from the evaluation sample.[17] Those projects, though important to the overall program, can reasonably be assigned the realization rate determined for the Small project stratum. Similarly, Navigant combined the Small projects of 2013 and 2014 into one stratum. These projects likely exhibit similar characteristics and in aggregate the realization rate does not likely depend on the year of installation.

[15] The very large project in 2012 is included in the sample for the Large Power Users (Schedule 258) evaluation. The 7 GWh of lighting savings is only a portion of the total lighting savings for the project, the remainder of which were rebated through Schedule 258. Navigant will not likely be able to accurately determine which lighting fixtures were channeled through which of the two programs. Thus, Navigant will apply the realization rate for the lighting measures for this project as evaluated in the Schedule 258 evaluation to the 7 GWh of savings reported through Schedule 250. This will enhance the overall precision of the evaluation savings.

[16] The *California Evaluation Framework* details stratification methodology and provides guidelines for setting stratification thresholds. When error ratios are equal, the thresholds achieve equivalent contribution to program savings. However, the *Uniform Methods Project*, the more recent protocol, suggests prioritizing cost-efficiency. That is, cost-effectiveness increases when thresholds are set such that the stratification is weighted toward projects that have the highest value to the evaluation (i.e., medium and large projects). The thresholds were set to achieve approximately an even allocation of strata based on savings contribution to the program. The thresholds are consistent across the program years to enable direct *ex post* comparison, thus exactly equivalent allocation was not possible.

[17] For more information, please refer to the Uniform Methods Project. The Uniform Methods Project is available at http://energy.gov/eere/about-us/ump-protocols.

Table 6. Project Size Stratification Boundaries for 2013-2014 C&I Lighting Projects

Project Size	Range of Reported Savings (kWh)	No. of Projects	% of 2013-2014 Savings Represented
Very Large	1,992,451 – 993,821	2	5.3%
Large	487,687 – 300,000	18	11.5%
Medium	299,999 – 100,000	154	44.8%
Small	99,999 – 16,000	444	34.4%
Very Small	15,999 – 847	259	4.0%
Total		877	100%

Source: Navigant analysis of PSE tracking database.

3.1.4 Sample Design

Navigant has developed a sample design and statistical calculation tool that relies on Excel's built-in optimization software. The tool selects the optimal number of projects needed to determine a population mean based on statistical characteristics of the sample and the desired confidence and precision criteria. This tool is based on the stratification methodology discussed above and weights each stratum according to its approximate contribution to the total mean. In this case, the strata weights were defined by the relative percentage of *ex-ante* energy savings.

In developing the overall sample, Navigant leveraged its sample design tool to determine proposed sample sizes. The error ratio of 0.24 assumed for the sample design was based on Navigant's most recent Impact Evaluation of PSE's E250 and E258 Commercial/Industrial Retrofit Schedules. Lighting technologies comprised approximately 50% of *ex-ante* savings for these Schedules during the 2009-2010 program years, and the *ex-post* findings revealed accurate realization rates that exhibited low variation. [18] Moreover, lighting technologies are well researched and understood, and prior experience has shown that these projects are documented very well within PSE. Because realization rates for lighting projects are typically independent of project size, Navigant estimated an error ratio of 0.24 for each stratum.

[18] Lighting measures achieved a realization rate of 103% within the Impact Evaluation Sample. Project realization rates ranged from 96% to 140%, and the final program error ratio was 0.12. Navigant selected 0.24 (two times 0.12) as a more conservative estimate than 0.12. The higher initial error ratio will provide a reasonable safeguard for the unlikely event of any outlier results.

Table 7 presents the final stratification for the evaluation and the corresponding sample sizes. Predicted relative precision is listed at the 80% confidence level for each stratum, and at the 90% confidence level for the overall.

Table 7. On-Site Verification Sample Sizes

Stratum	Population (# of Projects	Error Ratio	Mean Savings (kWh)	Total Savings (kWh)	Sample Size	Stratum Relative Weight	Predicted Relative Precision (80% confidence for strata; 90% confidence for overall)
2012_Very Large	1	0.24	7,635,647	7,635,647	1	12.3%	0.0%
2013_Very Large	2	0.24	1,493,136	2,986,272	2	4.8%	0.0%
2013_Large	6	0.24	375,118	2,250,710	4	3.6%	12.4%
2013_Medium	79	0.24	162,289	12,820,850	6	20.7%	14.0%
2014_Large	12	0.24	357,709	4,292,510	5	6.9%	13.1%
2014_Medium	77	0.24	167,195	12,539,613	6	20.2%	14.0%
2013/14_Small	444	0.24	43,912	19,497,108	6	31.4%	14.4%
2013/14_Very Small	259	N/A	8,793	2,277,445	0	N/A	N/A
Overall	879			64,300,155	30	100%	7.3%

Source: Navigant analysis of PSE tracking database.

