Evaluation of 2020-21 Non-Residential Programs

Puget Sound Energy

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1 EXECUTIVE SUMMARY

Puget Sound Energy (PSE) hired DNV to complete an independent evaluation of the program years 2020-21 non-residential energy efficiency programs. This report presents the methods, results, and findings of the evaluation of two compliance programs. The goal of the evaluation was to independently estimate program savings performance and identify opportunities to improve each of the evaluated programs.

1.1 Background and approach

DNV completed independent evaluations of two PSE compliance programs in 2021: Commercial Industrial New Construction and Commercial Rebates. Each impact evaluation includes an independent estimate of the ratio of energy savings being realized by each program or sub-program to the energy savings tracked by PSE, referred to as the program realization rate. Impact evaluation methods were based on the program design, measures offered, and historic program performance. In general, each program was evaluated based on our review of program documentation and a representative sample of completed projects. All additional process evaluation activities were initiated based on findings from the impact evaluation. Process evaluation activities were not completed for all PSE programs.

1.2 Evaluation results

The primary results of our evaluation are program realization rates estimated through our impact evaluation activities. These realization rates are an independent estimate of the ratio of achieved savings to tracked savings for the 2020-21 biennium. The relative precisions are calculated at the 90% confidence interval and represent the relative precision of the resulting energy savings estimated after the realization rate is applied. There is no relative precision shown for Lighting to Go as the estimated realization rate is based not on a sample, but a review of all program records. Each PSE program within the Commercial Rebates program was evaluated separately. The combined realization rate for Commercial Rebates is calculated based on the savings tracked by PSE over the biennium.

Table 1-1. Evaluated program realization rates

Compliance Program	PSE Program	Electricity Savings (kWh)		Gas Savings (therms)	
		Realization Rate	Relative Precision @ 90% CI	Realization Rate	Relative Precision @ 90% CI
Commercial Industrial New Construction	**All Projects**	**85%**	**4%**	**95%**	**14%**
Commercial Rebates	Lighting to Go	97%	*N/A*	*N/A*	*N/A*
	Small Business Direct Install	94%	12%	*N/A*	*N/A*
	Commercial Kitchens	104%	9%	79%	10%
	All Projects	**95%**	**N/A**	**79%**	**10%**

1.3 Key evaluation findings and recommendations

This section provides key findings and recommendations resulting from DNV's evaluation. Additional findings are presented within each program-specific section.

1.3.1 Commercial New Construction Grants

1) **Key Finding** – The Commercial New Construction Grants (CNC) program is achieving 85.4% of tracked electricity savings and 94.9% of tracked natural gas savings. These realization rates are primarily driven by changes outside of PSE's control.

   - **Recommendation** – None.

2) **Key Finding –** Many of the new construction whole building projects have installed water source heat pumps (WSHPs) along with natural gas-fired condensing boilers. The natural gas boilers exist to provide required supplemental heat. The installed boiler provides heat to the WSHP loop when the ground heat is not adequate and usually comes on based on a loop water temperature setpoint. The eQuest simulation modelling tool was used for these whole building projects, but the tool does not have ability to model this type WSHP configuration. Only one of the project applicants (P_545412) identified this issue and adopted an out-of-box approach to determine the correct measure savings.

   - **Recommendation** – PSE should require a savings adjustment outside eQuest for buildings using WSHPs with back up natural gas boilers as the standard procedure or develop a consistent calculation method to estimate savings for these projects.

1.3.2 Commercial Rebates – Lighting to Go

1) **Key Finding** – The Lighting to Go program achieved a gross realization rate of 97.4%. Evaluated savings were slightly lower than tracked savings because of inconsistencies in rounding when calculating savings for a few measures and because PSE did not apply the assumed 20% reduction to the number of units installed for the omnidirectional A-lamp measure.

   - **Recommendation** – Update measure calculations for measures identified. Review new measures and ensure consistent rounding.

2) **Key Finding** – The Lighting to Go program significantly changed the key parameter assumptions for TLED lamps between 2020 and 2021. The change more than doubled the per-unit savings and aligned the assumptions with historic participants in the Business Lighting program. Further investigation is required to assess this change, which will likely increase the total program savings in the near future.

   - **Recommendation** – PSE should include review of Lighting to Go TLED input parameters in their next evaluation of the Business Lighting program. This review should include an assessment of the annual hours of use for these lamps, the baseline equipment, and a comparison to savings assumptions used in other midstream or upstream commercial lighting programs.

3) **Key Finding** – The following findings are specific to the current program design element to not collect installation address or contact information for purchases of 50 lamps or fewer.
   - During 2020 and 2021, more than 88% of all sales transactions of LTG incentivized lamps or fixtures were for purchases of 50 or fewer units. Less than 12% of the transactions required the collection of installation location (business address where units were installed) and customer contact information. Because of the program design and the relatively low share of units whose installation locations are tracked, the Lighting to Go program is inherently difficult to evaluate.

- Purchases of 46-50 units represent more than 12% of all transactions. This indicates to DNV that some contractors and business customers are aware of program rules and may be intentionally avoiding purchases of lighting products over 50 units so that they aren't required to provide customer address and contract information.
- Responding distributors stated that collecting installation location under the current rules was easy, collecting information for purchases of 10+ units would be harder but not difficult, and collecting information for all transactions would be difficult.

– **Recommendation** – DNV believes that the evaluability and reliability of this program is too low. PSE should lower the threshold for the collection of the installation address to a minimum of purchases of more than 15 units. This should result in the capture of the installation address for 50% of transaction and 80% of savings. This change will significantly increase the reliability of the program by reducing the cost to fully evaluate and verify savings in the future.

1.3.3 Commercial Rebates – Small Business Direct Install

1) **Finding** – The evaluation team verified the quantity and equipment type installed and in use for all of the evaluated projects. The measure case savings algorithms for all measures are appropriate. The realization rates reflect adjustments to the measure case savings for reported hours of use at each evaluated project. The SBDI program is achieving 93.7% of tracked electricity savings. This realization rate is primarily driven by differences between the actual facility operating hours and PSE's assumptions for this program.

   – **Recommendation** – None.

2) **Finding** – The program operating hours assumptions are reasonable even though there is considerable variation in operating hours at the site level savings. There was significant variation in site hours of use within the projects evaluated, but the overall program realization rate demonstrates that current program assumptions are accurate.

   – **Recommendation** – PSE should continue to use the same methodology and assumptions for estimating operating hours.

1.3.4 Commercial Rebates - Kitchens

1) **Key Finding** – The evaluation team verified the quantity and equipment type installed and in use for all of the evaluated projects. The measure case savings algorithms for all measures are appropriate. The realization rates reflect adjustments to the measure case savings for hours of use and installed equipment efficiency. The Commercial Kitchens program is achieving 104.0% of tracked electricity savings and 79.4% of tracked natural gas savings. This realization rate is primarily driven by differences between the actual facility operating hours and PSE's assumptions for this program.

   – **Recommendation** – None.

2) **Key Finding** – The Commercial Kitchens program is achieving 97% of tracked site energy savings, when electric and gas projects are combined. This realization rate demonstrates the operating hours assumptions used by the program are reasonable when all participants are combined.

   – **Recommendation** – None.

2 INTRODUCTION

This report summarizes the results of the impact and process evaluations of two Puget Sound Energy (PSE) 2020-2021 non-residential demand side management programs. In this report program evaluator DNV presents results for the following programs:

- Commercial New Construction Grants (CNC)
- Commercial Rebates:
  - Lighting to Go (LTG)
  - Small Business Direct Install (SBDI)
  - Commercial Kitchens

These programs offer incentives to commercial and industrial (C&I) customers through downstream rebates for new construction, mid-stream rebates through retailers (lighting and commercial kitchens), and direct install for the Small Business program. Table 2-1 shows the energy savings tracked for the four programs evaluated. These programs accounted for approximately 33% of PSE's C&I electricity savings and 6% of C&I natural gas savings during the biennium.

Table 2-1. Tracked energy savings, 2020-2021

Program	Unique Projects/ Transactions	Tracked Electricity Savings (kWh)	Percent of Tracked C&I kWh Savings	Tracked Natural Gas Savings (therms)	Percent of Tracked C&I therm Savings
Commercial Industrial New Construction	98	27,438,087	12.2%	85,281	3.0%
Lighting to Go	5,853	21,965,971	9.7%	0	0.0%
Small Business Direct Install	3,112	23,941,236	10.6%	1,862	0.1%
Commercial Kitchens	147	180,308	0.1%	93,938	3.3%
Total Savings Evaluated		**73,525,602**	**32.6%**	**181,081**	**6.3%**

2.1 Evaluation objectives and researchable issues

The expected outcomes of this evaluation were to conduct the following research:

- **Impact evaluation**: Estimate the ratio of energy savings achieved to energy savings tracked for each program. This ratio is the program realization rate. These estimates were achieved by independently reviewing savings estimation methodologies and verifying savings achievement through file reviews and inspections.
- **Process evaluation**: Provide process findings for the programs from the perspective of the program participants. When necessary, provide information on why programs are over/underperforming and recommendations for improvements.

2.2 Evaluated programs

DNV evaluated four non-residential PSE programs in the 2020-2021 program cycle. Each evaluation utilized phone interviews, web surveys, and virtual site visits to verify the installation and continued operation, determine the baseline, and collect other key performance parameters to evaluate the measures. No in-person site visits were conducted for the evaluated programs due to the increase in health and safety risks during the COVID-19 pandemic. For process evaluation, we interviewed program staff, program contractors, and program participants to collect qualitative information on the programs and to identify program improvement opportunities.

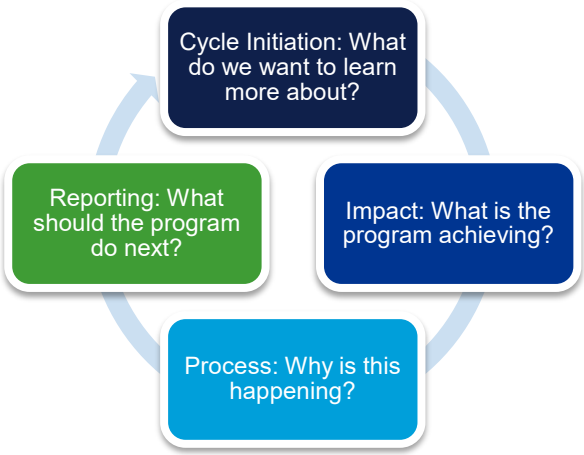
2.3 COVID-19 adaptations

This evaluation was executed during a time of increased health and safety risk. DNV used remote methods for all data collection. Evaluated savings are based both on as-found conditions and assumed post-installation normal conditions developed through participant interviews. This is grounded on our presumption that the operation conditions during the pandemic period are only temporary and do not substantially influence the lifetime performance and savings of the installed measures. Given the impact of COVID-19 on participant consumption, the evaluation does not directly use the results of any pre/post consumption analysis (IPMVP Option C) as the evaluated savings when the post period overlaps with the COVID-19 pandemic in Washington state. Instead, the evaluation used the results of any pre/post consumption analysis as one piece of information available from which to estimate evaluated savings.

3 EVALUATION APPROACH AND METHODOLOGY

DNV utilized a dynamic forward-looking developmental evaluation approach. This evaluation approach provided PSE with annual program feedback structured to help improve savings reliability and program performance. DNV successfully completed two developmental cycles for this biennium. Each cycle starts with an objective and concludes with program feedback and recommendations. Figure 3-1 shows the basic steps in each cycle. Each cycle was initiated by seeking to learn more about program savings performance.

Figure 3-1. DNV's developmental evaluation cycle



3.1 Sample design

Each impact evaluation step in the development cycle started with a review of program achievements and sample design. Each sample was designed to provide accurate independent estimates of energy savings achieved by the program and the associated program realization rates. DNV utilized a stratified random sampling approach with certainty selection to identify the sample for this impact evaluation. The sample was selected in two phases, a first phase selected in 2020 and a second phase selected in 2021. The preliminary sample design was based on 2019 program achievements for each program with the goal of achieving 10% relative precision on site energy savings (kBtu) at the 90% confidence interval for each compliance program. The sample targets were adjusted during the second phase of sample selection in 2021 based on actual 2020 program performance and observed variance during the first phase. All evaluation results present electric and gas realization rates separately. DNV intentionally oversampled in both phases for this evaluation due to an expectation that recruitment would face additional challenges during the COVID-19 pandemic.

Table 3-1 summarizes the final impact evaluation sample design implemented and the associated expected relative precision of the results. All relative precisions are shown at the 90% confidence interval for site energy savings (kBtu) which combines electricity and gas savings into one single value with consistent unit of measure for size stratification. The error ratios used in the sample design were based on DNV's experience evaluating similar programs. For lighting programs/domains, we chose an error ratio of 0.6, for commercial kitchens and small business direct install an error ratio of 0.8, and for all other programs/domains we used an error ratio 1.0. The full sample design is discussed in Appendix A: Sample design. The design and final achieved sample for each program is discussed in the program-specific sections of the report.

Table 3-1. Sample summary

Compliance Program	PSE Program	Phase I	Phase II	Total Sample	Designed kBtu RP @ 90%
Commercial and Industrial New Construction	All Projects	28	24	52	10%
Commercial Rebates	Lighting to Go	110	110	220	6%
	Small Business Direct Install	15	15	30	26%
	Commercial Kitchens	15	15	30	29%
	All Projects	140	140	280	10%

3.2 Data collection

The evaluation utilized multiple data sources to evaluate each program. All site- or project-specific data collection was completed remotely via telephone or virtual meeting interviews. DNV and PSE agreed that the additional health and safety risks associated with travel and in-person interactions due to the COVID-19 pandemic made in-person site visits inadvisable. Table 3-2 shows the data sources used to evaluate each PSE program.

Table 3-2. Evaluation data sources

	Program Materials	Sampled Project Documentation	Project-Specific Calculations	Utility Consumption Data	EMS/BMS Trend Data	Participant Interviews	Trade Ally Interviews
C/I New Construction							
New Construction Grants	✓	✓	✓	✓	✓	✓	✓
Commercial Rebates							
Lighting to Go	✓	✓				✓	✓
Small Business Direct Install	✓	✓				✓	
Comm. Kitchen	✓	✓				✓	✓

3.3 Impact evaluation methods

Program impact evaluation was initiated after the primary and back-up samples were identified. The impact evaluation steps used for this project are illustrated in Figure 3-2.

Figure 3-2. Impact evaluation steps

The steps in this process were primarily applied at the program level and are discussed in more detail in the program-specific sections. A brief description of each step is provided below:

- **Program Documentation Review:** Review program application forms, program guides, measure savings documentation, and program plans to understand the program design and theory, measures supported by the program, and the assumptions and methods used to estimate energy savings.
- **Project File Review**: A thorough review of the project files for sampled projects, focused on the energy savings calculations, assumptions, and other supporting documentation. The review identified any missing information critical to the evaluation, original calculation methodology, key uncertainty parameters to research, and any concerns with the original savings estimation methods.
- **M&V Planning**: Upon the completion of program document review and project file review, DNV created a program, measure or site data collection and analysis plan based on the measures sampled. This plan documented the project: the expected installed conditions, the data to be collected through the evaluation process, and the anticipated analysis method. In general, our plans followed the framework provided in the International Performance Measurement & Verification Protocol (IPMVP). However, there were times when the best evaluation approach was outside of the IPMVP framework. The following are the key elements that supplement the preparation of project evaluation plans:
  - **Evaluating Standard Calculated/Prescriptive Measures.** The measurement and verification (M&V) plan for standard calculated and prescriptive measures was the same across each project selected for evaluation. The same information was gathered across all projects and the same analysis methodology employed unless project-specific circumstances required an alternative analysis method.
  - **Evaluating Complex Projects.** For projects with custom measures or multiple interactive measures, the evaluation team reviewed all measures as one interactive system and estimated the evaluated savings across all measures. DNV developed a site or project specific evaluation plan for these projects.
- **Data Collection**: Data collection primarily occurred through participant phone interviews and virtual meetings. In some cases, the impact evaluation was informed by market actor interview findings. DNV verified equipment installation, confirmed the intended operation of the measure, assessed the baseline conditions, and collected key operational parameters necessary to determine evaluated savings.
- **Analysis**: The evaluated savings analysis followed the M&V plan. In most cases, DNV utilized the tracked savings estimation tools and their methodologies, unless the evaluators determined that there were major flaws in the original savings methodologies or that an alternative method provided a more reliable estimate of savings. The data and information collected was typically used to adjust operating parameters such as efficiency of equipment, hours of use, setpoints, and operating schedules. For each sampled project, DNV produced estimates of evaluated electric and/or gas savings. DNV also noted any opportunities for improvement in the accuracy of tracked savings estimates determined during the course of the analysis.
  - **COVID-19 Analysis Adjustments**: The current COVID-19 pandemic was considered when calculating a project's evaluated savings. The evaluated savings are based on post-installation normal conditions, not just as-found conditions. For each site, DNV assessed if the data collected directly represented normal post-installation loads, operation, and consumption or if adjustments are necessary to better represent normal consumption levels. Examples of inputs to savings estimates for which as-found conditions were not considered normal: tenant occupancy rates, space occupancy schedules, production rates, total building consumption, and current HVAC and lighting controls setpoints.
- **Reporting.** Analysis results were recorded in program or measure specific spreadsheets along with reasons for any variance between the tracked and evaluated savings. This report summarizes the results for each program across all measures evaluated.

3.3.1 Sample extrapolation to track and program

DNV used a separate ratio estimator to obtain unbiased estimates of the total evaluated savings (either kWh or therms) for any group of interest. This estimator will yield, by design, unbiased estimates of some outcome measure, and is particularly beneficial when the outcome measure is correlated with something known for all members of the sample frame. In this case, the evaluated savings are logically correlated with tracked savings as listed in the tracking database. In general, the separate ratio estimator works as follows.

Suppose the indices:

g = Application domains which are defined by track and fuel type (kWh or therms). For some outcome measures and domains of interest, strata had to be collapsed with one another during the estimation process. This occurred with $Y_g \neq 0$ but $\sum_{i \in Sample} w_{ig} y_{ig} = 0$ (these terms are defined below).

i = Site.

And suppose:

x_{ig} = Evaluated savings for site i in group g.

y_{ig} = Tracked savings for site i in group g.

w_{ig} = Sample weight for site i in group g. This reflects the sample selection process that was used at the beginning of the study to select the original 202 sample points.

Y_g = Population total tracked savings in group g. So $Y_g = \sum_{i \in Frame} y_{ig}$

$\hat{R}_g = \dfrac{\sum_{i \in Sample} w_{ig} x_{ig}}{\sum_{i \in Sample} w_{ig} y_{ig}}$ is the Ratio estimate for group g.

Then the separate ratio estimator that will yield the total evaluated savings is:

$$\hat{T} = \sum_g \left(Y_g \cdot \hat{R}_g \right)$$

And the ratio estimate of total modeled savings to total tracked savings is:

$$\hat{R} = \frac{\hat{T}}{\sum_g Y_g}$$

The procedure used for calculating ratio estimation by domains provides the correct standard error of the estimate for each domain and overall. The procedure also takes into account defined clusters of observations (customers) and stratification.

The standard error is calculated as drawn from a finite population: the measures completed within the analysis period with associated energy impacts in the program-tracking database. This calculation uses the Finite Population Correction (FPC) factor. This factor is a reduction to the calculated variance that accounts for the fact that a relatively large fraction of the population of interest has been observed directly and is not subject to uncertainty. It is appropriate to apply precision

statistics, such as confidence intervals, based on the standard error calculated in this manner when quantifying the results of the program during the study period only. The FPC factor reduces the calculated sampling error around the estimate more for smaller populations than for large.

3.4 Process evaluation methods

We conducted a process evaluation for the purpose of identifying program successes and opportunities for program improvement. DNV's process evaluation relied on interviews with program staff, program participants, and for some programs' trade allies. These interviews allowed DNV to compare the PSE's program goals to the participant and/or trade ally's program experience. DNV's process evaluation activities focused on identifying opportunities to improve savings reliability, expand program participation, increase the savings achieved through PSE's program portfolio, and improve the PSE customer experience throughout the program. Details on the process evaluation methods and findings are presented in each program specific section.

DNV's process evaluation approach generates feedback that enables adaptive management of PSE's programs. The over-arching process evaluation goal is to provide the contextual information necessary to understand how programs are performing, why certain results are occurring, what is working well, and what opportunities for improvement exist. Our evaluation provides PSE with feedback focused on understanding what happened and identifying opportunities to adjust program delivery and achieve program goals.

Our team used a variety of techniques to systematically assess program processes and provided actionable recommendations that address opportunities to improve customer and stakeholder satisfaction and determine the appropriateness of program activities given current market conditions. Table 3-3 summarizes these and some other core process evaluation methods, their value to the evaluation, and the topics we address.

For each program, we present within the respective chapter the process methods applied given the availability of data and participant contacts.

Table 3-3. Process evaluation methods overview

Method	Topics	Value to the Evaluation
In-depth telephone interviews with PSE's program staff (may include program managers, Energy Advisors, outreach staff, and/or implementation contractors)	Changes to program since the last evaluation cycle; marketing/outreach activities; operations; stakeholder interaction	Ensures understanding of how specific members of PSE's team plan to use the evaluation results (helps ensure we provide results in formats that maximize their usefulness to PSE). Provides PSE staff with opportunities to contribute to evaluation's content and share perspectives on program performance. Additional basis for data collection instruments.
In-depth telephone interviews with other stakeholders (e.g., as installation contractors, or other vendors, retailers, etc.)	Please refer to specific topics in the program-specific subsections.	Ensures understanding of how entities involved with programs interact with PSE or other implementation staff, with each other, and/or with customers
Telephone surveys of PSE's customers for customer satisfaction	Customer satisfaction and experience. Some programs may combine verification and satisfaction surveys.	Report salient findings on an ongoing basis to allow PSE to enhance the participant experience or adjust program design to better serve customer needs. Some programs may survey shortly following project completion to increase the probability of getting useful feedback.

4 COMMERCIAL NEW CONSTRUCTION

This section summarizes the impact and process evaluation results of PSE's 2020-21 Commercial New Construction program (CNC). A program overview is presented first. Sample design approach is discussed next followed by the impact and process evaluation approach. Finally, the impact and process evaluation results are presented along with findings and recommendations on how to improve the tracked savings for the CNC program and projects.