3.1.5 Site Selection

The participant sample for on-site verification was drawn at random from the list of projects in the tracking database using the RAND() function in Excel. The projects were sorted in increasing order by the RAND() output and the first projects were selected until each stratum allocation was met. Navigant selected the required number of projects for each stratum, as well as up to three additional projects to facilitate recruitment. After selecting the projects, Navigant reviewed the distributions within each stratum and confirmed the sampled projects sufficiently represent their respective stratum populations. For example, the average reported savings for the population of 2013/2014 Small projects is 43,912 kWh, and the average reported savings for the sampled 2013/2014 Small projects is 40,844 kWh. Additionally, the sampled 2013/2014 Small projects include a range of measures categories: LED lighting, Lighting Fixtures plus Controls, Lighting Standard, Lighting Standard with Controls, Lighting Enhanced with Controls.

3.1.6 Project File Reviews

Navigant completed a thorough review of the project file for each project selected as part of the sample. For each project file reviewed, Navigant characterized any data gaps, consistency issues, and the accuracy of the information used to estimate project-level savings. For example, checks were made for possible biases in the data, either because some customers were not included or because there was an absence of eligibility data for a particular group of customers.

Navigant complied a detailed tracking database from the project files for the sampled sites, extracting all relevant data for each line item on fixture descriptions, quantities, watts, HOU, control types, locations, heat types, and claimed energy consumption and savings. Using this data, Navigant completed a

detailed QC of the project file savings, identifying and fixing any errors in the data entry, and making notes of any line items for which the savings was calculated incorrectly.

Navigant compared the re-calculated savings for each project to what was claimed in the project file, to determine if there were significant errors in the project savings values that PSE is tracking in their database. All sampled projects had total error rates of 1% or less, indicating that PSE is doing a good job of faithfully representing the actual project activity in their aggregate tracking system. Based on this finding, Navigant decided that it would not be necessary to present findings with the tracking data error impacts indicated separately from the overall realization rates.

Finally, Navigant cross-checked the total savings calculated from the line-item data with the totals tracked in the project files and the tracking database to search for missing data and ensure that all measure line items were included in the on-site verification work.

3.1.7 On-Site Measurement & Verification Analysis

Navigant collected on-site measurement and verification data from all sites selected in the sample, employing the IPMVP Protocols to guide the on-site data collection and evaluation strategies used. Table 8 provides an overview of these IPMVP Options:

Table 8. Overview of M&V Options

IPMVP M&V Option	Measure Performance Characteristics	Data Requirements
Option A: Engineering calculations using spot or short-term measurements, and/or historical data	Constant performance	• Verified installation • Nameplate or stipulated performance parameters • Spot measurements • Run-time hour measurements
Option B: Engineering calculations using metered data	Constant or variable performance	• Verified installation • Nameplate or stipulated performance parameters • End-use metered data
Option C: Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multivariate regression analysis	Variable performance	• Verified installation • Utility metered or end-use metered data • Engineering estimate of savings input to SAE model
Option D: Calibrated energy simulation/modeling; calibrated with hourly or monthly utility billing data and/or end-use metering	Variable performance	• Verified installation • Spot measurements, run-time hour monitoring, and/or end-use metering to prepare inputs to models • Utility billing records, end-use metering, or other indices to calibrate models

Since the vast majority of the lighting technologies evaluated (with the exception of dimmer/photocell controls measures) exhibit constant performance, Navigant used Option A to evaluate all projects included in this evaluation.

The on-site data collection effort focused on the following key elements:

- Verification of lighting fixture counts
- Confirmation of the fixture type and details of installed fixtures
- Confirmation of the presence and type of lighting controls
- Run-time data logging of a sample of fixtures, to provide verified HOU
- Confirmation of baseline conditions (as possible)
- Interview with building operators about occupancy schedules and holidays

3.1.8 Verification Data Analysis

Navigant first created a line-item-level database with all of the custom lighting measures for all sampled projects, in order to verify that the *ex-ante* calculations had been performed correctly. This also served to ensure that all line items for each project were included in the on-site verification.

Next, using the verified fixture counts, Navigant calculated an in-service rate (ISR, total verified fixture count / total claimed fixture count) for each project. For the single project in which the ISR was greater than 105%, verified quantities were adjusted down so the total ISR was 105%; based on extensive experience evaluating commercial lighting programs, Navigant has determined that ISRs greater than 105% are generally due to spillover, and thus are best excluded from the gross savings analysis.

Navigant then analyzed the data from the run-time data loggers to determine adjusted HOU for each line item. First, individual logger files were checked extensively for evidence of logger failure, daylight interference, improper calibration, flickering, or other suspicious data, and all loggers deemed compromised were removed from the analysis. Next, logged data was converted from on/off timestamp data to percent on per hour for all logged hours, and the data from before install and after removal was removed. Finally, the logged data was extrapolated to a full typical year by taking the average percent on by hour of day (1-24) and day type (weekday, weekend, holiday).

The resulting annual HOU for each logger was compared to the claimed HOU of the logged fixture, and a customer self-reported ratio (CSRR) was calculated for each. The average CSRR for each site was then used to adjust the claimed HOU to determine verified HOU for all un-logged lighting fixtures.[19]

Navigant next assigned verified values of controls savings factors (CSFs) and HVAC interactive effects factors (HVAC IEs) for all line items, assigning the PSE-approved values from the Business Lighting Workbook based on verified values of space type and heating and cooling type, respectively.

Finally, verified energy savings were calculated for each line item, using the same algorithms as in the PSE Business Lighting Workbook, with the verified values of fixture count, HOU, CSF, and HVAC IE.

[19] This methodology was followed for all but 7 sites, in which Navigant could not install data loggers: 3 Home Depot sites which had all lights controlled by a central system, 1 site where the site contact refused to allow installation, and 3 car washes with photocell lights, in which the loggers could not be properly calibrated since the lights would not turn on in the daytime. For the 3 Home Depots, Navigant used documentation of the lighting system controls to verify HOU, and for the 4 other sites, the average CSRR from the logged sites was used.

The verified savings for all line items were summed by project to determine the verified (*ex-post*) energy savings for each project.

3.1.9 Realization Rate Calculations

Navigant calculated a project realization rate for each project, by taking the ratio of verified savings to the claimed savings from the project file, for all custom measures:

$$\underset{Realization\ Rate}{Project} = \frac{Verified\ Ex\ Post\ Energy\ Savings}{Project\ File\ Custom\ Ex\ Ante\ Energy\ Savings}$$

Prescriptive measures such as screw-in LEDs and LED exit signs were not evaluated explicitly and were assumed to have the same realization rate as the custom measures. The project realization rate was calculated based on the total claimed savings from the custom measures in the project file, and this realization rate was then applied to the project's total savings from the tracking database.

Stratum-level realization rates were calculated by taking the ratio of the total verified savings to the total tracking database savings, for all sites in each stratum:

$$\underset{Realization\ Rate_i}{Stratum} = \frac{\sum_{i=1}^{n} Project\ Verified\ Ex\ Post\ Energy\ Savings_i}{\sum_{i=1}^{n} Tracking\ Database\ Ex\ Ante\ Energy\ Savings_i}$$

Total realization rates for each program year and for the combined 2013/14 program years were then calculated by summing the product of the stratum tracked savings with the stratum realization rate for all strata, and dividing by the total tracked savings:

$$\underset{Realization\ Rate}{Total} = \frac{\sum_{i=1}^{n} Stratum\ Ex\ Ante\ Energy\ Savings_i * Stratum\ Realization\ Rate_i}{\sum_{i=1}^{n} Stratum\ Ex\ Ante\ Energy\ Savings_i}$$

3.1.10 HVAC Interactive Effects Methodology

The current methodology for assigning lighting HVAC interaction factors accounts for heating fuel type and presence, as well as refrigerated spaces. Navigant reviewed the values for each of these categories and compared to the range of values in the RTF interactive effects workbook for all building types, as illustrated in Table 9. The team made the following observations regarding the current methodology and values:

- It is not clear whether the PSE values account for the presence of cooling. A value of 1.0 for gas heat is reasonable for heated-only spaces, but if there is cooling the interaction should likely be higher. PSE should consider adding a dimension for presence of cooling, or at minimum specify whether the current values are for cooled spaces, uncooled spaces, or a weighted average of the two.
- Although this comparison references regional estimates rather than estimates specific to PSE's service territory, the ranges for electric resistance heat (with or without cooling) indicate that

PSE's current value for electric heat may be too high. (Footnote: The majority of the region's floor space is in climate zone 4C, the zone for Portland and Seattle, giving this zone strong weight in regional averages)

- Interactions can vary by building type and HVAC system type. This is why the RTF factors have a wide range for each combination of space heating and cooling. PSE should consider incorporating building type into the matrix. BPA and the RTF are currently conducting research on updating lighting interaction values and PSE could leverage this new data to develop updated values in the future.