4.1 Program overview

The C&I New Construction (CNC) Program encourages more efficient building designs and building components beyond the applicable building Energy Code or industry standard practice (ISP) where code requirements do not exist. Incentives are provided for the installation of cost-effective energy-saving measures in new buildings. The program can be grouped into three general measure types:

Lighting: This includes lighting power density improvements above and beyond code and horticulture lighting projects. This measure type makes up the largest portion of the program. Savings are calculated using approved spreadsheets.
Whole Building: This type uses building energy simulation to compare total building energy consumption for a beyond code building design compared to the same building built to code.
Component/Custom: This type includes measures that are neither lighting only nor whole building. Measures can be custom or prescriptive, and can include things such as new compressor, refrigeration, or HVAC equipment as part of a new facility or facility expansion. Energy savings are calculated using site-specific spreadsheets or vendor-owned calculation models.

4.1.1 Program savings

Table 4-1 shows the energy savings tracked by the program during the biennium. Lighting measures were the primary contributor to program electricity savings followed by Whole Building. The Component/Custom measures accounted for 2.3% of electricity savings in total.

Table 4-1. Tracked energy savings, CNC 2020-21

Measure Type	Program Measure	Unique Project Count	kWh Savings - Tracked	kWh, % of Total Tracked	Therms Savings - Tracked	Therms, % of Total Tracked
Lighting	Lighting	46	22,095,725.00	80.5%		
	Lighting Power Density Reduction	25	1,650,465.00	6.0%		
	Lighting - Base	1	10,639.00	0.0%		
Whole Building	Whole Building Design	15	3,054,090.00	11.1%	69,942.00	82.0%
Component / Custom	Fan - VFD	1	219,761.00	0.8%		
	Refrigeration	1	112,241.00	0.4%		
	Generic Measure	1	96,426.00	0.4%		
	Commissioning	1	52,409.00	0.2%		
	HVAC - VRF	1	50,058.00	0.2%		
	Compressor or Dryer or Receiver	2	48,074.00	0.2%		
	HVAC Control - Only	1	24,960.00	0.1%		
	Process - Control	1	20,216.00	0.1%		
	Unitary Equipment	7	3,023.00	0.0%		
	Boiler - Hot Water	1			7,560.00	8.9%
	Water Heater - Commercial	2			7,779.00	9.1%
Program Totals		**98**	**27,438,087.00**	**100.0%**	**85,281.00**	**100.0%**

4.2 Impact evaluation

This section documents DNV's independent estimate of the program realization rate and review of the calculation methods used by the program. Each element of our evaluation process is discussed below along with relevant findings. The section concludes with our estimate of the program realization rates followed by the primary drivers of variance between PSE's tracked savings estimates and DNV's evaluated savings estimates.

DNV completed the following steps for the impact evaluation of the CNC program:

- Sample selection: Selection of a representative sample of completed projects for evaluation
- Project file review: Review of project files provided by PSE to identify calculation methods and key parameters, and to ensure sufficient information exists to evaluate the project
- Project-specific M&V planning: Creation of project-specific measurement and verification plans
- Data collection: Phone interviews with sampled participants to review each project, baseline assumptions, and current operating parameters
- Project-specific analysis: Estimated evaluated savings using the data collected to update key input parameters

4.2.1 Sample design

This sub-section presents an overview and summary of the sample design used to evaluate the 2020-2021 CNC program. DNV used stratified random sampling to select an efficient representative sample of projects for evaluation. The sample was designed to provide a reliable estimate of program performance while also selecting a variety of measures to increase the breadth of the DNV's review. The sample was selected from CNC projects completed between July 1, 2019, and March 31, 2021. Sampling occurred at the project level. Table 4-2 summarizes the planned sample design for this program. Key design elements were:

- Creation of domains based on the primary fuel saved, electricity or gas. This helped ensure sufficient results for both fuels.
- Creation of domains based on the project type according to PSE's tracking data. This helped ensure a variety of measures and calculation methods were reviewed. Without these domains, almost all sampled projects would have been lighting projects.
- Stratification by size of savings reported and use of a certainty stratum to increase the magnitude of savings evaluated and the accuracy of the estimated savings realization rates.

Table 4-2. CNC sample design

Compliance Program	Measure Type	Sampling Frame Population	Planned Sample 2020-2021
Commercial Industrial New Construction	Lighting	55	33
	Whole Building	18	15
	Component/Custom	15	10
Total		**88**	**58**

4.2.2 Project file review

Project file reviews are structured site-specific reviews of PSE's CNC program application files and calculations that systematically examine and record the evaluation team's conclusions on ex ante savings development practices. Project file reviews were conducted for each sample point selected for evaluation. DNV reviewed each sampled project file for sufficient documentation, program savings methodology, and accurate savings reporting. This review included:

- Verification of the existence of signed application or participation agreement
- Identification of the building type
- Perform a web-based search to determine if the sampled commercial entity was operating normally, operating under modified conditions, or closed
- Determination if the file folder contained enough information for evaluation
- Verification of the existence of engineering calculations and/or energy simulation models with outputs that match the reported savings
- Identification of key building or system operation parameters contributing the reported savings
- Identification of Washington State Energy Code used to determine the baseline
- Verification of building electric and natural gas (NG) meter numbers, assessment of building annual electric and NG consumption to determine the percentage of savings resulted from the project
- Determination if facility energy management system (EMS) data collection is required to evaluate the project
- Identification of building operating parameters that may have been revised because of COVID-19
- Assessment of the completeness of documentation
- Communication with program administrators to collect missing program documentations or to obtain confirmation on queries, if any

4.2.3 Project specific M&V planning

DNV created project-specific M&V plans to guide the data collection effort. These site-level M&V plans were created for each sampled site using DNV's project-specific M&V Plan template. These plans focused on the collection of information specific to the key research parameters identified during file review. The study did not collect information on all drivers of end-use energy consumption.

4.2.4 Data collection

All data collection occurred remotely, either via telephone, videoconference, or virtual inspection. Data collection followed the M&V plan developed for each project. In many cases, facility EMS screenshots of current setpoints and schedules were captured to document the as-found building controls sequences. No independent data logging or metering was completed for this evaluation. Our data collection also included gathering information on how COVID-19 has impacted the building's current and foreseeable occupancy schedule, HVAC operation schedule, and anticipated changes in HVAC operation setpoints such as outside air flow rate.

When valuable to the evaluation, DNV requested and received utility meter data showing a facility's recent consumption. This data was used to both confirm facility use and calibrate energy models to consumption levels.

4.2.5 Project analysis

DNV used the information gathered during data collection to update the key calculation input assumptions. Whenever possible, DNV used the same calculation tool used by the program to estimate savings with revised inputs where necessary. Inputs for the evaluated savings calculations were determined from the most valid data source including participant interviews, site EMS data, schedules, setpoints, program project files, and utility meter data. Typically, adjustments were made to the evaluation analysis to model the conditions observed by the evaluation. When DNV found that the evaluation period facility operating parameters (setpoints, schedule and control logics, etc.) were different from their respective program modeled values, the evaluation determined if such parameters were part of the implemented improvement or not. If they were part of the implemented measure improvements, the evaluation energy model implemented those changes to the post-

project model only, and those evaluation findings became the basis of having a different modeled evaluation savings compared to program modeled savings. However, if the parameters and setpoints were not part of the implemented measure, the evaluation ensured that such parameters, setpoints, and control logics should act as energy-neutral while determining the evaluation savings. In other words, these parameters are kept identical both in the pre and post project models. This is achieved by utilizing identical values of such parameters in both baseline and post project energy analysis.

If the original savings were estimated using energy simulation models, DNV used the simulations to estimate hourly energy consumption of all end-use categories (heating, cooling, ventilation fan, lighting, domestic hot water, etc.) . DNV used the modeling to ensure that the implemented project improvements affected the correct building end-use types, and their interactive impacts are realized in the simulation model output. The evaluation analysis used identical building systems operating schedules and occupancy schedules for both baseline and post-project energy models to ensure that they act as energy neutral.

Instead of evaluating against the conditions found at the time of data collection, the team assessed projects based on conditions prior to the COVID-19 disruption or against reasonable estimates of future expected conditions once the pandemic-driven disruption has abated. In a few cases, the evaluation adjusted the baseline inputs based on interviews with the participants.

4.2.6 Final evaluated sample

Table 4-3 shows the final sample achieved for this impact evaluation alongside the planned sample. The difference between the planned sampled and completed sample is due to challenges recruiting participants for evaluation. Each sampled participant was called up to five times at different times of the day. DNV also contacted the participant by email after calling. Finally, PSE's program implementation staff assisted with recruiting if customers continued to be non-responsive. If customers refused to participate or were deemed unresponsive, backup sample points were added to the evaluation. DNV believes the recruitment challenges were primarily a direct result of the COVID-19 pandemic, as DNV experienced similar recruitment challenges during this period in other jurisdictions. The final sample, while smaller than originally planned, is representative of the program.

Table 4-3. CNC final sample summary

Compliance Program	Measure Type	Sampling Frame Q3 2019 – Q1 2021	Planned Sample 2020-2021	Completed Sample 2020-2021
Commercial Industrial New Construction	*Lighting*	55	*33*	*28*
	Whole Building	18	*15*	*14*
	Component/Custom	15	*10*	*10*
Total		**88**	***58***	***52***

4.2.7 Program realization rates

The project-specific results for the final evaluated sample were extrapolated back to the sampling frame to estimate the evaluated savings for the sampling frame and the program realization rate. The calculated realization rates should be applied to the final 2020-2021 biennium tracked savings to estimate the evaluated savings for the program over the biennium. Table 4-4 provides the electric evaluation results from the evaluation sample of 49 projects with electric savings that have been expanded to the sample frame of 83 projects with electric savings. Table 4-5 provides the gas evaluation

results from the evaluation sample of 13 projects with gas savings that have been expanded to the sample frame of 17 projects with gas savings.

Table 4-4. CNC electric impact evaluation results

Projects w/ kWh Savings	Tracked MWh Savings in Sample Frame	Evaluated MWh Savings in Sample Frame	CNC Realization Rate, kWh	Relative Precision at 90% Confidence Interval
Sample Frame = 83 Evaluated = 49	32,627	27,861	85.40%	4.06%

Table 4-5. CNC gas impact evaluation results

Projects w/ Therm Savings	Tracked Therm Savings in Sample Frame	Evaluated Therm Savings in Sample Frame	CNC Realization Rate, therms	Relative Precision at 90% Confidence Interval
Sample Frame = 17 Evaluated = 13	101,502	96,307	94.90%	13.69%

Table 4-6 shows the tracked energy savings directly evaluated and the weighted average realization rates for each measure type. These are weighted using only the evaluation results and or not extrapolated to the sampling frame. Table 8-5 in Appendix B: New construction project-level evaluation results shows the new construction evaluation results for each sampled project that was evaluated, along with a short description of the primary reason behind any discrepancy between the tracked savings and the evaluated savings.

Table 4-6. New construction evaluation results of sampled projects by measure type

Measure Type	Evaluated Projects	Tracked kWh Savings Evaluated	Tracked Therm Savings Evaluated	Tracked kBtu Savings Evaluated	Weighted kWh Realization Rate	Weighted Therm Realization Rate	Weighted kBtu Gross Realization Rate
Horticulture Lighting	16	19,546,028	0	74,194,429	84.6%	N/A	84.6%
Generic Lighting	12	597,525	0	2,038,840	92.2%	N/A	92.2%
Total Lighting	28	20,143,553	0	76,233,269	84.9%	N/A	84.9%
Whole Building	14	2,455,994	51,300	13,508,973	100.5%	108.7%	103.6%
Component/Custom	10	1,255,032	30,742	7,355,812	71.7%	71.9%	71.8%
Sample Total	**52**	**23,854,579**	**82,042**	**97,098,055**	**85.8%**	**94.9%**	**86.6%**

4.2.8 Sources of variance

This section describes the factors the evaluation team observed that drove the final realization rates for the lighting, whole building, and component/custom measure types.

4.2.8.1 Lighting

Lighting projects make up 80% of tracked program electric savings so the evaluation results for the lighting projects are the primary driver of the overall new construction electric realization rate of 85.4%. Overall, no significant sources of controllable variance were identified in the new construction lighting projects evaluated. The key lighting results from this evaluation are:

- In 13 out of the 28 projects sampled and evaluated, the evaluators found no reason to change any of the key parameters in the lighting savings calculations after interviewing the site contact and completing the desk review. These 13 projects received a realization rate of 100%.
- In eight of the projects evaluated, the adjustments made were minor, meaning that the evaluated savings differed from the tracked savings by less than 10% (realization rates between 90% and 110%).
- The most common adjustment made to the lighting savings values were adjustments to the assumed annual operating hours.
  - Nine out of the 28 projects had adjustments made to the annual operating hour assumptions after conversations with the site-contact.
  - Four of those nine projects had operating hour adjustments that resulted in a discrepancy less than 10%, while the remaining five had adjustments greater than 10%.
  - These five projects with low realization rates had a simple average realization rate of 69%, so these projects were the primary cause of the final lighting realization rate being 84.9%.
- There were three horticulture lighting projects that had a significant impact on the overall lighting realization rate, due to their size.
  - Project P_1053636 had a tracking savings of 2.5 GWh, and an evaluated savings of 1.7 GWh, and a 67% realization rate. The customer at this facility stated that they had altered the operation at this facility after the inspection by PSE had been completed. The lights were initially on 24/7/365 but after the change in operation they operated in a veg/flower cycle, which reduced the operating hours from 8,760 per year to 5,840 hours per year.
  - Project P_1053634 had a tracking savings of 3.2 GWh, and an evaluated savings of 1.9 GWh, for a realization rate of 58%. This site has 58% realization rate because the evaluators were informed by the site contact that the plants are not kept at this site from June through October because there is insufficient insulation, airflow, and air conditioning to keep the plants cool. Therefore, the lights are used for 7 months/year instead of the 12 months assumed in the tracking estimates.
  - Project P_724661 had a tracking savings of 0.24 GWh, but achieved a realization rate of 0%. Evaluators learned that the system was still not yet operational at the time of the evaluation, due to delays in permitting. The customer confirmed that this horticultural lighting site was not yet operational, and that although the fixtures were purchased, they were not yet in use. This information was also confirmed by reviewing the billing data for this site.

4.2.8.2 Whole building

Whole building projects made up 13% of the same frame total tracked kBtus, and 14% of the evaluation sampled kBtus. The 14 sampled whole building projects had a weighted average kBtu realization rate of 104%, a 100% kWh realization rate, and a 109% therm realization rate.

Adjustments were made to all 14 of the sampled whole building projects based on the data collected through this evaluation. Key results for this measure type are:

- One-half of the projects required minor set-point, schedule, and efficiency adjustments that resulted in less than 10% savings variance (realization rates between 90% and 110%).
- The other seven sampled projects required significant changes to schedules and setpoints that resulted in larger savings variances. Six of the seven projects achieved a realization rate greater than 110%, while one achieved 25%.
    - Two of these seven projects (which had realization rates of 115% and 118%) attributed some of the savings variance to modeling discrepancies related to the temperature and fan schedules, but the majority of the discrepancies were attributed to facility operational changes observed during the evaluation. For project P_545361, some of the disparity was caused from a HAP version difference.

4.2.8.3 Custom/component

Custom/component measures made up 7% of the evaluation population's total tracked kBtus and 8% of the evaluation sampled kBtus. The 10 sampled custom/component projects had a weighted average kBtu realization rate of 72%, based on a 72% electric realization rate and a 72% gas realization rate. The savings variance for these projects does not significantly impact the program realization rate, but the evaluation findings identified opportunities to improve the savings estimations for these projects. Key results for this measure type are:

- Five of the 10 projects required minor or no adjustment and achieved realization rates between 95% and 100%.
- The remaining 5 of 10 projects evaluated required significant adjustments due to as-found operating parameters such as air compressor load, hours of use, or return water temperature. These projects achieved realization rates between 13% and 85%.

4.3 Process evaluation

This section summarizes the key findings for the CNC process evaluation. It includes results from customer surveys from participants who participated in program years 2020 and 2021 (PY2020 and PY2021).

4.3.1 Survey methodology

DNV conducted a process evaluation for the purpose of identifying program successes and opportunities for program improvement.

DNV conducted participant telephone surveys in conjunction with the impact evaluation. Participants were asked a set of process evaluation questions to gauge satisfaction. Targeting these customers provided two benefits: first, it prevents the customers surveyed for the impact evaluation from having to complete a second survey, and second, it provided feedback about program processes as they are currently executed, rather than how they were executed up to two years previously. The survey was conducted in two phases, and the number of participants in each phase is presented below. Phase two contained an enhanced set of process questions. The number of respondents for each question was based on whether the project was selected for the year one or year two evaluation.

Despite making multiple attempts on different days and at different times and leaving multiple voicemails, connecting with the knowledgeable contact person proved challenging. DNV contacted customers in both the sample and backup populations and completed and interviewed a total of 28 unique respondents for whom 37 projects were represented. This resulted in a response rate of over 65% based on unique respondents. In DNV's years of experience with NC programs, we found response rates with participants to be lower than expected due to employee turnover and general non-response. To support the evaluability of the program, it is helpful to have additional contacts who can serve as a knowledgeable backup if the primary participant is no longer with the company. Therefore, as part of the file review, when the contact data identifies the contact role within the project, it should include design team members or any other individuals the program interacted with.

Table 4-7. Response rates for CNC process surveys

Disposition	Phase 1	Phase 2	Total
Sampled projects	28	24	52
Sampled project contacts	25	19	44
Completed surveys (projects)	19	18	37
Completed surveys (respondents)	14	14	28
Survey response rate (projects)	68%	75%	71%
Survey response rate (respondents)	56%	74%	65%

The participant survey included a broad set of research questions. Table 4-8 shows the research objectives used to inform the participant experience and measure aspects of program delivery. Response rates throughout the report vary based on respondent knowledge, willingness to participate in the survey, and based on the program cycle they were selected to participate as the set of process questions were enhanced in the phase two of the evaluation.

Table 4-8. Research objectives for the CNC process evaluation

Objective
Source of program awareness
Project phase participants became involved with the program
Satisfaction with program features
Aspects of the program that went well/could be improved
Rebates participants would like to see offered through the program
Awareness of post-occupancy commissioning/interest in commissioning
Effectiveness of program marketing
Plans to use the program again in the future

In addition to the process findings below, DNV delivered to PSE a market assessment and gap analysis of its CNC program in August 2021. PSE requested the commercial market characterization provide suggestions for program design that enhance the commercial program's ability to reach its targeted customers. The commercial market characterization report's main research objective was to identify methods to increase participation levels for the CNC program. DNV achieved this objective by comparing the capacity of the current new construction market to recent program activity, identifying current barriers to participation, and providing recommendations to increase participation rates. The report collected program experience surveys from (11) participants and web surveys from (79) non-participants and leveraged data from the New Construction Dodge database to inform new construction market and non-participant projects in PSE service territory.

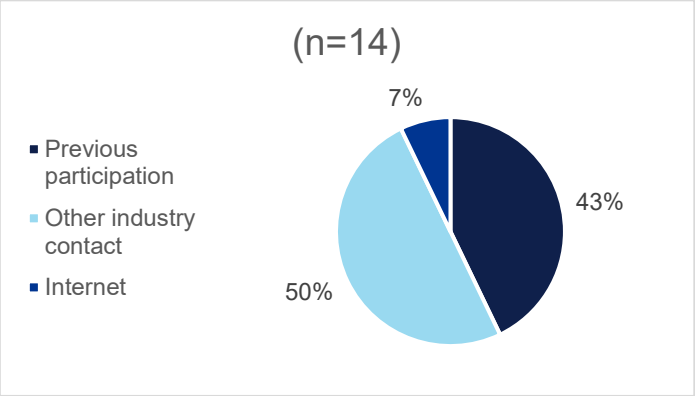
4.3.2 Participant survey results

This section summarizes the telephone survey results with CNC decision-makers.

4.3.2.1 Source of CNC program awareness

Participants broadly characterized their source of program awareness into three main sources, for which the most common source (50%) was "other industry contact" (such as a design consultant or architect) followed by previous participation (43%), and internet (7%). The results are normal for a commercial program whereby participants learn to navigate the process, see the benefits, and return to the program for their next project. Ideally, the mix of repeat participation is lower and represents 25% or less of the population. If previous participation exceeds 50%, then the program is likely not performing enough marketing and outreach to attract new participants. PSE should continue to monitor this metric and adjust accordingly.

Figure 4-1. Source of awareness for CNC program



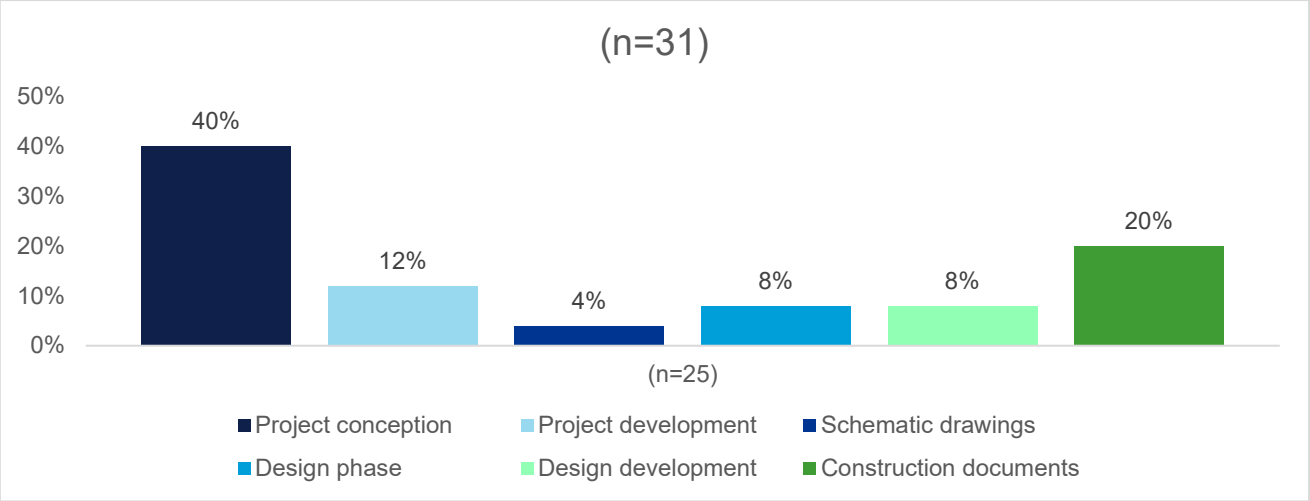
In addition to asking participants the source of awareness, we also let them know the track they participated in (systems vs. whole building) and asked why they selected that track and whether they considered any other track. Unfortunately, responses to this question did not produce useable findings other than that the majority of respondents (10/13) did not know which track they participated in or why.