Table 9. Comparison of PSE Interaction Factors to Current RTF Value Ranges

Space Heating Type	Abbreviation	Current Interaction Factor	Range of RTF Interaction Factors, Heating Only	Range of Interaction Factors, with Electric Cooling
Non-Heated Space	Non-Heated	1.0	1.0	1.0 – 1.3
Electric	Electric Heat	0.9	Electric resistance: 0.27 – 0.87; mean = 0.61 Heat Pump: 0.64 – 0.94; mean = 0.81	Electric Resistance: 0.29 – 1.17; mean = 0.77 Heat Pump: 0.65 – 1.24; mean = 0.93
Exterior	Exterior	1.0	1.0	1.0
Gas	Gas Heat	1.0	0.93 – 1.0; mean = 0.97	0.94 – 1.24; mean = 1.06
Refrigerated Space	Refrig Space	1.2	n/a	1.12 (Refrigerated Warehouse)
Street Lights	Street Light	1.0	1.0	1.0

3.2 Impact Evaluation Findings

3.2.1 Program-Level Savings

Table 10 below shows the total C&I lighting *ex-post* gross program savings and realization rates for program years 2012-2014 and for 2013-2014 combined. Navigant and PSE determined that program years 2013-2014 were more representative of the future program, and thus the evaluation sample included almost exclusively projects from those program years[20].

[20] The one exception was one very large project from 2012, accounting for 7 GWh of ex-ante savings, which was included in the sample.

Table 10. Total Program Savings by Program Year

Program Year	*Ex-Ante* Savings (kWh)	Realization Rate	*Ex-Post* Savings (kWh)
2012	35,133,581	105%	36,778,140
2013	27,259,064	104%	28,267,158
2014	29,958,246	112%	33,695,151
2013/14	57,217,310	108%	61,962,308

Source: Navigant analysis of M&V data

Overall realization rates were all slightly greater than 100%, indicating that PSE's tracking database is providing a reasonably good indication of program savings, but tends to under-report. Program year 2014 showed a significantly increased realization rate over program years 2012-2013, and the combined 2013-2014 realization rate was also higher than 2012.

3.2.2 Total Savings by Stratum

Navigant developed the stratification for the sample based on program year and project size, focusing on the 2013-2014 program years. All 2013-2014 strata were included in the sample except the 2013/14 Very Small stratum, accounting for only 4% of claimed savings, which was assigned the realization rate from the 2013/14 Small stratum. The 2012 program year was determined to be less representative of the program, so the strata for that year were assigned the realization rates from the 2013 stratum of the same size group, except for the 2012 Very Large stratum, which was included in the sample. Total savings by stratum is shown in Table 11 below:

Table 11: Total Savings by Stratum

Stratum	Total Projects	Sampled Projects	*Ex-Ante* Savings (kWh)	Realization Rate	*Ex-Post* Savings (kWh)
2012_Very Small	102	0	913,069	114%	1,036,388
2012_Small	219	0	10,510,039	114%	11,929,525
2012_Medium	77	0	12,556,355	96%	12,078,826
2012_Large	9	0	3,518,471	111%	3,907,530
2012_Very Large	1	1	7,635,647	102%	7,825,871
2013/14_Very Small	259	0	2,277,445	114%	2,585,037
2013/14_Small	444	6	19,497,110	114%	22,130,390
2013_Medium	79	6	12,820,850	96%	12,333,262
2013_Large	6	4	2,250,710	111%	2,499,585
2013_Very Large	2	2	2,986,272	100%	2,990,360
2014_Medium	77	6	13,092,413	116%	15,154,494
2014_Large	12	5	4,292,510	99%	4,269,180

Source: Navigant analysis of M&V data

All *sampled* strata except for the 2013 Medium stratum came in at or above 100%. Interestingly, the 2013 Medium stratum had the lowest realization rate, while the 2014 Medium stratum had the highest. These differences were largely driven by variability in the verified fixture counts and HOU (discussed below).