4.3.2.2 When participants first become involved with the CNC program

The survey asked participants when they got involved with the program based on construction/architectural design process phases. DNV asked "*Which phase in the design and construction process did PSE first become actively involved with the program?".* The potential responses were, "*1 - Project Conception, 2 - Project Development Phase, 3 - Schematic (drawings electrical or mechanical) 4 - Design Phase, 5 - Design Development, 6 - Construction Documents, or 7 - Other"*

The greatest ability to influence a project's design and materials requires early intervention (before the end of the design development phase). As the project evolves the likelihood in influence decreases, as changes in the materials selected will potentially cause delay in construction and increase costs. However, reoccurring participants may be able to get involved late, as they are already familiar with the requirements. Additionally, projects on a prescriptive path (e.g., efficient lighting) may already have met the requirements. We would not expect projects on the whole building track to participate late beyond design development. Figure 4-2 illustrates that about a quarter of projects would be too late to influence the design (Construction documents, 23%). If PSE's program wanted to have the greatest influence on design, we would recommend the program establish the construction document phase as the cut-off point. As illustrated in Figure 4-2, the program has generally done well at enlisting customers early on in the program, with the majority of customers participating at project conception (42%).

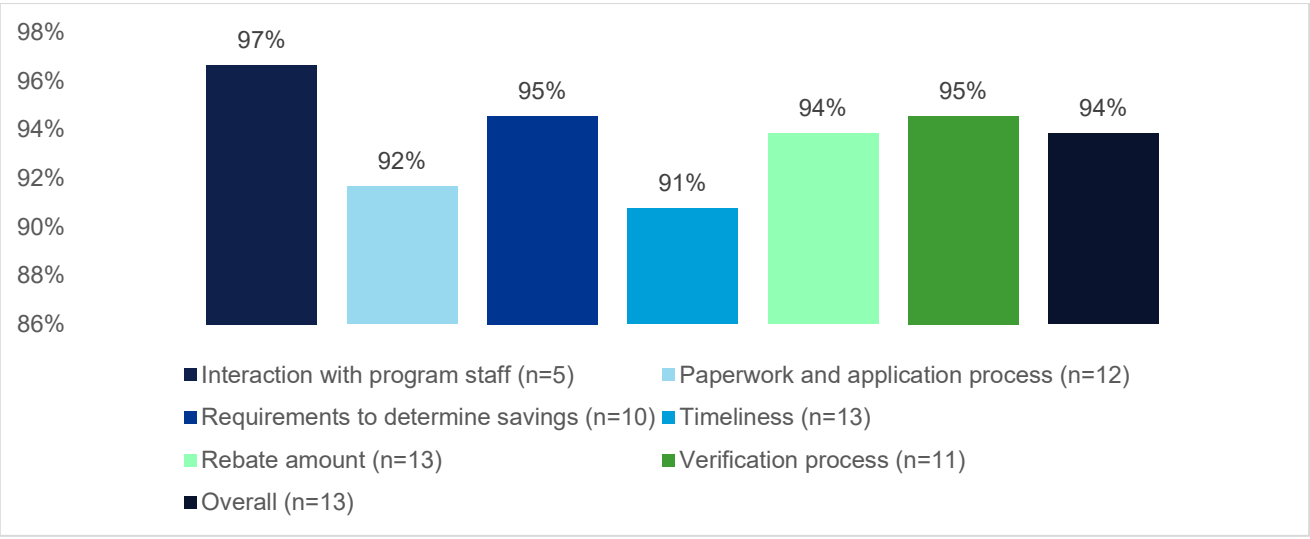
Figure 4-2. Construction phase when owners participate in the CNC program



4.3.2.3 Satisfaction with CNC program delivery

The survey asked participants to rate their satisfaction with various aspects of program services and delivery using a five-point scale. DNV's measure of a program success is when customers rate 90% or higher on program delivery. Figure 4-3 illustrates program satisfaction is high among all delivery and services evaluated, but the areas the program should monitor are paperwork and application (92%) and timeliness at (91%).

Figure 4-3. Satisfaction with CNC program delivery



During the interview, we gathered open-ended feedback from participants on what aspects of the program worked well for them and what could be improved. These questions were also captured in the 2021 CNC market assessment study. Here is the high-level feedback from both studies:

- The key areas where the program can be improved are:
  - Market Assessment Study: streamlining paperwork requirements and providing more customer one-on-one service, better education, and support of program measures.

- Program Process Evaluation: provide a check list of program requirements, a list of program measures, an online status portal, and evaluate options to provide incentives for horticulture and refrigeration.

- Aspects of the program that work well include:
  - Market Assessment Study: overall ease of participation, how approachable the staff is, actively assisting customers with program applications and requirements, cross coordination with other PSE departments, and building modelling results.
  - Program Process Evaluation: overall ease of participation and responsiveness of program staff. Among repeat participants who work with the same program contact for all projects, we heard that PSE serves as a good resource for a second opinion to share ideas and vet concepts.

In your opinion, what aspects of this program show room for improvement?	In your opinion, what aspects of this program work well?
Regular updates - they need an online portal/dashboard to see the status of their project. Program staff and customers need a common ground to interact and see timely response/status updates.	“Straightforward. PSE point of contact was very helpful, quick response, knew our project very well.”
“More transparency in the rebate amount and how its calculated.”	“Working with design professionals/contractors who are familiar with the program.”
“If PSE is serious about encouraging efficient use of energy it needs to be more realistic and capable of making decisions, to facilitate the incentives, based on field realities. We don’t always have luxury of planning every detail in advance. Sometimes the field reality prompts necessary adjustments that warrant due consideration and not outright rejection based on arbitrary timelines.”	"The ability for the engineer to talk to the project stakeholders for the options."
“Provide more comprehensive indoor horticulture offerings. Beyond lighting with HVAC and controls.” “Could use more advice about equipment, didn’t know how many lights we could use without needing a power upgrade.”	“Simple application process.”
“Website should outline what eligible rebates are available for new construction convenience stores. Per the project contact, there are not refrigeration measure available for such stores.”	“The rebate itself, the ease of the program, for not too much effort.”

"Would be better to get a sense on what the expected incentive would be during the design phase instead of get a surprise later in the process.

"Involve the participants, designers, and PSE in a pre-design phase meeting."

"PSE having a clear list of measure offerings with their incentive rates along with their cost effectiveness that participant can refer to in the pre-design phase to decide the design alternatives."

"Having the same program manager for all of our projects is a HUGE help. The file sharing site is a big benefit as well so I don't have to email big files."

4.3.2.4 Awareness and interest in post-occupancy commissioning

One area the evaluation sought to capture feedback is the lower-than-ideal utilization for post-occupancy commissioning agent services (rebate). Building commissioning is a process to ensure, through documented verification and functional performance testing, that all building systems perform interactively according to the design intent. It can ensure that energy efficiency design aspects are realized. The program incentives cover up to 75% of the cost: $0.35/SF for electric and gas PSE customers, $0.25/SF for electric only customers, and $0.15/SF for gas only customers. The survey asked participants if their project had a commission agent and a separate question asked if they were aware of the PSE rebate for commissioning services.

Figure 4-4 illustrates that 36% of respondents had a commissioning agent (with or without PSE assistance) and among those that did, many expressed the importance of this service on a project. Among the 64% that did not, we asked why they didn't. Only nine respondents were able to provide feedback for which the stated reasons were either they didn't see the value in it (5) or were unaware of a program offering (4).

The survey then asks (Figure 4-5), "*Are you aware that PSE offers incentives for post-occupancy commissioning services provided by third-party commissioning agents?"* More than 80% (or 17 of 21 respondents) were unaware of the program. To enhance program utilization, the program will need to both upsell benefits and ensure representatives relay program offering as part of the delivery of services.

Figure 4-4. CNC projects with post-occupancy Cx

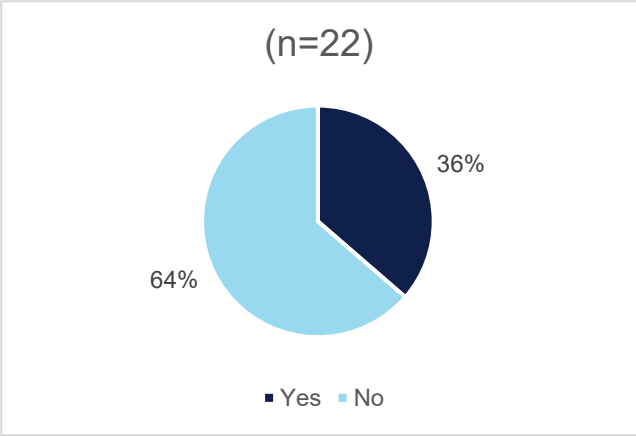
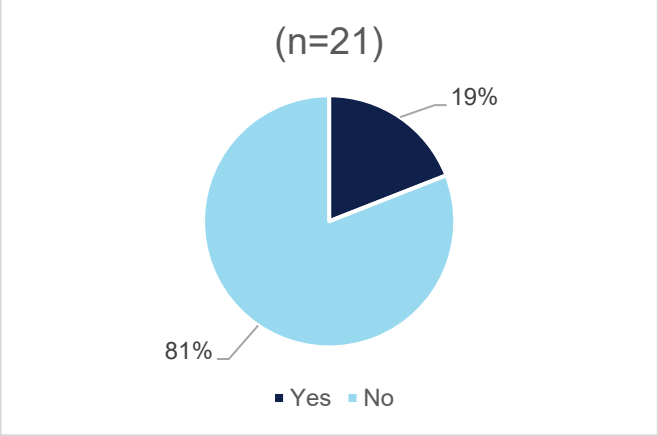


Figure 4-5. CNC participant awareness of post-occupancy Cx incentive



4.3.2.5 Expanding program measures and services

The survey asked participants if they had any suggested building system technology and/or control that should be promoted by the PSE New Construction program. Responses to this question are cataloged below with the frequency with which they were mentioned.

- Battery backup / solar
- HVAC rebates for greenhouses.
- Energy sub-metering and dashboarding
- HVAC and humidity controls (2X)
- Refrigeration
- Building automation system (2X)
- PSE should promote low water usage systems
- Electrification for heat source – help customers navigate this process (2X) (*"Facilities have to make a choice between large geo-thermal heat pumps or small modular heat pumps. Large heat pumps which can meet the load alone do not work well. Only large heat pumps work moderately well, but all other commonly available large heat pumps do not operate well".)* The participant is interested to learn from PSE on any WSHP that work well in cold weather.
- EV charging stations and rate plans (*"PSE needs to look at the demand charges as schools are adding electric car charging infrastructure, such as separate meters for such charging stations separate from the school electric meters."*)

4.3.2.6 CNC participant opinions on program marketing and outreach

In the PSE program years of evaluation, the program had performed the following outreach: one-page flyer to select building departments on requirements and benefits, occasional outreach to the design community, an ad placed with ASHRAE, and promotion of the program on the PSE website.

The survey asked respondents if they thought the program has done an effective job at outreach, promotion, and communicating the program benefits to developers and the design community, and what they thought was the best way to communicate incentives and services. Only eight respondents had an opinion, of which 5/8 (63%) thought the program has done a good job. Some recommendations for program improvement included more frequent communication of incentives and changing service offerings, making the program more prominent on the website and doing targeted marketing emails, and periodically mailing a physical packet to show the program is authentic (one respondent was concerned about false advertising).

4.4 Findings and recommendations

This section documents DNV's findings, recommendations, and considerations associated with this program.

4.4.1 Impact findings and recommendations

This section's recommendations are based on the results of the impact evaluation.

1) **Key Finding** – The Commercial New Construction Grants (CNC) program is achieving 85.4% of tracked electricity savings and 94.9% of tracked natural gas savings. These realization rates are primarily driven by changes outside of PSE's control.
   - **Recommendation** – None.

2) **Key Finding –** Many of the new construction whole building projects have installed water source heat pumps (WSHPs) along with natural gas-fired condensing boilers. The natural gas boilers exist to provide required supplemental heat. The installed boiler provides heat to the WSHP loop when the ground heat is not adequate and usually comes on based on a loop water temperature setpoint. The eQuest simulation modelling tool was used for these whole building projects, but the tool does not have ability to model this type WSHP configuration. Only one of the project applicants (P_545412) identified this issue and adopted an out-of-box approach to determine the correct measure savings.

   - **Recommendation** – PSE should require a savings adjustment outside eQuest for buildings using WSHPs with back up natural gas boilers as the standard procedure or develop a consistent calculation method to estimate savings for these projects.

2) **Finding** – Lighting measures are performing well and are the primary contributors to program electric savings. The primary variance drivers were adjustments to the facility operating hours for two large-savings projects (>2.5GWh). The changes occurred after PSE completed their final inspection, so PSE would not have been able to know at the time of the inspection that the facility would reduce operating hours at some point in the future.

   - **Consideration** – PSE could include a review of the expected growing cycles with the customer during each project, especially for projects expected to save over 1 GWh annually and/or those expecting to use grow lights 8,760 hours per year. PSE could review each growth stage along with outside air conditions, discuss lighting during the expected flowering cycle, and assess if the facility will have sufficient HVAC throughout the year. This review would create an opportunity for PSE to discuss non-lighting equipment and savings opportunities with the customers.

3) **Finding** – The PSE standard lighting calculation tool allows for different methods to estimate hours of use for the baseline and as-built case. For example, in lighting project P_1031184 the baseline operating hours were different for different spaces, but the same (3796 hr/year) in the as-built case. Consistent calculation methods are best practice for lighting programs and PSE should consider the following program changes.

   - **Consider** requiring the baseline and as-built calculations to use identical space types and associated floor areas.

   - **Consider** adjusting the calculation so that the baseline lighting power (kW) for each space type is determined by multiplying the WSEC specified LPD (W/sq. ft.) and specific space area (sq. ft.). The as-built lighting power (kW) for each space type is determined by multiplying the actual installed lighting fixture power (kW) and number of fixtures for the same space. The baseline operating hours should be consistent with the deemed annual hours provided in tab 'LTG-INT-SPACE' for different space types. The as-built operating hours should be consistent with the actual operating hours.

4) **Finding** – Whole building measures are performing well as the weighted realization rate for evaluated projects is close to 100% for both electricity and gas. As a result, no immediate changes to the program are recommended. DNV offers the following considerations to improve consistency and evaluability of this measure type.

   - **Consider** using TMY3 weather for all projects going forward. This will provide consistency and align with program best practices.

   - **Consider** creating a baseline model checklist for participants to follow and program staff to verify. This will help ensure consistent modeling of baseline assumptions throughout the program. In many cases, this should simplify the baseline models used by providing modelers with clear guidelines. Specific recommendations for this list include.

      i. Baseline schedules that match WSEC Appendix B.

ii. Baseline schedules for multi-family new construction not covered by WSEC. This should include schedules for occupancy and lighting, cooling and heating setpoints, water heater setpoints, receptacle and refrigeration assumptions, etc.

iii. Checks to prevent the use of the building area method and the space-by-space method to calculate lighting savings in the same building. Some reviewed projects used one method for the baseline and one method for the as-built case.

iv. Expected baseline internal load densities, such as those found in Table B102 in Appendix B of 2015 WSEC.

- **Consider** developing a uniform approach to variable refrigerant flow (VRF) savings estimation. Reviewed projects used different approaches, such as i) custom spreadsheet calculation outside the whole building simulation and ii) use of a custom performance curve in the eQuest simulation. PSE can suggest a uniform approach for applicants claiming VRF savings.

5) **Finding** - The 5 of 10 custom/component projects evaluated with significant variance required due to as-found operating parameters such as air compressor load, hours of use, or return water temperature. These projects have minimal impact on the program realization rates, but adjustments to program processes should be able to reduce the savings variance in the future.

- **Consider** adding additional quality assurance checks when significant energy savings are expected due to a boiler operating in the condensing zone. The check should ensure that the site controls and processes will provide the required return/inlet water temperatures to achieve condensing mode operation.

- **Consider** adding steps or adjusting the program process when savings are expected from equipment installed as part of a new process or facility expansion and tracked savings will not be achieved unless specific loading or production volumes are achieved. In these cases, PSE could request additional assurance that the operating conditions are expected to occur or mitigate the savings risk by adjusting the calculations to reduce anticipated savings. This could include requiring the receipt of production data or actual operating parameters before the final incentive is paid.

4.4.2 Process findings and recommendations

This section summarizes conclusions and recommendations sourced from the CNC process evaluation.

1) **Findings – EM&V cooperation rates.** The evaluation team found participant willingness to cooperate / ability to reach a decision-maker lower than expected for a program of this type (at 65%). This reduces the evaluability of the program and results may not represent the full range of experience among the non-respondent population.

- **Consideration** – Identify and implement customer and stakeholder communications regarding the value of research to the program and associated requirement for participants. Two ways the program could improve the evaluability and cooperation rate are:

i. On the project application, record the owner and any design team members the program will be working with. Require the applicant to provide name, title, email, and phone.

ii. PSE project staff could prepare a project close out that briefly describes who they interacted with and major project accomplishments and decisions made.

2) **Finding – source of program awareness**. Some 43% of respondents learned about the program through previous participation. The results are normal for a commercial program whereby participants who learn to navigate the process, see the benefits, and return to the program for their next project.

   - **Consideration** – PSE should continue to monitor the share of participants who are first time vs. previous participants. Ideally, the mix of repeat participation is lower and represents 25% or less of the population. If participation exceeds 50%, these are indicators the program is not performing enough marketing and outreach to attract new participants and the program will need to make an investment in program marketing and outreach.

3) **Findings – when participation starts**. The program has generally done well at enlisting customers early in the program with the majority participating at project conception (42%). However, the evaluation team found about 25% of respondents participated too late in the process, at the construction document phase, for the program to have influenced the project.

   - **Consideration** – PSE should continue to monitor phase of construction and consider establishing the construction document phase as too far along into the project to participate in the program.

4) **Finding** – **satisfaction with program delivery**. Satisfaction with program delivery is high and the program has ratings of 90% and above for all program components. However, given the lower-than-expected response rates, these opinions may not be representative of the population.

   - **Consideration** – The satisfaction rates are lowest for timeliness and paperwork and application process. One way participants would like to see this process improve is by providing an online tracking/portal system that tracks the project and allows any member of the project team access.

5) **Finding** – **incentive offerings**. The program found customers were satisfied with the program incentives and rebate amounts but had several suggestions for enhancements. Additionally, the evaluation found low levels of participant awareness for the full range of incentive offers. Particularly, the post-occupancy commissioning incentive is not well known and benefits are not understood.

   - **Consideration** – i**ncentive amount** - Participants also expressed a desire to understand what the approximate incentive will be early in the process. PSE could use past projects as a starting point to inform customers about the range of incentives and may want to develop a calculator to provide “soft” estimates.

   - **Consideration** – **measures rebated** - Customers would also like to see the program enhance the incentive offerings with emphasis on renewables (PV), storage, EV charging, building automation systems, water conservation, options for all electric heating in place of boiler, and customized measures for horticulture and refrigeration. PSE should consider options to integrate communications between energy efficiency programs with other PSE customer programs.

     Additionally, if the program intends to continue offering a post-occupancy commissioning incentive, it will need to both upsell benefits and ensure representatives relay program offering as part of the delivery of services as it is not well known nor understood as a valuable resource.

6) **Finding** – **program delivery** – The evaluation found customers’ experience with the program was relatively seamless and barriers to participation were minimal. However, if the program wants to have deeper energy savings across projects, changes will be necessary. We expect these changes would increase the overhead cost to run the program but what customers are asking for will result in high satisfaction and a better understanding of benefits.

- **Consideration** – PSE could improve its online presence in the following ways: make the application process entirely online; develop a program manual or guide that outlines the steps in the process, incentive tracks, incentive amounts, a comprehensive list of services, etc.; and improve the application to collect more information about the customers and designers. Each project should have a project close out that briefly describes the project, who was involved, and what their role was. Give respondents access to an online portal that allows them to track their project. Customers expressed a need for a subject matter expert to collaborate with them early in the design process. Consider adjusting incentives to design team members to help offset the cost to improve design.

5 COMMERCIAL REBATES – LIGHTING TO GO

5.1 Program overview

Lighting to Go offers instant incentives to business customers who purchase qualified LED lighting measures at participating distributors or showrooms and install the lighting measures in commercial facilities or spaces. Distributors have stores that are geared toward commercial customers and pass on these discounts to PSE's commercial customers, who buy discounted lighting products through the program.

Key elements of the program design are:

- Eligible customers for this program are Puget Sound Energy electric customers on commercial rate schedules that install the lighting in their place of business. Residential and new construction installation addresses are not eligible for this program.
- Eligible products must be on the Design Lights Consortium (DLC) list. The incentivized lamps during the 2020-21 biennium are TLEDs, 4-pin CFL replacement LEDs, and LED HID replacements.
- Lighting is sold with instant incentive by lighting distributors. Installation location is collected by the distributor according to these rules.
  - For transactions that are 50 bulbs or less, no customer information is required.
  - For transactions that are 51 bulbs or more, the distributor must collect from the purchaser the end user's name, phone number, email, and address where the product is installed. Speculative buying that is not tied to a particular customer is not allowed. The transactional-level data and customer information are then submitted to PSE's rebate processor within 30 days after purchase.
  - For stores located outside of PSE electric territory, customer data is collected on every sale, regardless of purchase quantity.
- The rebate processor then aggregates and qualifies the data and submits an invoice to PSE for PSE to pay. Distributors are then reimbursed.
- PSE assumes that 20% of the lamps sold are either not installed or is installed outside of PSE's territory. As a result, PSE reduces savings for lamp measures by 20%. No adjustment is made for fixtures purchased through the program.

5.1.1 Program savings

Table 5-1 shows the tracked energy savings for this program from 2019 to 2021. The program contributed 9.7% of the electricity savings to the C&I portfolio over the biennium. The program was the fourth-largest C&I electricity program over the biennium. The reduction in savings from 2019 to 2020 is due to both the COVID-19 pandemic and the change in eligible measures from 2019 to 2020. The increase in savings from 2020 to 2021 is due to an increase in program participation and a change in the assumed per unit savings for linear LEDs (TLEDs).