3.2.3 Verified Savings by Sampled Project

Table 12 below shows the verified savings for each of the 30 projects which were included in the sample:

Table 12: Verified Savings by Sampled Project

Program Year	Project Size	Project Number	*Ex-Ante* Savings (kWh)	Realization Rate	*Ex-Post* Savings (kWh)
2012	Very Large	877096	7,635,647	102%	7,825,871
2013	Small	901562	54,806	93%	50,800
2013	Medium	870511	180,605	65%	117,374
2013	Medium	874096	102,382	92%	94,608
2013	Medium	876642	141,461	100%	141,339
2013	Medium	881138	122,767	112%	138,097
2013	Medium	884513	100,141	108%	107,960
2013	Medium	895767	182,882	109%	199,286
2013	Large	881316	334,972	109%	363,693
2013	Large	889426	480,250	91%	437,609
2013	Large	894818	319,631	138%	441,468
2013	Large	897174	349,422	116%	405,631
2013	Very Large	870692	993,821	93%	925,386
2013	Very Large	875601	1,992,451	104%	2,064,974
2014	Small	907351	37,927	166%	63,036
2014	Small	922536	39,830	103%	41,102
2014	Small	922574	22,470	109%	24,476
2014	Small	937377	22,154	97%	21,418
2014	Small	956314	96,365	114%	109,666
2014	Medium	905925	102,056	44%	44,808
2014	Medium	905984	145,186	90%	130,959
2014	Medium	907709	291,390	120%	348,483
2014	Medium	913515	137,187	148%	202,982
2014	Medium	913981	258,866	145%	375,027
2014	Medium	945916	113,560	98%	111,086
2014	Large	902076	363,188	54%	195,854
2014	Large	914449	307,449	82%	253,273
2014	Large	914455	432,872	116%	502,122
2014	Large	934494	314,783	113%	354,451

Source: Navigant analysis of M&V data

Despite the stratum-level realization rates being fairly consistent and close to 100%, the individual projects showed considerably more variability in their realization rates. Most of this variability is due to differences between reported and field-verified fixture counts and HOU found at each site (discussed below), but a few projects' realization rates were affected by closure or demolition of portions of the site itself. These exceptional findings are summarized in Table 13:

Table 13: Exceptional Findings by Project

Project Number	Finding
870692	One small parking garage, accounting for 2.6% of claimed savings, had been demolished. Realization rate would be 96% without including this portion of the project.
905925	One large wing of the building, accounting for 33.3% of claimed savings, had been closed to all use due to economic reasons. Realization rate would be 66% without including this portion of the project.

Source: Navigant analysis of M&V data

3.3 Factors Influencing Program Realization Rates

Other than the exceptional findings noted above, the main drivers of realization rates were differences between reported and verified fixture counts and HOU. Other minor drivers included cases where the project claimed installation of lighting controls but no controls were found on-site, and differences in the CSFs and the HVAC interactive effect factor values between the project file and what was verified[21].

Verified quantities were relatively consistent with what was reported for most projects, with a few larger exceptions. Quantities were within 5% for most projects, though a few projects had significantly lower verified quantities than reported, and one had significantly higher verified quantities.

HOU, on the other hand, showed a slight increase in verified versus claimed values with the average customer self-reported ratio (CSRR, the ratio of logged to claimed hours of use) across all projects coming in at 109%. Project-level HOU averages showed significant variability ranging from 59% to 169% of what was claimed. This variability is to be expected, due to the difficulty of accurately estimating HOU specific to all of the lights included in a project.

3.3.1 Drivers of Realization Rate by Project

Table 14 below shows the primary drivers of the realization rate for each project, along with specific notes on certain projects with high or low values. The realization rate for each project is shown, followed by columns tracking the percent impact on the realization rate by differences between reported and verified fixture counts (Qty), hours of use (HOU), presence of lighting controls (Ctr), controls savings factor (CSF), and HVAC IE factor.

[21] Controls savings factor and HVAC interactive effects factor values were updated as part of the verification work by using the same values from the PSE business lighting workbook, but using the verified values of space type and heating/cooling type.

Table 14: Drivers of Realization Rate by Project

Program Year	Project Size	Project Number	RR	Qty	HOU	Ctr	CSF	HVAC IE	Notes
2012	Very Large	877096	102%	3%	1%	0%	-1%	0%	
2013	Small	901562	93%	0%	-4%	0%	0%	-3%	
2013	Medium	870511	65%	0%	-29%	0%	1%	-7%	Almost all loggers showed significantly lower HOU than claimed.
2013	Medium	874096	92%	25%	-22%	0%	0%	-9%	Field tech reported high variability in the usage of different spaces on-site.
2013	Medium	876642	100%	0%	4%	-2%	-2%	0%	
2013	Medium	881138	112%	0%	11%	0%	1%	0%	
2013	Medium	884513	108%	0%	13%	0%	0%	-5%	
2013	Medium	895767	109%	-3%	8%	0%	3%	0%	
2013	Large	881316	109%	0%	9%	0%	0%	0%	
2013	Large	889426	91%	-7%	10%	0%	-12%	0%	
2013	Large	894818	138%	-1%	38%	0%	2%	0%	Several loggers showed significantly higher HOU than claimed.
2013	Large	897174	116%	0%	16%	0%	0%	0%	
2013	Very Large	870692	93%	-4%	-3%	0%	0%	0%	Small parking garage had been demolished.
2013	Very Large	875601	104%	0%	9%	0%	-5%	0%	
2014	Small	907351	166%	0%	66%	0%	0%	0%	All loggers showed significantly higher HOU than claimed.
2014	Small	922536	103%	0%	11%	0%	-8%	0%	
2014	Small	922574	109%	0%	9%	0%	0%	0%	
2014	Small	937377	97%	0%	8%	0%	0%	-12%	Verified heat type was electric, claimed was gas.
2014	Small	956314	114%	0%	14%	0%	0%	0%	
2014	Medium	905925	44%	-33%	-19%	-1%	-2%	0%	Large wing of building closed down.
2014	Medium	905984	90%	-34%	22%	0%	0%	0%	Field tech reported much lower fixture qty than claimed in exterior space.
2014	Medium	907709	120%	0%	20%	0%	-1%	0%	
2014	Medium	913515	148%	0%	48%	0%	0%	0%	Several loggers showed significantly higher HOU than claimed.
2014	Medium	913981	145%	0%	49%	0%	0%	-4%	All loggers showed higher HOU than claimed.

Program Year	Project Size	Project Number	RR	Qty	HOU	Ctr	CSF	HVAC IE	Notes
2014	Medium	945916	98%	0%	-2%	0%	-1%	0%	
2014	Large	902076	54%	-8%	-39%	0%	0%	0%	Several loggers showed significantly lower HOU than claimed, plus many incentivized outdoor pole lights were removed.
2014	Large	914449	82%	0%	-17%	0%	-1%	0%	
2014	Large	914455	116%	0%	16%	0%	0%	0%	
2014	Large	934494	113%	0%	13%	0%	0%	0%	

Source: Navigant analysis of M&V data

3.4 Validity and Reliability of M&V Findings

Navigant calculated confidence and precision values on all strata-level and annual total verified savings values. We developed the overall sample for this evaluation using the Stratified Ratio Estimation approach, with strata defined by program year and project size. The sample design targeted achieving 80% confidence and 20% precision at the stratum level, and 90/10 confidence and precision across the 2013-2014 program years.

Table 15 below shows the achieved precision, by stratum:

Table 15: Achieved Relative Precision by Stratum

Stratum	Total Projects	Sampled Projects	Realization Rate	Coefficient of Variation (CV)	Confidence Level	Relative Precision
2012_Very Large	1	1	102%	NA	80%	0%
2013/14_Small	444	6	114%	0.24	80%	14%
2013_Medium	79	6	96%	0.18	80%	11%
2013_Large	6	4	111%	0.20	80%	10%
2013_Very Large	2	2	100%	NA	80%	0%
2014_Medium	77	6	116%	0.32	80%	19%
2014_Large	12	5	99%	0.31	80%	17%
2013/14_All	879	29	108%	0.27	90%	8%

Source: Navigant analysis of M&V data

As shown in the table, the final results achieved the desired precision at the program level and across all of the strata, with several of the strata achieving much greater precision than targeted.

3.5 Impact Evaluation Recommendations

Based on the study of the PSE C&I Program impacts, and lessons learned in the evaluation process, Navigant offers the following recommendations:

3.5.1 Program Data Requirements

- ***Standardize the reporting of the rationale behind annual HOU calculations.*** Currently applicants provide a single annual value for baseline HOU, and rationale is generally provided in a notes section, often applying only to the most common schedule. Such numbers are more difficult to verify than detailed operating profiles. Requiring more detailed, line-item level operating hours numbers would aid in QC and facilitate evaluation activities. At a minimum, average hours per day and days per year could be reported for each line item.
- ***Require applicants to track space type.*** Tracking standardized space type values would be valuable for multiple reasons; space type is a key input into the energy savings calculation (used in calculating the CSFs), and it would also be useful data for guiding on-site data collection and M&V data analysis. PSE has already incorporated this requirement into the 2016 application.