Table 5-1. Tracked program savings, Lighting to Go

Program Year	Unique Projects	Tracked Savings	Percent of Tracked C&I Portfolio Savings
2019	7,793	11,360,946	10.1%
2020	2,779	7,076,184	6.3%
2021	3,074	14,889,788	13.2%
2020/2021	5,853	21,965,971	9.7%

5.2 Evaluation overview

Comprehensive evaluations of midstream incentive programs are challenging and resource intensive due to the lack of information on the final installation location and that equipment owners and operators are often unaware that they participated in an energy efficiency program. PSE and DNV agreed to not complete a comprehensive evaluation of the program and instead focus on key program attributes that could be reviewed without significant primary data collection efforts. The program evaluation was designed around the following objectives.

1. Provide an independent review of the unit energy savings estimates used for this program.
2. Gather feedback on the program experience from known market actors and participants.
3. Identify opportunities to improve the program.

5.2.1 Evaluation data sources

DNV developed an evaluation plan that utilized multiple data sources to examine the program from the program perspective, the distributor perspective, and the customer perspective. The mid-stream nature of the program incentive structure makes it difficult to account for all program measures and incentives. DNV used and collected the following data sources to evaluate this program.

- **Program Tracking Data:** DNV reviewed program tracking data for the 2019 – 2021 Lighting to Go program.
- **Distributor Sales Records:** DNV reviewed a sample of 2019 and 2020 lighting sales data from participating distributors. These data were also used to draw a sample for the distributor and business customer surveys.
- **Distributor Interviews:** DNV completed 14 distributor interviews from a provided sample of 19 distributors in PSE territory. Distributors were interviewed about topics such as program understanding and process, communications, customer participation, program barriers, quality control and verification, and marketing, outreach, and education activities.
- **Participant Interviews**: DNV interviewed 24 business customers that had purchased at least one Lighting to Go incentivized LED lamp or fixture in 2019 and/or 2020 out of a population of 112 customers with known contact information (purchased more than 50 units). DNV asked business customers about program impact, program understanding, communication, customer participation, program barriers, quality control and verification, and marketing, outreach, and education activities.
- **Program Staff Interviews**. DNV interviewed PSE program staff in August of 2020 to understand LTG's program design, recent and planned program changes, and potential barriers to program participation.
- **Implementer Interviews.** DNV spoke with the program implementor, Energy Solutions, in December 2020 to understand program design, quality control processes used, and marketing and outreach efforts associated with the program.

5.3 Tracking data review

DNV analyzed the tracked Lighting to Go projects from 2019-2021. This review identified the program measure mix, the per unit savings used to track savings, and adherence to program rules regarding recording participant data.

DNV reviewed the tracking data to understand what participant information was available for the program given the 50-unit minimum for customer information. Figure 5-1 and Figure 5-2 provide key program participation information.

Figure 5-1. Projects by number of units purchased, 2020-2021

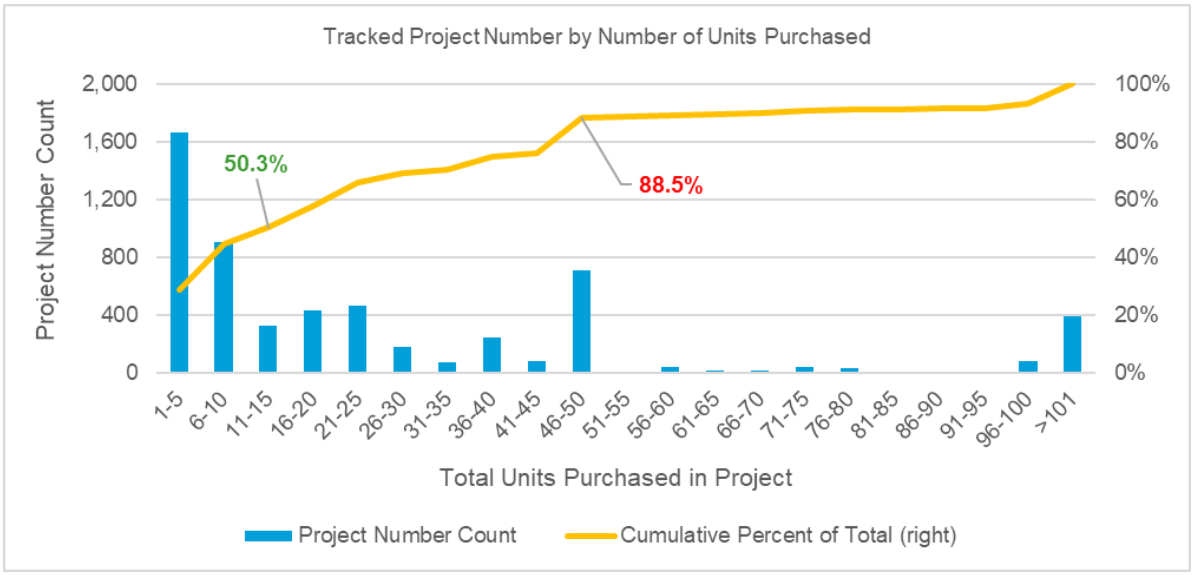
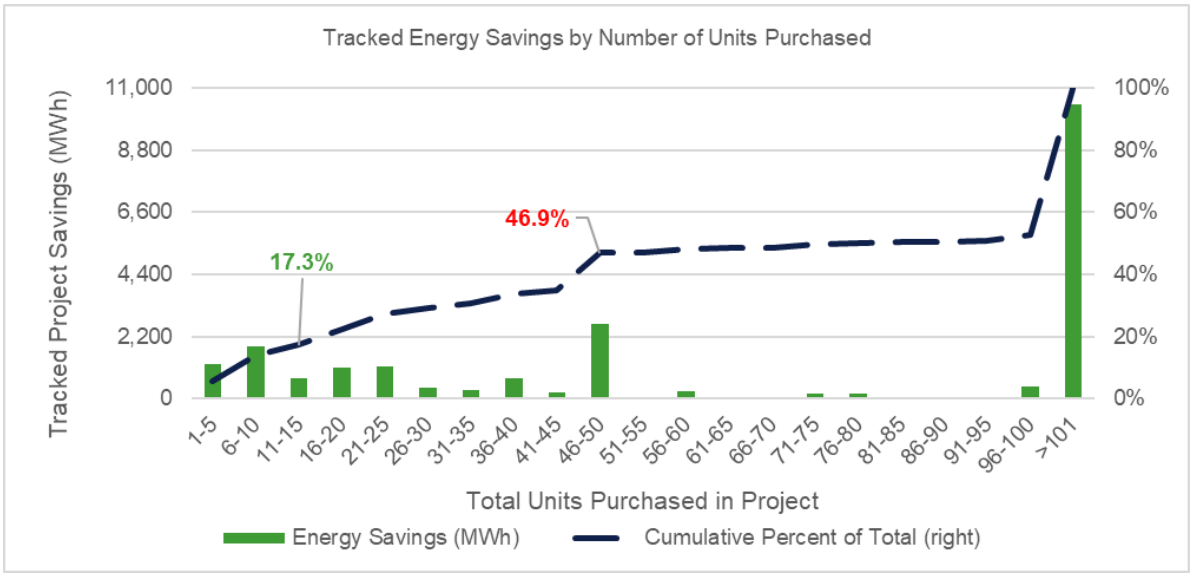


Figure 5-2. Tracked energy savings by units purchased per project, 2020-2021



The key findings from this review are:

- Over 88% of all projects were for 50 or fewer lamps and/or fixtures (93.2% if program year 2019 is included). The 88% of projects accounted for 46.9% of the tracked program savings. As a result, only 12% of the program supported transactions required the collection of customer installation address and customer contact information. Program evaluations will only have contact information for the 12% of end-users who account for 50% of the program savings.
- The 557 projects that included 101 units or more accounted for 38.5% of savings, or almost all of the savings associated with purchases of more than 50 units.

- The program does support a significant number of small transactions, with 50% of tracked projects being for 15 units or less, accounting for 17% of savings. Conversely, the 50% of transactions that purchased at least 16 units accounted for 80% of the savings.
- Purchases of 46-50 units represent more than 12% of all transactions. This is a noticeable spike. This spike indicates to DNV that some contractors and business customers are aware of program rules and may be intentionally avoiding purchases of lighting products over 50 units so that they aren't required to provide customer address and contract information.

5.3.1.1 Per-unit savings

DNV found that PSE used consistent per-unit savings for all measures from 2020-2021 except for linear LEDs or TLEDs. TLEDs are the largest contributor to program savings, accounting for 60% of the tracked savings over the biennium. PSE changed the assumptions used to estimate TLED savings for installations occurring in 2021. The changes in the assumptions resulted in an almost doubling of tracked savings from 31.8 kWh/unit to 79.2 kWh/unit. PSE changed the basis for the assumptions from prior Lighting to Go participants and CBSA results to assumptions based on TLED participants in the Business Lighting program. Both assumptions are reasonable and further investigation is required to understand which is a better estimate.

The higher savings carries additional risk due to an increase likelihood that the average TLED is operated fewer hours per year than assumed and that the baseline case for the measure is a T-8 or T-12 fluorescent. The evaluation found that 51% of the high-volume sales were installed at schools, which typically have a lower annual operating hours than other commercial buildings.

Since PSE has aligned the per unit savings to Business Lighting projects, DNV recommends including Lighting to Go TLED purchases in the next impact evaluation of the Business Lighting program.

5.4 Impact evaluation

This section documents DNV's independent review of the tracked program energy savings. DNV primarily relied on tracking data and program records associated with savings reported in 2019 through the first quarter of 2021 to complete this review.

5.4.1 Program documentation review

DNV reviewed the program documentation detailing the methods and assumptions used to estimate energy savings for measures delivered through this program. The LTG program uses the following savings parameters to estimate savings:

- **Delta Watts (ΔW)**. The difference between baseline lighting fixture/lamp wattage and the program lighting fixture/lamp wattage. DNV reviewed the assumptions used and agrees with the assumed wattage reductions.
- **Annual hours of use (*Hours*$_{annual}$*).*** Lighting hours of use (HOU) are based on a weighted average calculation using building type hours from the 2009 and 2014 NEEA Commercial Building Stock Assessments (CBSA) and records of building types that participated in the PSE program from April 2014 to April 2015. The one exception is the HOU used for 2021 installations of TLEDs. DNV verified the calculations completed. DNV did not collect additional data to evaluate this assumption.
- **Quantity**. The total fixtures/lamps purchased. DNV verified that the program tracking data matches the program implementer's invoices.
- **In-service rate (ISR).** The percent of fixtures/lamps expected to be installed in PSE territory after purchase. PSE assumes an ISR of 80% for this program. This value is a judgement by PSE and accounts for both leakage to non-PSE

territory locations and storage of units after purchase. DNV finds this assumption to be reasonable given the design of the program but did not directly evaluate this value.

Using these key savings parameters, annual measure energy (kWh) savings are very generally described as:

$$kWh_{savings} = \sum_{measures} \Delta W \times Hours_{annual} \times Quantity \times ISR$$

DNV finds the measure savings methodologies, assumptions, and values to be reasonable and sufficiently documented in measure case files. DNV identified two minor issues in the calculations that PSE should remedy. These issues are the only reason for the estimated program realization rate. All other measures were found to have a 100% realization rate.

- PSE inconsistently rounded the decimals in the calculation for 6 measures. DNV applied a consistent round of 1 decimal place across all measures in our evaluated savings calculations.
- In addition, PSE did not include the 80% ISR assumption for measure ID 10623.

Table 5-2. Lighting to Go measures with savings variance

Measure ID	Measure Name	Tracked kWh Savings – per Unit	Verified kWh Savings - per Unit	Realization Rate
10621	LTGO: Fixture - LED - Retrofit Kit - Hard Wired Recessed Can	110.0	109.8	99.8%
10623	LTGO: Lamp - LED - Integral - Omnidirectional	79.0	62.6	79.2%
10624	LTGO: Lamp - LED - Integral - from R BR or PAR20	99.0	98.8	99.8%
10625	LTGO: Lamp - LED - Integral - from R BR or PAR30	99.0	98.8	99.8%
10626	LTGO: Lamp - LED - Integral - from R BR or PAR38 or 40	128.0	127.5	99.6%
10627	LTGO: Lamp - LED - MR16 or PAR16	94.0	94.2	100.2%

5.4.2 Installation rates

DNV verified installation of purchased equipment during participant interviews. The installation rate for those interviewed was 99% for lamps and 100% for fixtures. While this installation rate may seem high, the business customers reached via the phone survey represent only a small share of total business customers who participate in the LTG program. At the time of data collection, customer contact information was only available for 4% of all program transactions. The installation rates are therefore not representative of the full program, but provide assurance that savings are being realized.

Table 5-3. Lighting to Go installation rates, 2019-2020

Product Type	Purchased	Installed	Installation Rate
Lamps	30,062	29,798	99.1%
Fixtures	679	679	100.0%

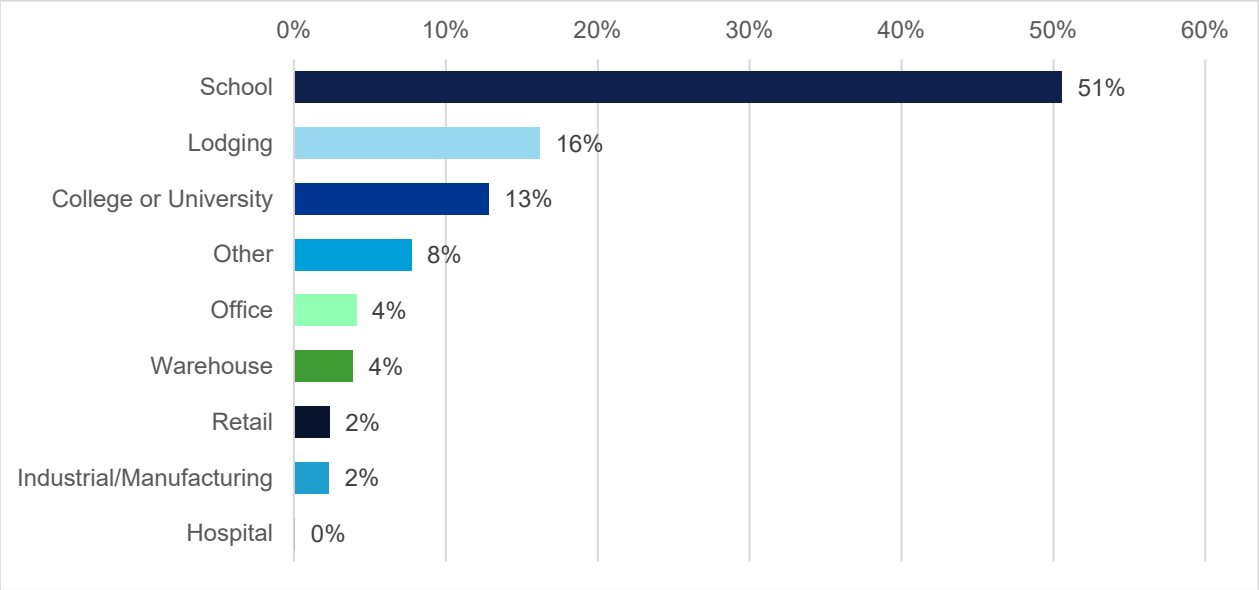
These results do indicate that customers who purchase large volumes of products or fixtures through the program are not storing products for future use but are installing the products soon after purchase. This provides some assurance that energy savings are occurring as tracked and does not indicate a reason believe the 80% Lamp ISR assumption is unreasonable.

5.4.3 Installation location

DNV asked Lighting to Go business customers what type of building or facility they installed lighting equipment in for the program lamps purchased in 2019 and 2020. Figure 5-3 shows that most prevalent 2019 installation location was schools (51%), followed by lodging (16%) and College or University (13%). In 2020, business customers stated that they installed 96% of their Lighting to Go products in schools, an increase from 51% in 2019.

These results are not statistically valid representations of the program but do provide feedback on the hours of use savings parameter. The results indicate that the weighting assumptions used to estimate annual hours of use for this program may no longer be valid. The current TLED HOU weighted average calculation only assumes 0.94% installation in schools but assumes 71.90% installation in offices. DNV believes the building type distribution for this program should be further evaluated once more information on the participating customers becomes available.

Figure 5-3. Lighting to Go program installation location, 2019



5.4.4 Impact evaluation results

Based on DNV's review of PSE's savings calculations and the 2019-2020 program tracking data, the calculated gross realization rate for the program is 97.4%. This realization rate can be applied to the 2020-2021 program year to accurately estimate the achieved programs savings.

5.5 Process evaluation

This section summarizes the key findings for the Lighting to Go process evaluation, including results from the distributor surveys and business customer surveys.

5.5.1 Recent and planned program changes

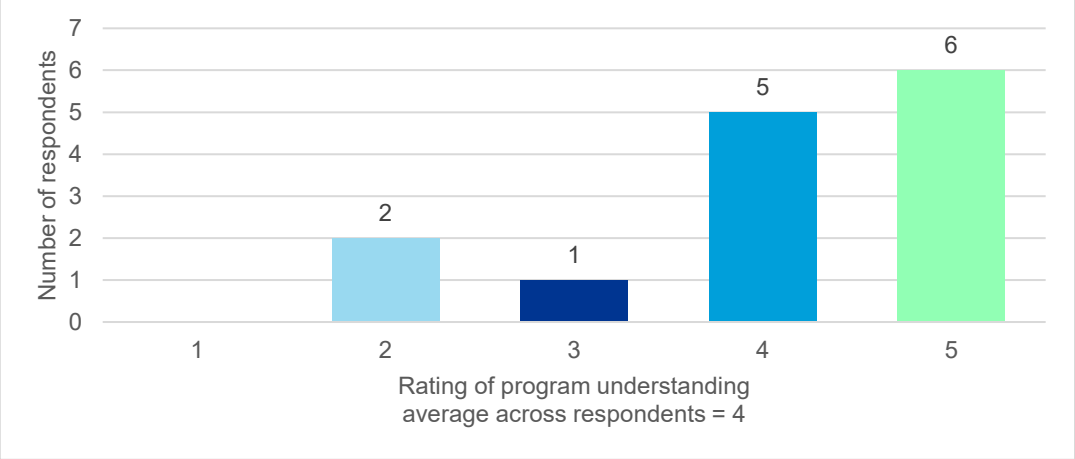
The most significant changes to the program took place between 2019 and 2020. New lighting codes and standards took effect in Washington in 2020 that required increased efficiency for most screw-base lamps (defined by the U.S. Department of Energy as general service lamps), including omnidirectional A-lamps, reflectors, and decorative lamps. As a result, these lamp types were removed from the program. In 2020, PSE continued to provide incentives for TLEDs as it did in 2019, but also added HID replacement LED lamps and fixtures as well as a CFLED downlight in 2020.

5.5.2 Distributor interviews

5.5.2.1 Understanding of program

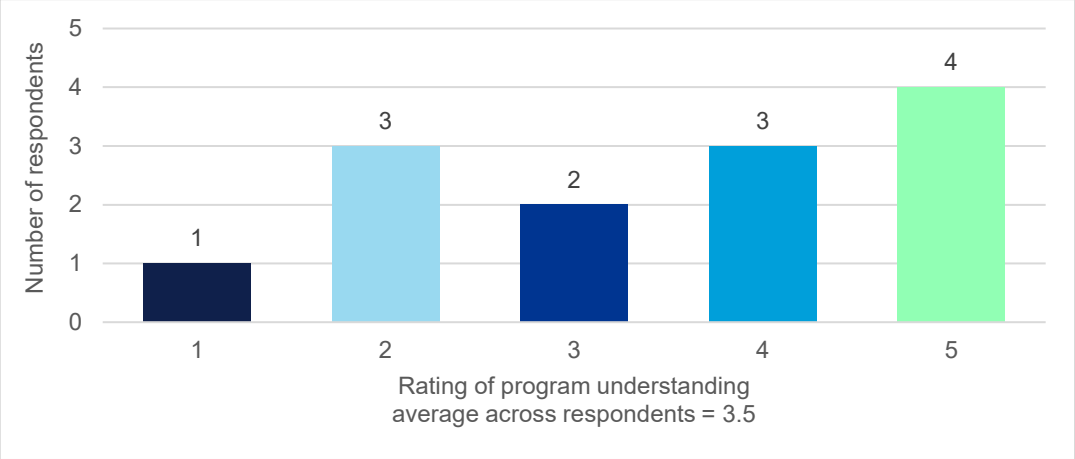
DNV surveyors asked participating distributors to rate their understanding of the Lighting to Go program rules on a scale of 1 to 5 where 1 is very difficult and 5 is very easy. The average response was a 4 out of 5, which points to distributors believing they had a strong understanding of the program rules. Eleven of the fourteen (78%) distributor respondents provided a rating of either 4 or 5 out of 5.

Figure 5-4. How easy was it to understand program rules, 2020



Surveyors also asked distributors about their employees' understanding of the Lighting to Go program rules. The average response was lower at 3.5 out of 5, which points to distributors believing their employees had a lower understanding of the Lighting to Go program. Only seven of the fourteen (50%) distributor respondents provided a rating of either 4 or 5 out of 5 for this question.

Figure 5-5. How easy was it for your employees to understand program rules, 2020

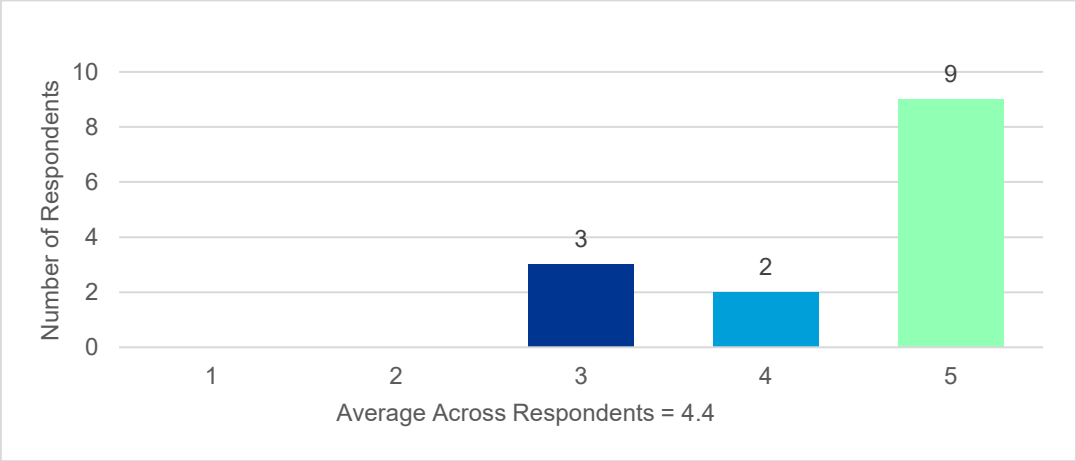


5.5.2.2 Collection of customer contact information

The Lighting to Go program rule is that the purchaser needs to provide contact information and an address if more than 50 bulbs are purchased. DNV surveyors asked distributors to rate the process of collecting this information on a scale of 1 to 5 where 1 is very difficult and 5 is very easy. The average response was 4.4 out of 5, which points to distributors finding the

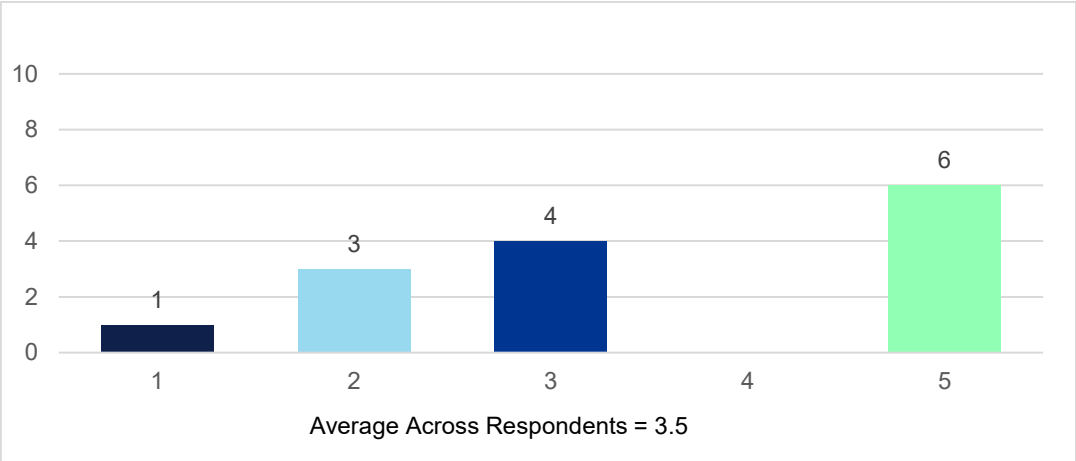
Lighting to Go program rules easy to follow. Eleven of the fourteen (78%) distributor respondents provided a rating of either 4 or 5 out of 5 for this question.

Figure 5-6. Level of difficulty collecting customer information, more than 50 units



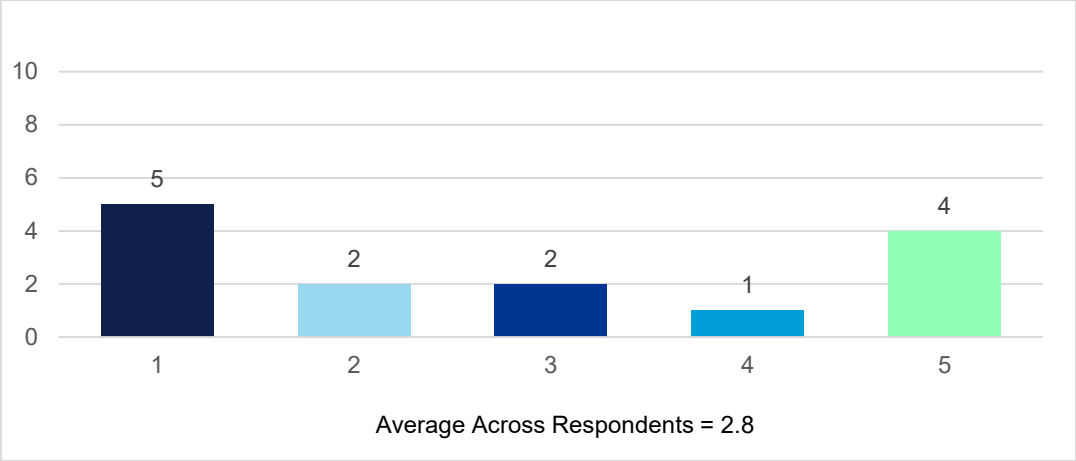
DNV surveyors then asked distributors to rate the process of collecting this information if it was required on all purchases of ten or more bulbs on a scale of 1 to 5 where 1 is very difficult and 5 is very easy. The average response dropped to 3.5 out of 5, which points to distributors finding the Lighting to Go program rules more difficult to follow as the threshold for purchases lowers from 50 or more bulbs to 10 or more bulbs. Only six of the fourteen (43%) distributor respondents provided a rating of either 4 or 5 out of 5 for this question.

Figure 5-7. Level of difficulty collecting customer information, 10 or more units



DNV surveyors then asked distributors to rate the process of collecting this information if it was required on all purchases of ten or more bulbs on a scale of 1 to 5 where 1 is very difficult and 5 is very easy. The average response dropped to 2.8 out of 5, which points to distributors finding the Lighting to Go program rules more difficult to follow as the threshold for purchases lowers from 50 or more bulbs to 1 or more bulbs. Only five of the fourteen (35%) distributor respondents provided a rating of either 4 or 5 out of 5 for this question.

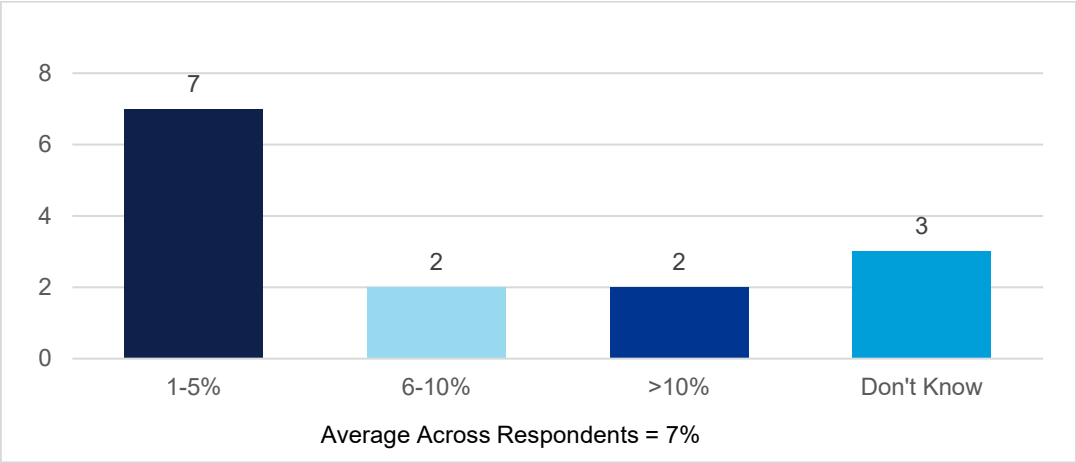
Figure 5-8. Level of difficulty collecting customer information, 1 or more units



5.5.2.3 Influence of program on sales

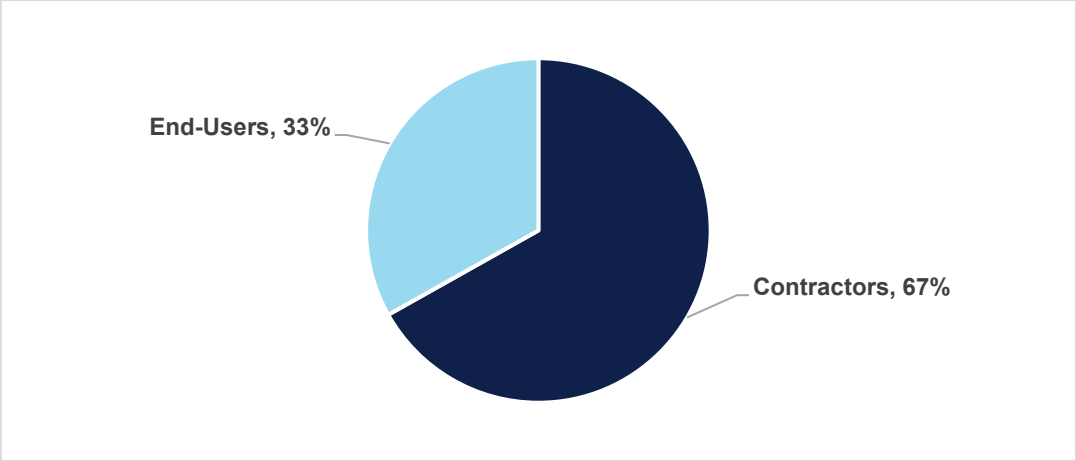
DNV surveyors asked distributors approximately what percentage of their sales were part of the Lighting to Go program in 2020. The average percentage of Lighting to Go program sales were only 7%. Only two of the fourteen (14%) distributors stated their Lighting to Go program sales were more than 10%.

Figure 5-9. Lighting to Go percentage of overall sales, 2020



DNV surveyors then asked distributors to approximate the percent of program lighting purchases that were made by contractors versus commercial end-users in 2020. Two-thirds of program lighting purchases were made by contractors versus commercial end-users in 2020.

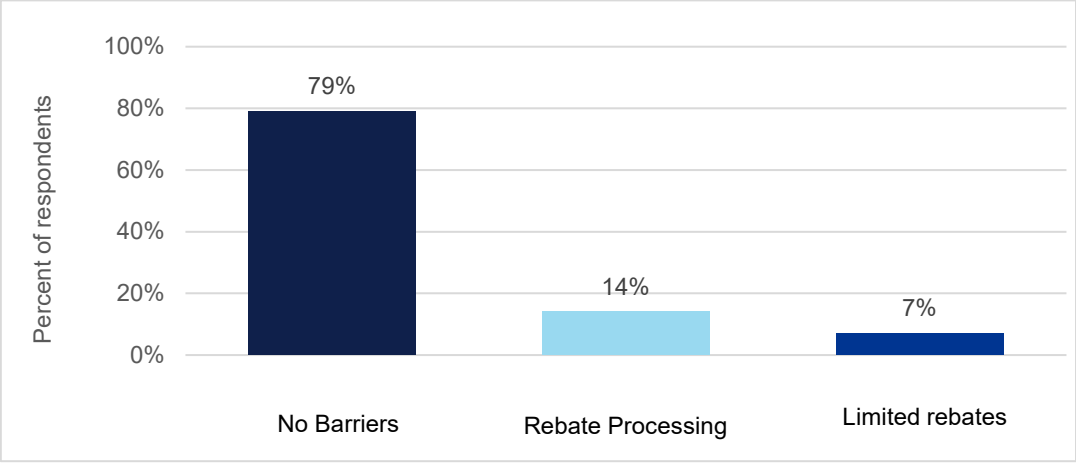
Figure 5-10. Lighting to Go percentage of overall sales, 2020



5.5.2.4 Barriers to program participation

DNV surveyors then asked distributors if there were any barriers for them or distributors in general to participation in this program. Nearly 80% of respondents stated there was no barrier to participation. Of the 20% of respondents that stated there was a barrier to participation in the program, 14% mentioned rebate processing and another 7% mentioned limited rebates as the main barriers.

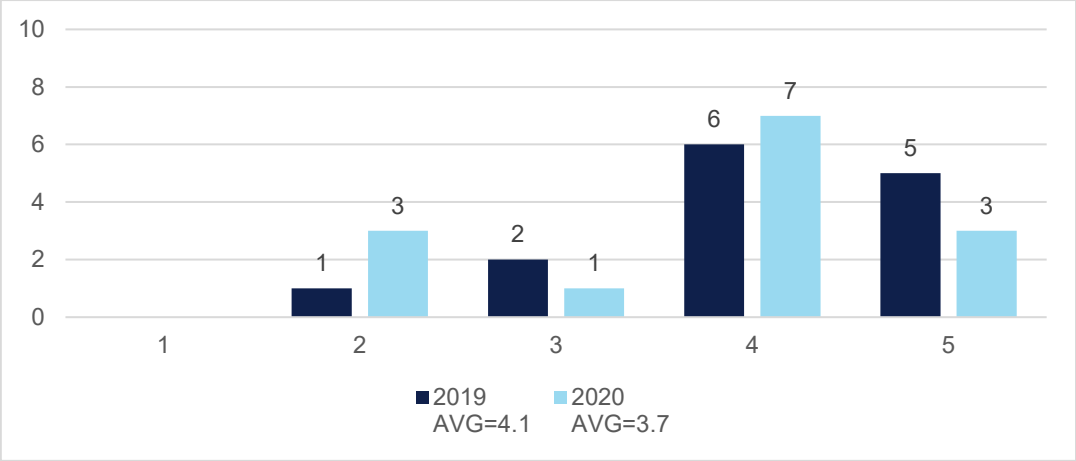
Figure 5-11. Barriers to distributor participation, 2020



5.5.2.5 Distributor satisfaction

DNV surveyors asked Lighting to Go program bulb distributors to assess their satisfaction for the 2019 program and 2020 program on a scale of 1 to 5 where 1 is very dissatisfied and 5 is very satisfied. Distributor satisfaction averaged a 4.1 out of 5 rating in 2019 and a lower 3.7 rating in 2020. Eleven out of fourteen (78%) distributors provided a rating of 4 or 5 out of 5 in 2019 while only ten out of fourteen (71%) distributors provided a rating of 4 or 5 out of 5 in 2020. Distributor satisfaction might have dropped between 2019 and 2020 due to legislation requiring the reduction of once-eligible products (e.g., omni-directional and reflector lights) that are commonly purchased for commercial buildings.

Figure 5-12. Lighting to Go program distributor satisfaction, 2019 and 2020

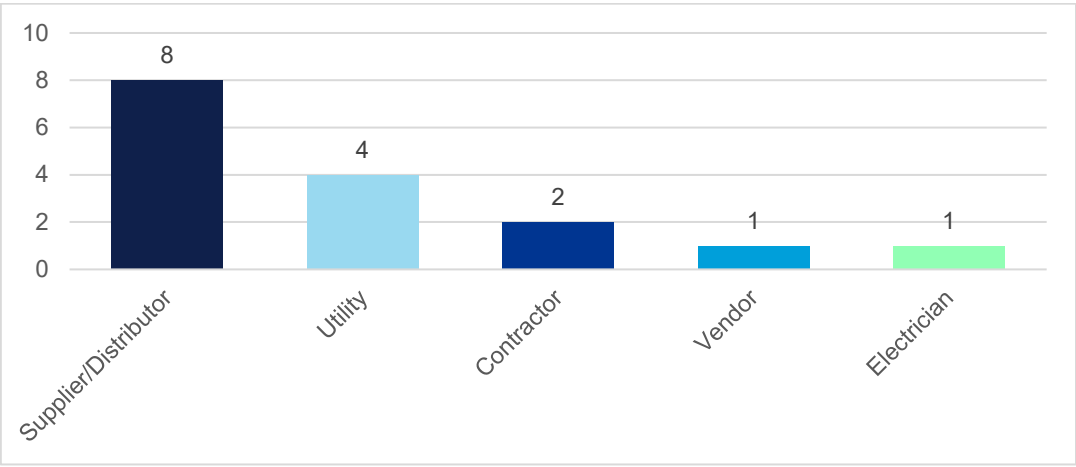


5.5.3 Customer interviews

5.5.3.1 Program awareness

DNV surveyors asked business customers how they first found out about the Lighting to Go point-of-sale instant rebate program. Eight of sixteen (50%) of respondents attributed their initial awareness of the Lighting to Go program to their lighting supplier or distributor. Another four respondents mentioned their utility as their initial point of reference while another two respondents stated their contractor introduced them to the program.

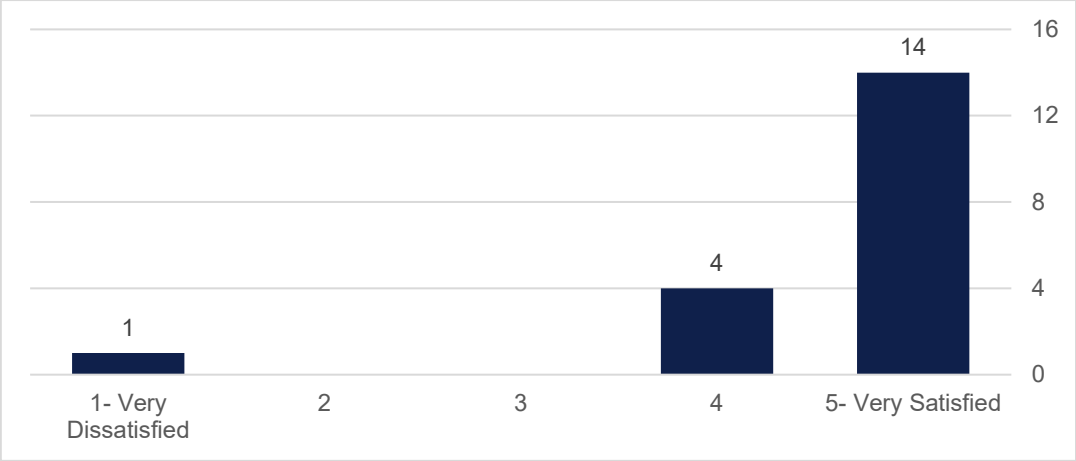
Figure 5-13. Source of program awareness, 2020



5.5.3.2 Customer satisfaction

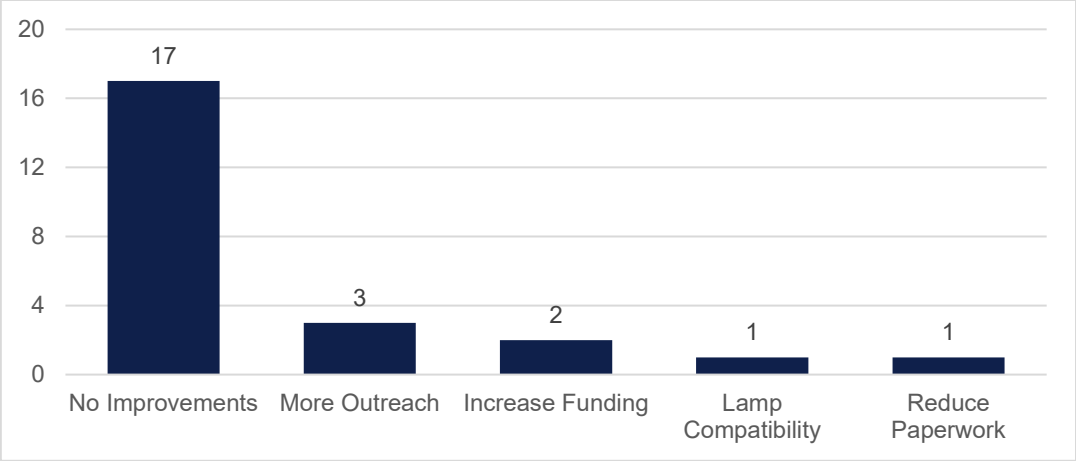
DNV surveyors also asked business customers to assess their satisfaction with the Lighting to Go program on a scale of 1 to 5 where 1 is very dissatisfied and 5 is very satisfied. Lighting to Go program customers provided an average a 4.6 out of 5 rating in 2020. Fourteen out of nineteen (74%) of respondents expressed the highest level of satisfaction with the Lighting to Go program in 2020.

Figure 5-14. Lighting to Go program customer satisfaction, 2020



DNV surveyors also asked customers to provide improvements that could be made to the program in the future. Seventeen of twenty-four (71%) respondents stated no improvements to the program could be made. Seven respondents mentioned areas of improvement for the program, these areas included more outreach (3), increased funding (2), more lamp compatibility (1), and a reduction in paperwork (1).

Figure 5-15. Lighting to Go program customer improvements, 2020



5.6 Findings and recommendations

DNV's findings and recommendations based on our evaluation of this program are below.

1) **Key Finding** – The Lighting to Go program achieved a gross realization rate of 97.4%. Evaluated savings were slightly lower than tracked savings because of inconsistencies in rounding when calculating savings for a few measures and because PSE did not apply the assumed 20% reduction to the number of units installed for the omnidirectional A-lamp measure.

   - **Recommendation** – Update measure calculations for measures identified. Review new measures and ensure consistent rounding.

2) **Key Finding** – The Lighting to Go program significantly changed the key parameter assumptions for TLED lamps between 2020 and 2021. The change more than doubled the per-unit savings and aligned the assumptions with historic participants in the Business Lighting program. Further investigation is required to assess this change, which will likely increase the total program savings in the near future.

   - **Recommendation** – PSE should include review of Lighting to Go TLED input parameters in their next evaluation of the Business Lighting program. This review should include an assessment of the annual hours of use for these lamps, the baseline equipment, and a comparison to savings assumptions used in other midstream or upstream commercial lighting programs.

3) **Key Finding** – The following findings are specific to the current program design element to not collect installation address or contact information for purchases of 50 lamps or fewer.

   i. During 2020 and 2021, more than 88% of all sales transactions of LTG incentivized lamps or fixtures were for purchases of 50 or fewer units. Less than 12% of the transactions required the collection of installation location (business address where units were installed) and customer contact information. Because of the program design and the relatively low share of units whose installation locations are tracked, the Lighting to Go program is inherently difficult to evaluate.
   ii. Purchases of 46-50 units represent more than 12% of all transactions. This indicates to DNV that some contractors and business customers are aware of program rules and may be intentionally avoiding purchases of lighting products over 50 units so that they aren't required to provide customer address and contract information.
   iii. Responding distributors stated that collecting installation location under the current rules was easy, collecting information for purchases of 10+ units would be harder but not difficult, and collecting information for all transactions would be difficult.

   - **Recommendation** – DNV believes that the evaluability and reliability of this program is too low. PSE should lower the threshold for the collection of the installation address to a minimum of purchases of more than 15 units. This should result in the capture of the installation address for 50% of transaction and 80% of savings. This change will significantly increase the reliability of the program by reducing the cost to fully evaluate and verify savings in the future

4) **Finding** – Overall satisfaction with the program was high among participating business customers surveyed for the evaluation (n=19) with an average satisfaction rating of 4.6 on a five-point scale.

   - **Recommendation** – None

5) **Finding** – Distributors expressed above average satisfaction with the Lighting to Go program (n=14), but average ratings trended downward from 2019 (4.1) to 2020 (3.7). Because of changes in codes and standards for lighting products in Washington in 2020, most screw-base lamps are required to be LEDs or compact fluorescent lamps. Thus, many lamps discounted by the program in 2019, such as omni-directional A-lamps, reflectors, and decorative lamps, were no longer eligible for utility discounts in 2020. DNV believes this may help explain the decline in satisfaction among distributors in 2020. PSE did provide distributors with information on the changes at the time.