3.5.2 Program Data Tracking

- ***Track line-item-level program data in the tracking database.*** Currently, PSE only tracks data aggregated by project and measure category, though Excel workbooks containing detailed data are submitted for all custom lighting measures as part of the program. Maintaining this line-item-level data in a detailed program tracking database would allow PSE to more readily check for errors in the submitted project data, and would streamline future evaluation efforts.
- ***Keep electronic copies of custom lighting spreadsheet data.*** In the absence of putting together a full line-item-level tracking database (discussed above), it would be valuable for PSE to keep copies of the Excel spreadsheets submitted with project applications. This would also allow for PSE to do further error checking and facilitate evaluation efforts, though somewhat less than a full database. For most projects in this evaluation, line-item data was only available in scanned PDF form, which is considerably less useful than the same data in Excel form.
- ***Create and track detailed measure types in the tracking database.*** Much of the current program data is tracked with measure names that don't specifically indicate the details of the lighting technology installed (e.g. Lighting fixtures plus controls). PSE currently tracks detailed measure information in the application spreadsheets, but that detail is lost when the data is aggregated in the tracking database. Creating a standard set of measure names that indicate lighting fixture type and control type, for example, and aggregating all project data by measure type in the tracking database, would allow PSE to more accurately account for the performance of different lighting technologies in its programs. This would also enable future evaluations to provide more specific results and recommendations.

3.5.3 Energy Savings Calculations and Documentation

- ***Limit the allowed annual HOU by space type.*** Some of the variability in the evaluated CSRRs and overall realization rates could be mitigated by setting bounds on acceptable claimed HOU

values by space type, based on a review of secondary literature. PSE could restrict these values in the application files by default, but allow for exceptions if documentation is provided.

- ***Require the use of approved occupancy sensor CSFs.*** PSE can increase traceability and report more accurate savings if the occupancy sensor CSFs were changed from custom inputs to industry-accepted standards by space type. In the past, PSE provided a table of suggested values in its Business Lighting Workbook, but allowed the user to enter any value. In the 2016 application, PSE has switched to Navigant's suggested strategy of using standard factors as the default while allowing applicants to submit custom reduction factors with sufficient evidence.

PUGET SOUND ENERGY

Evaluation Report Response

PUGET SOUND ENERGY

Evaluation Report Response

Program:	Commercial Lighting
Program Manager:	Michael Lane
Study Report Name:	2012-2014 Commercial Lighting Programs Impact and Process Evaluation
Report Date:	February, 2016
Evaluation Analyst:	Michael Noreika
Date of ERR:	March, 2016

Evaluation Overview, Key Findings, Recommendations and Program Responses:

Overview:
This evaluation report documents the results of the impact and process evaluations of the PSE 2012-2014 Commercial Lighting Programs. These programs are designed to encourage the installation of selected cost-effective energy efficient lighting measures in existing commercial buildings. The program provides financial incentives toward the installation of such measures.

The study's goals were to verify measure installations, quantify program level energy savings, collect feedback from trade allies, and present best practices for similar programs. Navigant developed the following as part of the process and impact evaluations of the 2012-2014 program years:

- Statistically representative savings analysis sample
- Program document and database review
- Logic model development
- Trade ally in-depth interviews

Key Findings:

Impact Evaluation –

- The analysis yielded the following electric gross savings realization rates:
    - PY 2012: 105%[4]
    - PY 2013: 104%
    - PY 2014: 112%
    - Combined PY 2013/2014: 108%
- The sample design and results achieved the PY 2013/PY 2014 realization rate at 90% confidence and 8% precision. The overall coefficient of variation among the sampled projects was 0.27.

[4] PY 2012 was reported independently of PY 2013 and PY 2014, because the latter two program years were determined to be more representative of future program activity. Only one very large project from 2012 was included in the evaluation sample design; the remaining 2012 projects were assigned realization rates from the 2013 and 2014 projects based on similar project size classificiation.

- The main drivers of lighting realization rates were differences between reported and verified fixture counts and hours of use. Other minor drivers included cases where the project claimed installation of lighting controls but no controls were found on-site, and differences in the controls savings factor and the HVAC interactive effect factor values between the project file and what was verified.

Process Evaluation –

- Interviews with trade allies yielded the following:
    - All trade allies interviewed utilize the program for almost all of their customers.
    - Trade allies generally report positive experiences with PSE staff.
    - Some trade allies would like to see quicker application processing time.

- Research into best practices of similar programs focused on market segmentation, timely application processing, trade ally relationship management, and program data management.

Impact Evaluation Recommendations and Program Responses.

The evaluation was looking back at the program as implemented in 2012, 2013 and 2014. Since those program years, the program has undergone significant implementation revisions, and several of the report's impact and process recommendations have already been implemented in or after the 2014-2015 program cycle. The program team strives to ensure that the program is operating at a high level of efficiency and maximizes all opportunities to improve. Still, there are ample opportunities to improve the customer interactions, track & report savings and program outreach/education. As the team plans & implements the 2016-2017 program we will address the evaluation report's additional recommendations. This section presents the specific recommendations made in the evaluation report, and program responses.

1. ***Standardize the reporting of the rationale behind annual HOU calculations.*** *Currently applicants provide a single annual value for baseline HOU, and rationale is generally provided in a notes section, often applying only to the most common schedule. Such numbers are more difficult to verify than detailed operating profiles. Requiring more detailed, line-item level operating hours numbers would aid in QC and facilitate evaluation activities. At a minimum, average hours per day and days per year could be reported for each line item (p. 46).'*

Program Response: In most cases, PSE program staff confirms the ex ante hours of use, typically through interviews with facility staff or benchmarking against available data sources (e.g., CBSA). Any discrepancies are reconciled prior to rebate payment and project finalization. In the 2014-2015 program cycle, the program began requiring documentation for hours of use by program staff (e.g., EMEs). Documentation can include references to data sources (e.g., CBSA) and average hours per day.

2. ***Require applicants to track space type.*** *Tracking standardized space type values would be valuable for multiple reasons; space type is a key input into the energy savings calculation (used in calculating the CSFs), and it would also be useful data for guiding on-site data collection and M&V data analysis. PSE has already incorporated this requirement into the 2016 application (p. 46)."*

Program Response: Confirming the statement above, in the 2016 program application workbook PSE has built in the ability for users to select space types from pre-populated drop down menus for each installed measure. The space types follow those of the Washington State Energy Code (WSEC).

3. ***Track line-item-level program data in the tracking database.*** *Currently, PSE only tracks data aggregated by project and measure category, though Excel workbooks containing detailed data are submitted for all custom lighting measures as part of the program. Maintaining this line-item-level data in a detailed program tracking database would allow PSE to more readily check for errors in the submitted project data, and would streamline future evaluation efforts (p. 46).'*

Program Response: PSE program staff has developed a database of projects from mid-2014 through 2015 with project line-level data. Staff continues to input past projects and will continue to update the database with future projects. Because of limitations in the tracking database, the database is not part of the tracking database at this time. However, program staff will use the line-level database to analyze such things as measure trends over time.

4. ***Keep electronic copies of custom lighting spreadsheet data.*** *In the absence of putting together a full line-item-level tracking database (discussed above), it would be valuable for PSE to keep copies of the Excel spreadsheets submitted with project applications. This would also allow for PSE to do further error checking and facilitate evaluation efforts, though somewhat less than a full database. For most projects in this evaluation, line-item data was only available in scanned PDF form, which is considerably less useful than the same data in Excel form (p. 46).'*

Program Response: Please see the above response. Additionally, the implementation of a new project management system, known as "Demand Side Management central" (DSMc), later this year will enable the program to archive electronic workbooks with line-level detail, though currently no plan is in place to incorporated the detail into the tracking database.

5. ***Create and track detailed measure types in the tracking database.*** *Much of the current program data is tracked with measure names that don't specifically indicate the details of the lighting technology installed (e.g. Lighting fixtures plus controls). PSE currently tracks detailed measure information in the application spreadsheets, but that detail is lost when the data is aggregated in the tracking database. Creating a standard set of measure names that indicate lighting fixture type and control type, for example, and aggregating all project data by measure type in the tracking database, would allow PSE to more accurately account for the performance of different lighting technologies in its programs. This would also enable future evaluations to provide more specific results and recommendations (p. 46).'*

Program Response: See response to Recommendation #3.

6. ***Limit the allowed annual HOU by space type.*** *Some of the variability in the evaluated CSRRs and overall realization rates could be mitigated by setting bounds on acceptable claimed HOU values by space type, based on a review of secondary literature. PSE could restrict these values in the application files by default, but allow for exceptions if documentation is provided (p. 46).'*

Program Response: See response to Recommendation #1. PSE does a quality control check on all user inputs in the application, including hours of use. In the 2016 application workbook, applicants and/or PSE staff must include documentation for hours of use that are outside expected values (e.g., CBSA hours of use).

7. ***Require the use of approved occupancy sensor control savings factors (CSFs).*** *PSE can increase traceability and report more accurate savings if the occupancy sensor CSFs were changed from custom inputs to industry-accepted standards by space type. In the past, PSE provided a table of suggested values in its Business Lighting Workbook, but allowed the user to enter any value. In the 2016 application, PSE has switched to Navigant's suggested strategy of using standard factors as the default while allowing applicants to submit custom reduction factors with sufficient evidence (p. 47).'*

Program Response: Confirming the statement above, in the 2016 application workbook occupancy sensor savings factors are automatically populated based on the input space type. Users can override the deemed value, but they must include documentation.

Process Evaluation Recommendations

The process evaluation provided key findings and suggestions for program enhancements. However, the process evaluation was intentionally designed without statistical significance, thus the findings are informational, not actionable.