   - **Consideration** – Program staff and implementers should continue to provide information to distributors on changes in lighting codes and standards and the impact those changes have on PSE's ability to incentive different lighting products. This should temper distributor expectations on which lighting products are eligible for program discounts. However, changes that reduce the number of products or sales volume eligible for incentives should be expected to reduce satisfaction with the program.

6 COMMERCIAL REBATES – SMALL BUSINESS DIRECT INSTALL

6.1 Program overview

The Small Business Direct Install (SBDI) Program is designed to encourage hard-to-reach small business customers to complete energy efficiency upgrades to their facilities and buildings through lighting, refrigeration, and HVAC retrofits. The program focuses on providing varying levels of business energy assessments to identify basic and complex retrofit opportunities and facilitate participation in PSE's rebate programs.

SBDI measures are installed at the customer's site directly by the third-party implementer and/or a qualified subcontractor representative. Complex measures will require a co-pay by the customer. Incentives payments for measures with a co-pay will be in alignment with the Business Lighting rebate program. Incentives are paid to the contractor and are not intended to be a direct-to-customer rebate.

6.1.1 Program savings

Table 6-1 shows the tracked energy savings for this program from 2019 to 2021. The program contributed 10.6% of the electricity savings and 0.1% of the natural gas savings tracked across the entire C&I portfolio for the 2020-21 biennium. DNV evaluated the electric savings achieved by this program only. The program was the third-largest C&I electricity program over the biennium. The primary measures driving savings for this program are linear LEDs (TLEDs) and LEDs in high intensity discharge (HID) applications. The increase in savings from 2020 to 2021 is due to a large increase in the volume of LEDs installed, not any changes to per unit savings.

Table 6-1. Tracked program savings, SBDI

Program Year	Unique Projects	Tracked Electricity Savings (kWh)	Percent of Tracked C&I kWh Savings	Tracked Natural Gas Savings (therms)	Percent of Tracked C&I therm Savings
2019	3,644	6,666,949	5.9%	689	0.0%
2020	3,167	8,835,444	7.8%	38	0.0%
2021	4,977	15,105,791	13.4%	1,824	0.1%
2020/2021	8,144	23,941,236	10.6%	1,862	0.1%

6.2 Impact evaluation

DNV completed these steps to evaluate this program:

1. Documentation review: Review tracking data to identify savings reported, units reported, and measure ID used.
    a. Review of measure case documentation and tracking savings methodologies.
2. File review: Verification that tracking data matches sampled project data in 3rd party implementer reports
3. Data collection planning: Identification of the key input parameters for impact evaluation. Develop data collection and analysis tools.
4. Data collection: Phone interviews of sampled participants using the instruments developed.
5. Analysis: Estimate evaluated savings using the data collected to update key parameters.

6.2.1 Sample design

DNV used stratified random sampling approach to select a representative sample of projects for evaluation designed to provide reliable savings estimates. Sampling occurred at the project level. DNV selected 15 projects in each phase for evaluation. Table 6-2 summarizes the sample design for the SBDI program. Key elements of the design are:

- Stratification by size of savings reported to increase the magnitude of savings evaluated and the accuracy of the resulting program realization rate.

Table 6-2: SBDI sample design

Compliance Program	PSE Program	Sampling Phase	Project Size	Projects in Sample Frame	kbtu in Sample Frame	Primary Sample
Commercial Rebates	Small Business Direct Install	Phase I	Small	279	5,300,081	5
			Medium	114	6,516,706	5
			Large	57	7,879,287	5
		Phase II	Small	854	7,752,735	5
			Medium	201	9,508,193	5
			Large	85	12,126,376	5
		Totals		**1,590**	**49,083,378**	**30**

6.2.2 Documentation and file review

DNV reviewed the project documentation provided for all projects included the primary sample and any projects in the backup sample used to complete the evaluation. The third-party implementer submits monthly reports of all lighting projects and equipment installed. These monthly reports serve as the basis of the project level documentation. Project details such as site address, measure description measure quantity, kWh savings, and incentive were compared to tracking data. Additionally, documented measure savings estimates were reviewed. Measure savings methodologies, assumptions, and values are documented in measure case files. There were two key findings from this review.

1. Documentation was sufficient. The documentation for all projects was comprehensive and included all relevant measure information. Tracking data and the monthly lighting reports aligned for all evaluated projects.
2. Calculation methodology was reasonable. The program used a standard calculator (Excel workbook) to estimate project savings. No custom savings calculation workbooks were identified. The methodologies, assumptions, and savings values were all found to be appropriate for the program measures and applications.

6.2.3 Data collection planning

DNV updated our existing direct install lighting data collection plans and tools to accomplish the impact evaluation. The data collection plan focused on acquiring information to validate the accuracy of these key parameters used to estimate lighting energy savings:

1. **Annual hours of use** was the most uncertain savings parameter.[1] Reducing uncertainty around this parameter is often the most beneficial outcome of lighting impact evaluations. The evaluation gathered information on:
    a. Self-reported facility or fixture schedules (by space)
    b. Lighting fixture controls by space (occupancy sensors, timers, photocell controllers, combination of controls)
    c. Behavioral changes due to change in lighting fixture or lighting controls
2. **Delta watts** *(ΔW)* is the difference between the pre-existing lighting fixture wattage and the installed lighting fixture wattage. Verification of ΔW included examination of:
    a. Pre-existing fixture types (including ballast type)
    b. Pre-existing fixture/lamp conditions (e.g., 4 lamp T8 fixtures but 20% of fixtures had 1 or more failed lamps)
    c. Pre-existing fixture wiring or behavioral usage (e.g., 3-lamp T8 fixture wired to turn on 1 lamp, 2 lamps, or all 3 lamps; users turned off half of the bay lights in the afternoons)
    d. Installed fixture types

[1] Program savings use a reasonable estimate of hours-based building type of historical participation and secondary sources. However, there can be a wide variation in annual operating hours from project to project.

e. Installed fixture wiring and replacement strategy (e.g., were installed fixtures wired the same as the fixtures they replaced? Were they installed on a 1:1 ratio?)

3. **Quantity**
   a. Pre-existing fixture quantities (by space and/or fixture type)
   b. Installed fixture quantities (by space and/or fixture type)
   c. Quantity of fixtures added or removed since the original install date

Interactive effects: Current PSE policy does not account for heating and cooling interactive effects on lighting measures.[2] DNV recommends that interactive effects should be included to accurately estimate the value of the program. For this study, DNV estimated savings without interactive effects in order to directly assess the accuracy of the original savings calculations.

6.2.4 Data collection

In response to the COVID-19 pandemic, all data collection occurred via telephone interviews. We spoke with facility owners or operators to collect key parameter information.

6.2.5 Project-level analysis

DNV developed a savings calculation workbook template that calculates evaluated savings and verifies program savings values. Savings that were tracked by PSE and sampled by the evaluation were first re-created in the savings calculation workbook. Evaluated energy savings were calculated in the same workbook by adjusting the key savings parameters. The values used were determined from the most valid data source available.

Key Savings Parameters – The key savings parameters researched were:

- Annual hours of use
- Delta wattage (difference between pre-existing lighting fixture wattage and the installed lighting fixture wattage, ΔW)
- Quantity

Using these key savings parameters, direct annual energy (kWh) savings are very generally described as:

$$kWh_{savings} = \sum_{measures} \Delta W \times Hours_{annual} \times Quantity$$

For lighting controls measures the same equation structure is applied, except instead of ΔW there is an adjustment for percent savings resulting from the control measure.

6.2.6 Final evaluated sample

Table 6-3 shows the final evaluation sample achieved. DNV successfully recruited 28 customers for evaluation. Final impact evaluation results were calculated based on post-stratification weights of the combined Phase I and Phase II sample frames.

Table 6-3. Achieved SBDI sample

Compliance Program	PSE Program	Sampling Phase	Project Size	Projects in Sample Frame	kbtu in Sample Frame	Achieved Sample
Commercial Rebates	Small Business Direct Install	Post-Stratification	Small	1,018	9,472,120	7
			Medium	302	11,248,956	8
			Large	179	12,859,740	6
			Extra-Large	91	15,502,563	7
		Totals		**1,590**	**49,083,378**	**28**

[2] Heat is a byproduct of lighting. As lighting efficiency increases, the waste heat it generates decreases. This has an interactive effect on HVAC costs. During heating months, heating systems typically work harder to make up the heat that used to be generated by the lighting. In cooling months, the HVAC typically consumes less energy.

6.2.7 Program realization rates

Table 6-4 shows the final realization rate estimated for this program. The SBDI program is achieving 94% of the electric energy savings tracked. The realization rate should be applied to the final 2020-2021 biennium tracked electric savings to estimate the evaluated savings for the program over the biennium. No adjustment to the tracked natural gas savings is necessary given this program's minimal contribution to PSE's natural gas savings portfolio. Project-level realization rates varied from 48% to 261% across the 28 projects completed. The mean realization rate across the evaluated sample was 96%.

Table 6-4. Final Small Business Direct Install electric impact evaluation results

Projects w/ kWh Savings	Tracked MWh Savings in Sample Frame	Evaluated MWh Savings in Sample Frame	SBDI Realization Rate, kWh	Relative Precision at 90% Confidence Interval
1,590	14,374	13,475	93.7%	12%

6.2.7.1 Savings variance

The primary driver of savings variance is differences between the assumed operating hours used to estimate tracked savings and the self-reported lighting operating hours collected during the evaluation. For the 28 evaluated projects, the operating hours range from 1,626 up to 8,760 with a straight average of 3,351 hours. The tracking's savings generally assume 3,423 average operating hours. The results of the evaluation show that while significant variance exists on a project-by-project basis, the assumed program value is reasonable for the current participants.

6.3 Process evaluation

Under DNV's developmental evaluation framework, process evaluation is initiated when it is warranted by the findings of an impact evaluation. Impact findings for this program did not demonstrate the need for further investigation.

6.4 Findings and recommendations

This section documents DNV's findings, recommendations, and considerations associated with this program.

1) **Finding** – The evaluation team verified the quantity and equipment type installed and in use for all of the evaluated projects. The measure case savings algorithms for all measures are appropriate. The realization rates reflect adjustments to the measure case savings for reported hours of use at each evaluated project. The SBDI program is achieving 93.7% of tracked electricity savings. This realization rate is primarily driven by differences between the actual facility operating hours and PSE's assumptions for this program.
   - **Recommendation** – None.
2) **Finding** – The program operating hours assumptions are reasonable even though there is considerable variation in operating hours at the site level savings. There was significant variation in site hours of use within the projects evaluated, but the overall program realization rate demonstrates that current program assumptions are accurate.
   - **Recommendation** – PSE should continue to use the same methodology and assumptions for estimating operating hours.
3) **Finding –** Only one project evaluated did not have all the lighting fixtures replaced that were in the tracking data. Additionally, that same project did not have occupancy sensors installed, which was indicated in the tracking data to be installed on all the replaced fixtures. The source of this discrepancy was not identified. However, even with these

missing fixtures and occupancy sensors, the project is achieving 82% of the tracked savings. Across all the other evaluated projects, quantities of each measure were verified to be installed.

- **Consideration** – PSE should continue with its current quality control practices and ensure to collect all project related parameters to mitigate this risk.

7 COMMERCIAL REBATES – COMMERCIAL KITCHENS AND RESTAURANTS

7.1 Program overview

This section documents DNV's impact evaluation of the Commercial Kitchen and Restaurant Program, also called the Commercial Foodservice Program (CK or CFS). The data used for the impact evaluation period references two subset programs within the CK/CFS program: Downstream data for the entirety of the evaluation period and Midstream data through November 2020. Prior to that date, it is important to note that the Midstream subset of the program data was combined with the Downstream data and evaluated together by DNV. In November of 2020, a third-party vendor was hired to optimize Midstream program delivery and the Midstream program data was split off and tracked separately from the Downstream program data. DNV did not evaluate the Midstream program data after that split off date. DNV did, however, evaluate feedback from midstream equipment distributors who cross both the Downstream and Midstream timelines referenced above.

The Commercial Kitchens and Restaurants Program offers prescriptive incentives for a variety of electric and natural gas energy efficient kitchen equipment. Equipment can be purchased through participating distributors and direct customer-submitted rebate applications. Measures include commercial cooking equipment, ice makers and dishwashers.

7.1.1 Program savings

Table 7-1 shows the tracked energy savings for this program from 2019 to 2021. The program contributed 0.1% of the electricity savings and 3.3% of the natural gas savings tracked across the entire C&I portfolio this biennium. DNV evaluated both the electric and gas savings achieved by this program as the equipment types supported are often the same. The program was the 19th largest C&I electricity program and 5th largest C&I gas program over the biennium. The primary measures driving savings for this program are combination ovens, fryers, and steam cabinets. The reduction in savings for 2020 and 2021 is believed to be a direct result of the impact the COVID-19 pandemic has had on this industry and its equipment supply chain.

Table 7-1. Tracked program savings, commercial kitchens

Program Year	Unique Projects	Tracked Electricity Savings (kWh)	Percent of Tracked C&I kWh Savings	Tracked Natural Gas Savings (therms)	Percent of Tracked C&I therm Savings
2019	249	382,525	0.3%	113,058	6.4%
2020	116	155,037	0.1%	65,225	4.3%
2021	31	25,271	0.0%	28,713	2.1%
2020/2021	147	180,308	0.1%	93,938	3.3%

7.2 Impact evaluation

DNV used a project-specific approach for estimating evaluated savings. The following steps were completed:

1) Documentation review: Reviewed tracking data to identify savings reported, units reported, and measure ID used. Review of all measure case documentation to understand the eligibility requirements, savings algorithms, and savings values used to support reported savings.
2) File review: Reviewed sampled project files to verify reported information through invoices, applications, and other provided documentation.
3) Data collection planning: Identified the key input parameters and stipulated values to research and how they should be verified (i.e., file review, phone interview, internet lookup, etc.). Then, created a list of interview questions.

4) Data collection: Interviewed sampled participants by telephone using the survey instruments developed for this purpose. Additionally, rated performance specifications were collected from make and model lookups.
5) Analysis: Estimated evaluated savings using the data collected through surveys and model performance specification reviews to update key parameters to the savings calculations. DNV calculated savings using the reviewed measure case algorithms. The measure assumptions were replaced with key parameters when available.

7.2.1 Sample design

DNV used a stratified random sampling approach to select an efficient representative sample of projects for evaluation designed to provide reliable savings estimates across program fuels. The sample design for this program included:

- Sample stratification and sampling at the project level, using unique project numbers provided in the tracking data. All measures completed within a single sampled project of the same technology were therefore selected for evaluation.
- Stratification by primary fuel type to ensure the evaluation results include measures saving both gas and electricity.
- Stratification by size of savings reported to increase the magnitude of savings evaluated and the accuracy of the estimated realization rate.

The sample design resulted in the selection of 30 unique projects for evaluation which included the installation of 106 measures across seven different measure types. Some projects had multiple product types. Table 7-2 shows the sample design and primary sample counts by stratum. Table 7-3 shows the breakdown of projects sampled and the quantity of equipment.

Table 7-2. Kitchens sample design summary

Compliance Program	PSE Program	Sampling Phase	Project Size	Projects in Sample Frame	kbtu in Sample Frame	Primary Sample
Commercial Rebates	Commercial Kitchens	Phase I	Small	167	3,249,125	5
			Medium	38	3,905,065	5
			Large	25	4,397,995	5
		Phase II	Small	43	761,627	3
			Medium	13	885,815	3
			Large	7	1,017,176	3
			Extra-Large	6	1,322,968	3
			XX-Large	3	1,984,411	3
		Totals		**302**	**17,524,182**	**30**

Table 7-3. Commercial kitchen sample design

Product Type	Projects	Number of Units
Dishwasher	9	12
Fryer	18	39
Hot Food Holding Cabinet	1	1
Ice Machine	6	7
Combination Oven	15	29
Double Rack Oven	2	6
Convection Oven	8	8
Steam Cooker	2	4

7.2.2 Documentation and file review

DNV reviewed the tracking savings methodologies documented in PSE's measure case files. Each equipment type has a measure case file that documents each Measure ID and unit energy savings and the source of the savings values. All product types except for dishwasher reference California workpapers. Dishwasher savings are based on the ENERGY STAR Commercial Kitchen Calculator with modified inputs. The original source documents were obtained, and the savings were compared to the measure case files. For measures that rely on California workpapers, the savings were recreated using the provided algorithms and summary tables.

In general, the measure case savings were found to be reasonable and appropriate. However, for combination ovens the associated workpaper appears to use dated baseline and efficient case idle power assumptions. When manufacturer rated performance specifications are available for the installed equipment, they can be applied to the efficient case in energy savings. However, for the combination ovens, this was not appropriate as the source of the baseline idle energy was dated and appears to be overstated. DNV contacted Frontier Energy's foodservice division, Fishnick (https://fishnick.com/), an organization dedicated to researching foodservice equipment, to inquire about what a reasonable baseline idle power assumption might be. It appears that more recent baseline or conventional combination oven performance information is not available. ENERGY STAR offers some assumptions about these parameters, but the basis for those assumptions is unavailable and they cover limited oven size categories. Therefore, for evaluated savings DNV adopted the difference in idle power provided in the California workpapers as the basis for idle saving, rather than using the installed equipment performance as the efficient idle power. If the installed equipment rated idle power were applied, savings would be overestimated.

The equipment hours of use for all but ice makers assume equipment operates 12 hours per day, 365 days per year. Various TRMs, the ENERGY STAR Commercial Calculator, and input from Fishnick suggest that these hours of use assumptions are reasonable. However, the hours can vary considerably from project to project depending on the market segment.

For the file review, DNV compared project documentation to the tracking data. This includes things like service address, equipment type and quantity, and invoice model numbers. For all projects, the project documentation was complete and aligned with the tracking data.

7.2.3 Data collection

The only data collection method for this program was a telephone interview due to the health and safety risks of a site visit associated with COVID-19. The questions and overall evaluation approach for each measure were guided by the measure eligibility requirements, size and performance characteristics, complexity, available tracking data, and savings approach (stipulated or calculated values). For all measures, at a minimum DNV verified installation and active operation, confirmed the business type, reviewed business hours, and asked about pre-retrofit conditions when applicable. All measures also included measure-specific parameter or condition questions.

7.2.4 Measure analysis

DNV estimated evaluated savings for all sampled measures with completed data collection. Inputs for the evaluated savings calculations were determined from the most valid data source including the telephone interview, tracking data, project file review, tracking savings and other independent research. We reviewed the tracking savings algorithms and found them to be appropriate. Therefore, we used the same algorithms and modified parameters when better data was available. Excel workbooks were used to process and document the analysis and evaluated savings results and assumptions. Key elements of this analysis are:

- Except for combination ovens, the performance specification of the installed efficient equipment at each site was used in savings calculations.
- For combination ovens, it was determined that the delta efficiency between baseline and efficient cases in the measure case savings are reasonable based on the best available information. However, there is high uncertainty around what the appropriate baseline efficiency should be, as discussed in the documentation review section above. For all product types, the installed equipment exceeded the measure case efficient equipment performance specifications. Therefore, the evaluated savings are higher than the tracked savings due to this modification.

Table 7-4 shows the impact results for the evaluated projects. Site-specific equipment hours of use are applied to the evaluated savings calculations when site contacts were able to provide the schedule. For projects where the site contact was uncertain about the hours of use, the measure case default assumptions were used. There were a number of sites that do night operate for at least a few holidays. Some sites operate five or six days per week instead of the measure case value of seven days per week. Additionally, a school indicated that they did not use cooking equipment during the summer break. Many of the sites operated the equipment close to 12 hours per day. However, others operated fewer hours per day. Additionally, a senior care facility and a school indicated that the equipment was only used on days that specific food was prepared. The result of adjusting hours of use when known, was a reduction in the savings. This can be seen for the one project with steam cookers. This equipment was installed at a school and operates much less than the measure case value of 4,380 hours (12 hours per day, 365 days per year).

Gas oven measures have a realization rate of between 78% and 71%. The low gas oven realization rate is mostly attributed to a grocery store chain reporting lower hours of use across all of their stores. This impacted many projects in that product type and fuel type as the same equipment was installed at each location. There was nothing fundamentally different between the electric and natural gas ovens that impacted the hours of use. It just happened that most of the equipment with hours of use adjustment were natural gas.

Table 7-4: Evaluated project impact evaluation results by product type

Product Type	Unique Projects	Tracked kWh Savings in Evaluation Sample	Evaluated kWh Savings in Evaluation Sample	kWh Gross Realization Rate in Evaluation Sample	Tracked Therm Savings in Evaluation Sample	Evaluated Therm Savings in Evaluation Sample	Therm Gross Realization Rate in Evaluation Sample
Dishwasher	2	-	-	-	1,198	1,420	119%
Fryer	7	-	-	-	7,124	6,383	90%
Ice Machine	1	2,044	2,806	137%	-	-	-
Combination Oven	17	100,518	98,413	98%	20,725	16,085	78%
Double Rack Oven	1	-	-	-	4,208	2,990.68	71%
Convection Oven	3	-	-	-	1,928	1,399.01	73%
Steam Cooker	1	-	-	-	5,190	2,462.84	47%
Total	**31***	102,562	101,219	2,806	40,373	30,741	76%

**One project installed a fryer and a dishwasher*

7.2.5 Final evaluated sample

Table 7-5 shows the final evaluation sample achieved. DNV successfully recruited customers associated with 31 projects for evaluation. Final impact evaluation results were calculated based on post-stratification weights of the combined Phase I and Phase II sample frames.

Table 7-5. Achieved kitchens sample

Compliance Program	PSE Program	Sampling Phase	Project Size	Projects in Sample Frame	kbtu in Sample Frame	Achieved Sample
Commercial Rebates	Commercial Kitchens	Post-Stratification	Small	207	3,725,058	5
			Medium	46	3,788,485	8
			Large	31	4,858,803	14
			Extra-Large	18	5,151,835	4
		Totals		**302**	**17,524,182**	**31**

7.2.6 Program realization rates

Table 7-6 shows the impact results of the evaluated projects expanded to the evaluation sample. The gross realization rates for the evaluation sample are 104% and 79%, for kWh and therms respectively. The evaluated kWh savings are slightly higher than the tracked savings primarily due to the actual installed equipment rated performance being better than the measure case for ice makers. The low therm realization rate is primarily due to hours of use adjustments. The reduction in hours of use and the resulting reduction in savings was slightly counteracted by the installed equipment performance being better than the measure case assumptions for most measures.

Table 7-6. Final Commercial Kitchens impact evaluation results

Fuel	Number of Projects Evaluated	Realization Rate	Relative Precision at 90% Confidence Interval
Electricity (kWh)	5	104.0%	8.9%
Natural Gas (therms)	26	79.4%	9.8%
Total (kbtu)	**31**	**97.0%**	**7.2%**

7.3 Process evaluation

In this section we present interview results with kitchen equipment retailers to gather insights on PSE's Commercial Kitchen Program.

7.3.1.1 Retailer interviews

This section summarizes results from telephone surveys conducted with Commercial Kitchen (CK) retailers. DNV conducted retailer interviews to supplement interviews with customers for which a very few surveys were completed. The CK program operates as both a midstream and downstream rebate program model. Customers can claim rebates on their own or if they purchase from one of the participating retailers, they may get an instant rebate. Many retailers offer their customers instant rebates and submit the required documentation to PSE's online "IRIS" rebate portal.

For the retailer interviews, DNV sought to identify program feedback and ways in which the program could be improved in order to bolster participation and measure uptake. The five broad research topics included:

- Company Characteristics
- Program Awareness
- Levels of Participation
- Comparison to other Programs
- Satisfaction with Program Delivery
- Barriers
- Decarbonization Measures

7.3.1.2 Sample frame

DNV contacted "installers" sourced from the 2019-2020 program year (PY) tracking data. A total of 54 unique installers are listed in the tracking data among the 430 total rebates processed in PY 2019-20. DNV interviewed five local (within PSE service territory) retail store managers. We targeted interviews among the top performing companies who sold the largest volume of rebated equipment. The interviews represent 59% of all PY 2019-20 rebated equipment (Table 7-7).

DNV did not pursue interviews among trade allies who delivered fewer than three rebates in PY 2019-20, national chain companies, individual companies (program participants) who self-install, or companies located outside of Washington state. DNV attempted two additional surveys with local retailers, but unfortunately these two resulted in a refusal and non-response.

Table 7-7. Commercial Kitchen Retailer interview sample

CK Installations	Total Rebates in PY 2019-20	Count of Installers in PY 2019-20	Completed Interviews by DNV	Percent of Rebates Represented in Interviewees
< 5 rebates	64	39	1	1%
5 to <20	104	11	1	2%
20 to 140	262	4	3	56%
Total	**430**	**54**	**5**	**59%**

7.3.1.3 Results from Commercial Kitchen retailers

This section provides findings from the interviews DNV conducted with CK retailers and designers. DNV first reports the company characteristics (firmographics) of the companies we interviewed. Next follows the discussion on rebate awareness, such as awareness of the rebated equipment and experience with other CK programs. Following this discussion, DNV reports on and program satisfaction. Finally, DNV discusses barriers to program growth, overcoming these barriers, and selling decarbonization measures.

7.3.1.4 Company characteristics

We collected the following information on company characteristics:

- Respondent title
- Product distribution (e.g., whether they sell, install, or service)
- Percent of customers that are buying rebated equipment

DNV spoke with general managers and sales managers and other mid-level staff at these companies.

All the companies interviewed sell equipment. One provides service as well as sales, and another provides design and equipment selection services. Most sales for these companies' market share are equipment sales that serve existing kitchens (buildings). All companies but one have equipment in-store; another has limited in-store foot traffic due to the COVID pandemic.

The survey asked what percent of customers are buying rebated equipment. Responses ranged from 2% to 20%, with the majority selling about 5% or less.

Two additional local retailer interviews were attempted and resulted in an early termination/refusal. These companies expressed a lack of interest in the program, and one stated they required the customer to complete the application process on their own and thus had little to no involvement or interest in the survey. These two retailers accounted for fewer than 20 total rebates processed in PY 2019-20 out of the 430 pieces of rebated equipment sold.

7.3.1.5 Rebate awareness

DNV asked respondents several questions to determine their awareness of the PSE rebates and related aspects. The survey questions covered the following:

- Awareness of the rebates and source for information
- How actively has their company been promoting rebates
- Experience with other local utility sponsored CK programs

All respondents we spoke with were familiar with the CK program and several were able to cite the PSE staff that makes in-person visits by first name. Retailers were aware of PSE rebates. They expressed interest, but were unaware of rebates for cold food storage (refrigerators and freezers) and for maintenance and repair (e.g., compressors in refrigeration).

7.3.1.6 Levels of participation

DNV asked respondents to identify how actively they are promoting PSE's rebates. Respondents used a five-point scale to gauge program activity, where 1 is "not very active" and 5 is "very active." None of the respondents reported that they were "very active" in promoting the PSE rebate program. The three most active retailers, with the largest volume of sales, stated they were "somewhat active" (or a 4 out of 5), and the other two retailers rated a 3 and 2 on the 5-point scale.

DNV asked respondents who reported an average to low level of program activity to elaborate on why they were not more active in promoting the program. Verbatim responses to this question are below:

- "Suppliers are backordered we're just trying to get any equipment to our customers."
- "We push the Next Gen, an economy line, product and most of these sales about 60-70% don't qualify for the rebates."
- "We leave it up to the customer to handle the rebate applications." [This survey was not completed in full.]

7.3.1.7 Comparison to other programs in Washington

DNV asked respondents to reflect on similar programs that they have participated in, to compare and contrast these programs, and to identify best practices. The respondents we spoke with had processed rebates in the recent past or had limited experience with Cascade Gas, Lewis County PUD, Tacoma Power, and Seattle City Light.

All the respondents described PSE's CK program as equal to or better than any other utility program they worked with. The one area suggested for improvement was related to the rebate amounts. Respondents stated that that PSE's incentives are good, but not as good as some of the others.

7.3.1.8 Satisfaction with program delivery

DNV asked respondents to provide feedback on their experience with the rebate program. The aspects that retailers were most impressed with are:

Streamlined online application. The online IRIS portal that streamlines the submission process was identified as a much better system compared to other utilities that are still requiring applications to be processed through other means.

"While there was a learning curve the web-based portal is so much easier." The online portal was received as a significant upgrade to the overall program delivery.

Instant rebates for customers. Retailers like the ability to provide an instant point-of-sale rebate. And for those that take the extra step and help customers evaluate the return-on-investment, the incentivized measures become a very attractive offer. However, for one retailer, while they liked the ease of submitting it, they are unable to carry the debt for the duration of time it takes to get the refund, thus this is one reason they are not very active in the program. To get them more engaged the program would need to not only expedite the rebate turnaround time but would also need to work with them on promoting equipment that qualifies as their target market is an economy line product.

Dedicated program staff. Multiple retailers also expressed they were impressed with "*our dedicated PSE representative who is very helpful*" and the ability to get assistance when needed.

7.3.1.9 Barriers to growth

The survey asked respondents questions related to how the rebates are incorporated into their sales, if the rebate has any effect on their ability to sell commercial kitchen equipment, and what factors might prevent them from selling the most EE options available. In this section we distill barriers for EE sales.

The message was consistent among retailers, there are forces outside program influence that drive demand for equipment. At a fundamental level, demand is inextricably tied to the strength of the economy, and in this waning pandemic era the manufacturing activity and a resource shortage (metal) has constrained the industry. Additionally, sales were down in 2020 due to the pandemic (closure of restaurants) for the largest retailer by an estimated 60%. Factors that limit the sale of rebated equipment and general retailer barriers to participation was the limited supply, no products available to sell.

All respondents explained that suppliers are backordered and getting equipment is a significant issue. Challenges meeting the demand results in customers making decisions based on availability. The following open-ended comments illustrate the supply barrier:

- "In years prior we would either carry the product at the store or have it in 2-3 weeks, now that same product could take as long as January 2022 to acquire – it's a big issue and virtually nothing is unaffected by this."
- "The delays in certain equipment can take as long as 12 weeks."
- "Getting product can take as long as 8-10 months and prices are also higher."
- "Rebates make the products price competitive but right now we just don't have the product to sell. We're not in a position to get equipment."

While the program is constrained in improving the supply-side issue (based on the current program design), the survey found additional barriers:

- Limited demand (PY2020)
- Retailers are aligned with certain (economy line) manufacturers who don't carry rebated models. For one retailer, between 60-70% of the equipment they carry does not qualify
- No rebates, e.g., refrigeration/freezer
- Insufficient incentives, e.g., $50 – incentives insufficient to move consumer demand
- Existing equipment / early replacements – incentives are not big enough to promote early replacement and mainly influence purchases based on equipment failures or new businesses
- Lack of interest and not enough incentive to motivate them, thus they require customers to apply on their own

7.3.1.10 Overcoming barriers

DNV asked what PSE could do to help promote and sell EE equipment. The following suggestions were provided:

Quarterly visits to check in with the sales teams. Remind retailers of the program qualified equipment and potentially educate new staff. As one respondent put it "*when they come by, we seem to sell more rebated equipment after the weeks that follow."* Many respondents cited PSE program staff is already meeting their needs while others are eager for a visit now.

In-store advertising. Another recommendation is to assess qualified equipment and provide retailers updated marketing materials. Specifically, walk the stores to identify which equipment is eligible. If not doing so already, work with the PSE program marketing team to provide retailers with stickers, magnets, clings etc., that can be affixed to the eligible equipment. Help retailers who do not do in-store visits with co-branding by, for example, labelling rebated equipment in the digital space. One respondent felt the program was doing a good job at reaching local businesses and that about 20% or more of businesses know about the rebates before walking into the store while others thought the program should do more direct marketing to customers.

Upselling with lifecycle or ROI cost calculators. Instant rebates and ROI calculators have been effective methods for some of the more sophisticated retailers to upsell EE equipment. However, not all retailers have the tools or know-how to calculate the rebates and ROI. Work with retailers to determine those who are not using these tools and offer hands on assistance. The program may go as far as developing a calculator that retailers can plug-and-play for the products they sell. As one put it, *"It helps, for ovens there is a significant energy savings that are huge to the customer when they look at the cost of operation and not just the first cost. It is well worth it to look at operating costs and we help them do that."*

Evaluate different incentive strategies. Many retailers explained incentives need to be in the order of a couple hundred to move the demand and those less than $100 are inadequate. Retailers expressed desire for different incentive strategies such as:

Continue offering enhanced incentives, sometimes referred to as "bonus or kicker" incentives that offer additional monies can help improve the sale of early replacements. One retailer recalled such a program with kicker incentives for which many customers were willing to replace their existing equipment early because the incentives were very attractive.

Retailers would like to see the program offering incentives for freezers and refrigeration.

Retailers who provide service are unaware of other refrigeration incentives such as compressor replacements and would like to learn more about incentives that support the repair of existing systems. Retailers who have service contracts with big box stores (e.g., Grocery) are in a position to improve the EE of existing refrigeration, freezer, and related equipment.

The program may want to evaluate an upstream stocking model with the high-volume retailers where retailers provide sales data to measure program sales of EE equipment and establish a set of goals to upsell EE equipment. The program in turn will provide incentives to stock EE equipment, and incentives are paid directly to retailers with minimal transactional paperwork required. While retailers would like to see refrigeration offerings, current state code requirements for most traditional CK refrigeration equipment results in an Energy Star certified baseline. At least one retailer expressed interest in this alternative incentive model and another that couldn't carry the debt (delay in rebate payment) maybe a candidate as well.

7.3.1.11 Decarbonization measures

Lastly the survey asked to what extent customers are interested in EE and all electric (decarbonization) equipment. We obtained the following perceptions and insights:

- *"Induction is not practical, not affordable, owners care more about EE and less about carbon, and there is still a strong preference for gas."*
- Low confidence in reliability. "*After working for the largest manufacture of induction I've learned it doesn't hold up, so we do not recommend it*."
- Induction requires special training to use, and more expensive/not the same type of pots and pans, which is a burden for kitchen owners to switch over.
- Induction is a good fit for food trucks but otherwise (perceived) as limited in demand.
- The City of Seattle building code officials are phasing out natural gas in new construction however this will have no effect on existing commercial kitchen demand for induction cooking.

7.4 Findings and recommendations

This section documents DNV's findings, recommendations, and considerations associated with this program.

1) **Key Finding** – The evaluation team verified the quantity and equipment type installed and in use for all of the evaluated projects. The measure case savings algorithms for all measures are appropriate. The realization rates reflect adjustments to the measure case savings for hours of use and installed equipment efficiency. The Commercial Kitchens program is achieving 104.0% of tracked electricity savings and 79.4% of tracked natural gas savings. This realization rate is primarily driven by differences between the actual facility operating hours and PSE's assumptions for this program.
   - **Recommendation** – None.

2) **Key Finding** – The Commercial Kitchens program is achieving 97% of tracked site energy savings, when electric and gas projects are combined. This realization rate demonstrates the operating hours assumptions used by the program are reasonable when all participants are combined.
   - **Recommendation** – None.

3) **Finding –** The primary adjustment made to savings resulted from reported hours of use. The measure case hours of use are consistent with other sources and reasonable as an average across a large sample of kitchen equipment. However, there is considerable variation depending on the facility type. Schools, senior care facilities, catering, and one grocery store chain reported considerably lower hours of use than the measure case assumptions.
   - **Consider** a more conservative hours of use assumptions that better represents the mix of facility types in the program.

4) **Finding** - The combination oven measures make up a large percentage of energy savings in this program. During the review of the measure cases for this product type, it was revealed that dated sources are the basis for baseline and efficient equipment types. The difference between a new standard efficiency oven and high efficiency option available on the market may be comparable to the implied measure case change in efficiency. However, there is little information available to indicate what standard efficiency oven performance specifications are.
   - **Consider** revising the measure case baseline and efficient cases performance specifications. This includes the steam mode idle power, convection mode idle power, and cooking efficiency. Once supply chain disruptions from the COVID-19 pandemic normalize, consider a market study of the baseline case for lost opportunity measures installed through this program.

8 APPENDICES

8.1 Appendix A: Sample design

This appendix discusses our approach to sample development for the selected compliance programs. First, we summarize the program participants for the chosen compliance programs at the time of sampling, then discuss our sample design approach for the programs and lay out the preliminary sample design for the evaluation (selection for Phase I). The structure of the Phase II sample is the same. However, DNV did update the number of projects selected based on Phase I results and updated program tracking data.

8.1.1 Historic participant data

Program tracking data with customer contact information and program enrolment were provided by PSE. For program year 2019 (PY2019), there were 11,890 individual measures installed in the three compliance programs to be evaluated by DNV: Commercial Industrial New Construction, and Commercial Rebates.

Table 8-1 presents the electric (kWh), gas (therm), and combined site savings (kBtu) for each compliance and PSE program. For the new construction program measures were further separated by end-use.

Table 8-1. Preliminary sample frame, 2019 annual program savings

Compliance Program	PSE Program	Accounts	kWh Total Savings	Therm Total Savings	kBtu Savings (kWh+therms)
Commercial Industrial New Construction	Boiler - Hot Water - Custom	1	-	18,014	1,801,357
	Chiller - Custom	1	70,778	-	241,505
	Compressor or Dryer or Receiver - Custom	1	55,060	-	187,873
	Lighting - Custom	23	11,258,946	-	38,417,118
	Lighting Power Density Reduction - Custom	10	3,252,445	-	11,097,803
	Refrigeration - Custom	2	1,076,303	10,546	4,727,073
	Whole Building Design - Custom	12	1,324,840	39,985	8,518,946
	Total	50	17,038,372	68,545	64,991,675
Commercial Rebates	Commercial Kitchens	271	382,525	113,058	12,610,759
	Lighting to Go	7,793	11,360,946	-	38,765,158
	Small Business Direct Install	3,644	6,666,949	689	22,817,443
	Total	11,708	18,410,420	113,747	74,193,360

8.1.2 Sample design approach

Our initial sample design approach followed the principals of model-based statistical sampling (“MBSS”) to construct the sample design and provide the framework for the subsequent analysis. MBSS techniques have been used to create a very efficient and flexible structure for collecting data on countless energy efficiency evaluations, demand response evaluations, and interval load data analyses, e.g., load research and end-use metering, projects.

The key to this project was to develop statistically reliable data that could be dynamically analyzed. In 2021, DNV compared 2020 program achievements to this initial sample design and made adjustments where necessary to ensure the final sample

selected represented program achievements over the biennium. The following sections fully describe the sample design and analysis approach that we used in this project.

8.1.3 Background

Conventional methods are documented in standard texts such as Cochran's Sampling Techniques.[3] MBSS is grounded in theory of model-assisted survey sampling developed by C.E. Sarndal and others.[4,5] MBSS methodology has been applied in load research for more than 30 years and in energy efficiency evaluation for more than 20 years. This fusion of theory and practice has led to important advances in both model-based theory and interval load data collection practice, including the use of the error ratio for preliminary sample design, the model-based methodology for efficient stratified ratio estimation, and effective methods for domains estimation.

MBSS and conventional methodologies are currently taught in the Association of Edison Illuminating Companies' Advanced Methods in Load Research seminar. MBSS methodology is also documented in The California Evaluation Framework.[6] MBSS has been used successfully for decades in countless load research and program evaluation studies. It has also been examined in public utility hearings and in at least two Electric Power Research Institute, Inc. (EPRI) studies.

8.1.4 The role of the statistical model

MBSS uses a statistical model to guide the planning and the sample design. The parameters of the model, especially the error ratio, are used to represent prior information about the population to be sampled. The model describes the nature of the variation in the relationship between any target y variable of the study, in our case the normalized daily consumption of the customer, and one or more x variables that can be developed from known billing data and other supporting information. The x variable is usually a measure of the size of the customer, e.g., annual use, and assumes good information is available in the billing to support the analysis. The model is used to help choose the sample size n, to assess the expected statistical precision of any sample design, and to help formulate a sample design that is efficiently stratified for ratio estimation using case weights.

The model is used as a guide to the sample design, but the results of the study itself are not strongly dependent on the accuracy of the model.[7] Once the sample design is selected, the subsequent analysis of the data is based only on the sample design and not on the model used to develop the sample design. The resulting estimates will be essentially unbiased in repeated sampling and the confidence intervals will also be valid, provided that the sample design has been followed to select the sample customers. The results will be consistent with traditional sampling theory as found in texts such as Cochran's Sampling Techniques and consistent with standard load and market research practice.

8.1.5 Stratified ratio estimation

We assumed that the data collected and analyzed in the study is for a given population of N accounts in a given customer class. In this study, annual energy savings were the unit of measure. We let y denote any customer characteristic to be determined and we let x denote any suitable characteristic of the customer that is known from tracking data such as measure, quantity, project, or customer. We define the population ratio B by the equation

$$B = \frac{\sum_{i=1}^{N} y_i}{\sum_{i=1}^{N} x_i}.$$

3 Sampling Techniques, by W. G. Cochran, 3rd. Ed., Wiley, 1977.
4 Model Assisted Survey Sampling, by Carl Erik Sarndal, Bengt Swensson and Jan Wretman, Springer-Verlag, 1992.
5 Wright, R. L. (1983), "Finite population sampling with multivariate auxiliary information," Journal of the American Statistical Association, 78, 879-884.
6 The report can be downloaded from the webaccount http://www.calmac.org/calmac-filings.asp
7 Other methods, called model-dependent sampling, are much more dependent on the accuracy of the model. Such methods are not commonly used in load research applications since they would be more difficult to defend than MBSS and conventional methods.

Here the summations are over the entire N units (e.g., customers) in the target population. We note that the population mean or total of y is equal to B times the population mean or total of x. The latter is assumed to be known from the billing or tracking data.

We assumed that a sample of n customers is selected following a stratified sample design. For each sample customer we define the case weight w to be equal to the number of customers in the target population within the stratum containing the given customer divided by the number of customers in the sample within the given stratum. The case weight is used to avoid any bias that might otherwise arise from the different sampling fractions used from one stratum to another.

Using the case weight, we define the combined ratio estimator of B by the equation:[8]

$$b = \frac{\sum_{i=1}^{n} w_i \, y_i}{\sum_{i=1}^{n} w_i \, x_i}$$

Then, if desired, the population mean or total of y can be estimated as b times the population mean or total of x, known from the tracking data. Using the case weights, we calculate the relative precision at the 90% level of confidence in three steps:

1. Calculate the sample residual $e_i = y_i - b\,x_i$ for each unit in the sample.
2. Calculate $se(b) = \frac{\sqrt{\sum_{i=1}^{n} w_i(w_i-1)\ e_i^2}}{\sum_{i=1}^{n} w_i x_i}$. [9]
3. Calculate $rp = \frac{1.645\ se(b)}{b}$.

A 90% confidence interval for B is calculated using the equation $b \pm rp\ b$. A confidence interval for the mean or total can be calculated in a similar way.

We can also use the sample data to estimate a measure of population variability called the error ratio, denoted er. The error ratio is the key determinant of the expected relative precision, along with the sample size n. We estimate the error ratio from the sample using the following equation:

$$\hat{er} = \frac{\sqrt{\left(\sum_{i=1}^{n} w_i \ e_i^2 / x_i^{\gamma}\right)\left(\sum_{i=1}^{n} w_i \ x_i^{\gamma}\right)}}{\sum_{i=1}^{n} w_i \ y_i}$$

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[8] This equation gives the same result as the conventional stratum-weighted equation: $b = \frac{\sum_{h=1}^{L} N_h \, \bar{y}_h}{\sum_{h=1}^{L} N_h \, \bar{x}_h}$.

[9] The conventional equation is $se(b) = \frac{1}{\sum_{h=1}^{L} N_h \, \bar{x}_h} \sqrt{\sum_{h=1}^{L} N_h^2 \left(1 - \frac{n_h}{N_h}\right) \frac{s_h^2(e)}{n_h}}$ where $s_h^2(e) = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} (e_i - \bar{e})^2$. Our equation assumes that $\frac{1}{n_h - 1} \sum_{i=1}^{n_h} (e_i - \bar{e})^2$ is approximately equal to $\frac{1}{n_h} \sum_{i=1}^{n_h} (e_i)^2$ in each stratum.

The parameter γ (gamma) is defined in the next section. In practice, it is usually taken to be 0.8. We will not attempt to interpret the preceding equation here, but we will define both the error ratio and gamma in the following section.

8.1.6 The ratio model

The ratio model is used to choose the appropriate sample size n, to assess the expected statistical precision of any stratified sample design, and to develop an efficiently stratified sample design. The ratio model describes the relationship between y and x for the set of all units in the population. The model consists of two equations called the primary and secondary equations respectively:[10]

$$y_i = \beta\, x_i + \varepsilon_i$$

$$\sigma_i = sd(\varepsilon_i) = \sigma_0\, x_i^{\gamma}$$

Here i denotes any customer, account, or HVAC units in the target population. $x_i > 0$ is usually known throughout the population. The primary equation describes the relationship between the y variable of interest, e.g., normalized daily use, and the x variable used in the ratio estimate, i.e., actual daily use. Since we assume that $E(\varepsilon_i) = 0$, the primary equation can also be written as $\mu_i = E(y_i) = \beta\, x_i$. Here μ_i denotes the expected value of y for unit i. The primary equation says that under the model, the expected value of y_i is equal to a fixed constant β times the known x_i.

The quantity, $\varepsilon_i = y_i - \mu_i$, is called the residual. The N residuals are considered to be N independent random variables. The standard deviation of ε_i is denoted as σ_i. We refer to σ_i as the residual standard deviation of each customer i. The secondary equation is used to estimate the residual standard deviation and to guide the development of an efficient sample design.

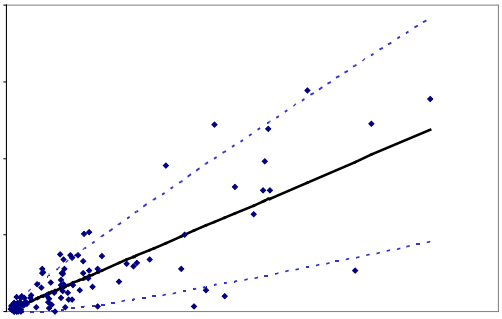
To summarize, under the ratio model, the target variable y_i is a random variable with expected value μ_i and standard deviation σ_i. The expected value μ_i is determined by the primary equation of the model. The standard deviation σ_i is determined by the secondary equation of the model. There are three parameters in the model: β (beta), σ_0 (sigma-naught), and γ (gamma).

Figure 8-1 shows an example. The points of the scatterplot represent the values eaof (x, y) for each site in the population. The solid line represents the equation $y = \beta\, x$, i.e., the expected value of y given x. This is a line through the origin with slope given by the parameter β. The two dashed lines represent the equation $y = \beta\, x \pm \sigma$, i.e., the one-standard deviation interval around the expected value. Here $\sigma = \sigma_0\, x^{\gamma}$ so the dashed lines are determined by the two parameters σ_0 and γ.[11]

[10] The x-variable in the primary equation is sometimes different than the x-variable in the secondary equation. In the SAS modules, we refer to the later as the stratification variable. For simplicity, we will not make this distinction in the theoretical discussion given here.

[11] The role of gamma can be seen by rewriting this equation as $\log(\sigma) = \alpha + \gamma\, \log(x)$ where $\alpha = \log(\sigma_0)$. This shows that for each site in the population the log of sigma is a constant plus gamma times the log of the value of x for the site. Gamma is the slope in the relationship between the log of x and the log of sigma.

Figure 8-1. Example of a ratio model of a stratified sample



Now we are finally positioned to define the error ratio. The error ratio is defined by the equation:

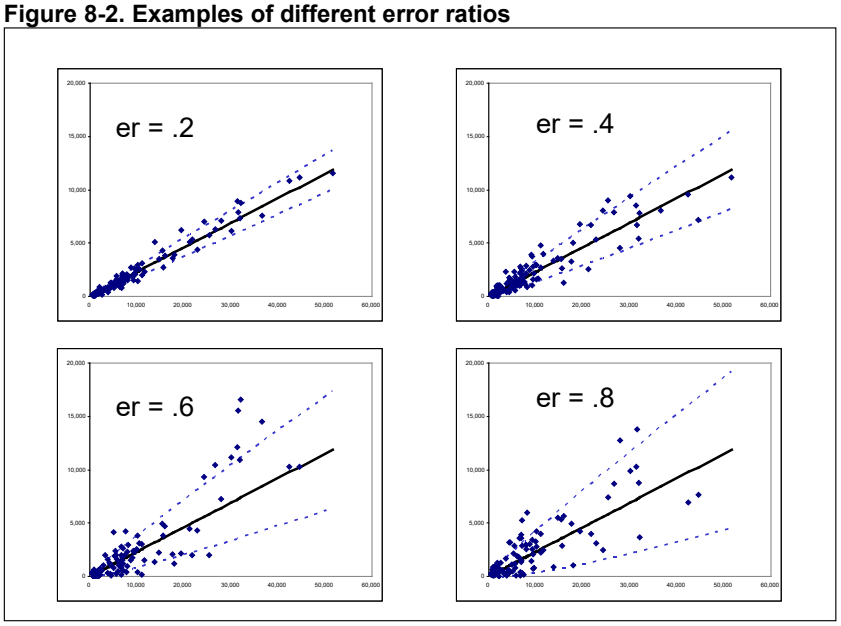
$$er = \frac{\sum_{i=1}^{N} \sigma_i}{\sum_{i=1}^{N} \mu_i}$$

The error ratio can be regarded as an alternative parameter to σ_0 since under the preceding ratio model, σ_0 can be calculated from the error ratio using the equation

$$\sigma_0 = er \frac{\sum_{i=1}^{N} \mu_i}{\sum_{i=1}^{N} x_i^{\gamma}}$$

The error ratio is the key measure of variability when stratified ratio estimation is to be used to analyze the data. Figure 8-2 shows some examples. If the error ratio is close to zero, there is a strong relationship between x and y. If the error ratio is larger, the relationship is weaker.

Figure 8-2. Examples of different error ratios



8.1.7 Choosing the sample size

We assumed that the ratio model provides a reasonably accurate description of the relationship between y and x in the target population. We also assumed that the sample design will be efficiently stratified as discussed previously and that the analysis will use stratified ratio estimation.

Under these assumptions and the added assumption that the population size N is large, then the expected relative precision is given by the equation: $rp = z\frac{er}{\sqrt{n}}$. Where z is the standard normal deviate or 1.645 for 90% confidence and 1.96 for 95% confidence, “er” is the error ratio and “rp” is the required relative precision. If the population is relatively small, the finite population correction factor can be added, giving

$$rp = z\sqrt{1-\frac{n}{N}}\frac{er}{\sqrt{n}}.$$

In Cochran, the relative precision “rp” is referred to as the desired relative precision “D.” If D, is specified, then the preceding equations can be solved to determine the required n. If the population size N is large, we have

$$n = \left(\frac{z\ er}{D}\right)^2.$$

Please note, the error ratio (er) and the z-value has a modest impact on the sample size whereas the desired relative precision has a significant impact. For example, halving the desired relative precision from ±10% to ±5% effectively quadruples the sample size.

If the population is small, the sample size can be calculated in two steps.

First, calculate $n_0 = \left(\frac{1.645\ er}{D}\right)^2$. Then calculate $n = \frac{n_0}{1+n_0/N}$. These equations and some reasonable assumptions are generally enough to develop a preliminary plan.

8.1.8 Preliminary sampling design

For this project, we examined the required sample size to achieve 90% level of confidence at ±10% precision for each compliance program across the two-year study. For planning purposes, a preliminary sample design estimate of precision

for the combined 2020 and 2021 program years was developed by projecting double the 2019 measures and program total tracking savings (kBtu) to estimate 2020-2021 program enrollment.

Table 8-2 presents the sample size requirements based on the program tracking savings data available for program participants. For this exercise, we elected to choose conservative error ratios for each program based on prior experience in evaluating similar energy efficiency programs. For lighting programs, we chose an error ratio of 0.6, for commercial kitchens and small business direct install an error ratio of 0.8, and for all other programs an error ratio 1.0. Of course, the true error ratio for each end use will not be known until the data is collected and analyzed. After the initial sample is analyzed the error ratios will be reviewed, any future updates to the sample design will incorporate updated error ratios.

Table 8-2. Preliminary sample design

Compliance Program	PSE Program	Accounts (2xPY2019)	Total kBtu	Error Ratio	Planned Sample	Expected Relative Precision
Commercial Industrial New Construction	Boiler - Hot Water - Custom	2	3,602,714	1.00	2	0%
	Chiller - Custom	2	483,009	1.00	2	0%
	Compressor or Dryer or Receiver - Custom	2	375,745	1.00	2	0%
	Lighting - Custom	46	76,834,237	0.60	23	15%
	Lighting Power Density Reduction - Custom	20	22,195,606	0.60	10	22%
	Refrigeration - Custom	4	9,454,146	1.00	4	0%
	Whole Building Design - Custom	24	17,037,892	1.00	15	26%
Commercial Industrial New Construction	Total	100	129,983,349	0.70	58	10%
Commercial Rebates	Commercial Kitchens	498	25,221,519	0.80	20	29%
	Lighting to Go	15,586	77,530,315	0.60	240	6%
	Small Business Direct Install	1,066	45,634,886	0.80	25	26%
Commercial Rebates	Total	17,150	148,386,719	0.70	285	10%

8.1.9 Stratification

The preceding results assume that the sample is efficiently stratified. Under the ratio model, an efficiently stratified sample design for ratio estimation can be developed in the following steps:[12]

Use the sampling frame and the assumed model to calculate σ_i for each customer in the population.

[12] This methodology is the model-based version of the Dalenius-Hodges method of constructing strata combined with optimal allocation of the sample using the within-strata population standard deviation of the e_i. However, Dalenius-Hodges stratification is approximately optimal for stratified mean per unit estimation whereas model-based stratification is approximately optimal for stratified ratio estimation. Moreover, with conventional methods it is common to calculate the required sample size from the within-stratum population standard deviation of x_i. This practice can yield very misleading results and cannot be recommended.

Choose the desired number of strata,[13]

Sort the sampling frame by increasing σ_i.

Choose stratum cut points to divide the sum of the σ_i approximately equally between the strata.

Allocate an equal number of sample customers to each stratum.

Make added adjustments if the sample size exceeds the population size in any stratum.

Under the ratio model, σ_i is determined by the x variable together with the value of γ. Methods are available for estimating γ from a sample. Indeed, we have estimated γ in numerous load research studies. We have found that the estimated values are clustered around 0.8. We have also found that the key results are not very sensitive to γ. Therefore, in interval load data collection applications, we generally recommend the use of $\gamma = 0.8$ both in constructing strata as discussed in this section and in estimating the value of the error ratio from a given sample.

Samples were stratified based on PSE program total tracking savings (kBtu). The tables that follow show the number of accounts in the population and sample, total savings, and inclusion probability for each end-use or stratum by compliance program and PSE program.

Table 8-3. Sample design stratification for new construction

Compliance Program	End Use	Number of Strata	Accounts	Total kBtu	Sample	On-Site M&V	Inclusion Probability
Commercial Industrial New Construction	Lighting - Custom	4	23	38,417,119	10	3	0.43
	Lighting Power Density Reduction - Custom	3	10	11,097,803	5	1	0.50
	Whole Building Design - Custom	4	12	8,518,945	8	4	0.67
	Refrigeration - Custom	2	2	4,727,073	2	1	1.00
	Miscellaneous - Custom (Boilers, Chillers, Air Compressors)	3	3	2,230,735	3	1	1.00
	Total		**50**	**64,991,675**	**28**	**10**	**0.56**

[13] With MBSS methodology we can systematically assess the gain from increased stratification. These studies indicate that five annual-use strata are usually sufficient in most load research applications. Some applications may call for added stratification by seasonal use, customer load factor, etc.

Table 8-4. Sample design stratification for commercial rebates

Compliance Program	PSE Program	Number of Strata	Accounts	Total kBtu	Sample	On-Site M&V	Inclusion Probability
Commercial Rebates	Commercial Kitchens	3	249	12,610,759	10	5	0.04
	Lighting to Go	5	7,789	38,775,977	110	10	0.01
	Small Business Direct Install	3	533	22,817,442	10	5	0.02
	Total		**8,571**	**74,204,178**	**130**	**20**	**0.02**

8.1.10 Evaluating the precision of any design

For any sample design, we define the inclusion probability of each site in the population, denoted π_i, to be the probability that the site is included in the sample. For a stratified sample design, the inclusion probability is the sampling fraction in each stratum, i.e., n_h / N_h.

Under the ratio model and any sample design, the expected relative precision of the stratified ratio estimator is

$$rp = z\sqrt{\sum_{i=1}^{N}\left(\pi_i^{-1}-1\right)\sigma_i^2}\Big/\sum_{i=1}^{N}\mu_i$$

Here $z = 1.645$ for the 90% level of confidence.

This key result has the following mathematical implications:

For any given sample size n, a sample design is said to be efficient if the sample design minimizes the expected relative precision. For any efficient sample design,

$$\pi_i = \frac{n}{\sum_{i=1}^{N}\sigma_i}\sigma_i$$

provided that the right-hand side is less than 1.

If the right-hand side is greater than 1, the site should be included with certainty.

If the sample design is efficient and the population is large, then the expected relative precision is $rp = \frac{z\ er}{\sqrt{n}}$.

The model-based sample design is practically efficient as long as the number of strata is large enough.

The preceding equation can also be used to calculate the expected statistical precision of any sample design in any domain of interest.

8.2 Appendix B: New construction project-level evaluation results

Table 8-5 shows the new construction evaluation results for each sampled project that was evaluated, along with a short description for the primary reason behind any discrepancy between the tracked savings and the evaluated savings.

Table 8-5. New construction evaluation results of each sampled project

Project ID	Project Sub Type	Tracked kWh Savings	Tracked Therm Savings	Tracked kBtu Savings	Evaluation kWh Realization Rate	Evaluation Therm Realization Rate	Evaluation kBtu Realization Rate	Variance Reason
P_950320.1	Horticulture Lighting	2,758,224	0	9,411,451	100%	N/A	100%	No variance
P_795361.1	Horticulture Lighting	1,300,119	0	4,436,190	100%	N/A	100%	No variance
P_968151.1	Horticulture Lighting	1,284,281	0	4,382,149	91%	N/A	91%	Adjusted hours
P_936511.1	Horticulture Lighting	590,475	0	2,014,784	100%	N/A	100%	No variance
P_933666.1	Horticulture Lighting	416,155	0	1,419,980	96%	N/A	96%	Adjusted Hours, Wattage.
P_967903.1	Horticulture Lighting	149,960	0	511,685	78%	N/A	78%	Adjusted hours
P_1027973.1	Horticulture Lighting	44,326	0	151,247	100%	N/A	100%	No variance
P_1068018.1	Horticulture Lighting	3,725,068	0	12,710,459	94%	N/A	94%	Adjusted hours
P_1053634.1	Horticulture Lighting	3,237,696	0	11,047,477	58%	N/A	58%	Adjusted hours
P_1053626.1	Horticulture Lighting	2,549,079	0	8,697,818	67%	N/A	67%	Adjusted hours
P_1096451.1	Horticulture Lighting	1,241,668	0	4,236,747	94%	N/A	94%	Adjusted hours
P_1042802.1	Horticulture Lighting	753,234	0	2,570,141	96%	N/A	96%	Adjusted hours
P_1043017.1	Horticulture Lighting	662,427	0	2,260,295	97%	N/A	97%	Adjusted hours
P_950442.1	Horticulture Lighting	547,641	0	1,868,629	100%	N/A	100%	No variance
P_724661.1	Horticulture Lighting	240,436	0	820,402	0%	N/A	0%	Project never fully installed
P_1099744.1	Horticulture Lighting	45,239	0	154,362	39%	N/A	39%	Adjusted hours
Total Horticulture Lighting		**19,546,028**	**0**	**66,693,815**	**85%**	**N/A**	85%	
P_784591.1	Generic Lighting	136,710	0	466,474	100%	N/A	100%	No variance
P_784609.1	Generic Lighting	32,881	0	112,195	105%	N/A	105%	Administrative adjustment, database error
P_906262.1	Generic Lighting	2,441	0	8,329	239%	N/A	239%	Adjusted baseline LPDs

Project ID	Project Sub Type	Tracked kWh Savings	Tracked Therm Savings	Tracked kBtu Savings	Evaluation kWh Realization Rate	Evaluation Therm Realization Rate	Evaluation kBtu Realization Rate	Variance Reason
P_1127032.1	Generic Lighting	172,248	0	587,735	73%	N/A	73%	Adjusted hours
P_1031184.1	Generic Lighting	86,282	0	294,406	94%	N/A	94%	Adjusted hours
P_1099661.1	Generic Lighting	79,816	0	272,343	100%	N/A	100%	No variance
P_1096159.2	Generic Lighting	25,113	0	85,689	100%	N/A	100%	No variance
P_1105850.1	Generic Lighting	20,195	0	68,908	100%	N/A	100%	No variance
P_1047221.1	Generic Lighting	19,783	0	67,502	100%	N/A	100%	No variance
P_984243.1	Generic Lighting	10,719	0	36,575	100%	N/A	100%	No variance
P_1098381.1	Generic Lighting	10,639	0	36,302	100%	N/A	100%	No variance
P_1107437.1	Generic Lighting	698	0	2,382	100%	N/A	100%	No variance
Total Generic Lighting		**597,525**	**0**	**2,038,840**	**92%**	**N/A**	**92%**	
Total Lighting		**20,143,553**	**0**	**68,732,655**	**85%**	**N/A**	**85%**	
P_559356.1	Education	115,072	1,952	587,795	103%	75%	94%	Adjusted HVAC setpoints
P_545358.1	Education	79,290	15,760	1,846,172	100%	88%	90%	Adjusted lighting and HVAC schedule, chiller efficiency
P_838577.1	Education	47,380	2,678	429,403	139%	100%	115%	Energy model discrepancy, adjusted GSHP efficiencies, HVAC schedules
P_545361.1	Education	13,866	8,354	882,513	90%	120%	118%	Energy model discrepancy, adjusted HVAC schedules
P_545416.1	Education	0	720	71,983	0%	122%	122%	Adjusted HVAC setpoints
P_600162.1	Education	407,441	0	1,390,246	114%	N/A	114%	Adjusted HVAC schedules
P_559863.1	Education	123,886	1,454	568,082	89%	111%	95%	Adjusted HVAC setpoints, schedules, HP efficiencies
P_545410.1	Education	123,574	458	467,441	89%	111%	91%	Adjusted HVAC setpoints, schedules, HP efficiencies
P_557415.1	Education	96,225	0	328,333	25%	N/A	25%	Adjusted HVAC setpoints, schedules, % outdoor air
P_545342.1	Education	85,182	0	290,653	90%	N/A	90%	Adjusted HVAC setpoints, schedules, DHW setpoints
P_545413.1	Education	63,964	11,864	1,404,371	131%	142%	140%	Adjusted HVAC schedules, setpoints

Project ID	Project Sub Type	Tracked kWh Savings	Tracked Therm Savings	Tracked kBtu Savings	Evaluation kWh Realization Rate	Evaluation Therm Realization Rate	Evaluation kBtu Realization Rate	Variance Reason
P_545412.1	Education	36,646	3,240	448,964	103%	117%	113%	Adjusted HVAC setpoints, schedules, DHW setpoints
P_545349.1	Medical	873,680	0	2,981,120	103%	N/A	103%	Adjusted HVAC setpoints, schedules, DHW setpoints, removed daylighting savings
P_604577.1	Nursing Home	389,788	4,820	1,811,897	100%	87%	96%	Adjusted HVAC setpoints, DHW setpoints
Total Whole Building		**2,455,994**	**51,300**	**13,508,973**	**100%**	**109%**	**104%**	
P_904898.1	Air Compressor	55,060	0	187,873	61%	N/A	61%	
P_892196.1	Boiler	0	18,014	1,800,969		55%	55%	Adjusted hours, removed 90% "conservativeness" factor
P_1019775.1	Heat Exchanger	96,426	0	329,019	13%	N/A	13%	Adjusted boiler efficiency, boiler not in condensing mode as often as assumed
P_1033327.1	HVAC Controls	24,960	0	85,167	100%	N/A	100%	Adjusted cooling load offset using actual shipped-in liquified CO2 usage, incorporated reduced load on chiller.
P_1105850.2	HVAC Equipment	771	0	2,631	96%	N/A	96%	No variance
P_1107437.2	HVAC Equipment	771	0	2,631	96%	N/A	96%	Used correct deemed value for unitary HVAC equipment.
P_1096159.1	HVAC Equipment	741	0	2,528	100%	N/A	100%	Used correct deemed value for unitary HVAC equipment.
P_784591.2	Refrigeration	963,071	0	3,286,135	79%	N/A	79%	No variance
P_989252.1	Refrigeration	113,232	10,546	1,440,712	58%	95%	85%	Adjusted compressor loading
P_1087412.1	Water Heaters	0	2,182	218,148	0%	100%	100%	Adjusted load factor, adjusted efficiency, hours, incorporated interactive factor
Total Component/Custom		**1,255,032**	**30,742**	**7,355,812**	**72%**	**72%**	**72%**	
All Sampled Projects		**23,854,579**	**82,042**	**89,597,441**	**86%**	**95%**	**87%**	

About DNV

DNV is a global quality assurance and risk management company. Driven by our purpose of safeguarding life, property and the environment, we enable our customers to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas, power and renewables industries. We also provide certification, supply chain and data management services to customers across a wide range of industries. Operating in more than 100 countries, our experts are dedicated to helping customers make the world safer, smarter and greener.

Evaluation Report Response

Program: Non-Residential Program (New Construction and Commercial Rebates)

Program Manager: Tianna Byrtus, Penny Kyser, Taylor Pitts, Alex Cimino-Hurt

Study Report Name: Evaluation of 2020-21 Non-Residential Programs

Draft Report Date: January 23, 2021

Evaluation Analyst: Kasey Curtis, Jesse Durst, Michelle Wildie

Date Final Report provided to Program Manager: February 25, 2022

Date of Program Manager Response: February 22, 2022

Overview:

DNV completed independent evaluations of two PSE compliance programs in 2021: Commercial Industrial New Construction and Commercial Rebates. The expected outcomes of this evaluation were to conduct the following research:

Impact evaluation: Estimate the ratio of energy savings achieved to energy savings tracked for each program. This ratio is the program realization rate. These estimates were achieved by independently reviewing savings estimation methodologies and verifying savings achievement through file reviews and inspections.

Impact evaluation methods were applied at the program level and included the following:

- Program documentation review
- Project file review
- M&V planning
- Data collection
- Analysis
- Reporting

Process evaluation: Provide process findings for the programs from the perspective of the program participants. When necessary, provide information on why programs are over/underperforming and recommendations for improvements.

Process evaluation methods included the following:

- In-depth telephone interviews with PSE's program staff (may include Program Managers, Energy Advisors, outreach staff and/or implementation contractors)

- In-depth telephone interviews with other stakeholders (e.g., installation contractors, other vendors, retailers)
- Telephone surveys of PSE's customers for customer satisfaction

Key Evaluation Findings, Recommendations, and PSE Responses

This section provides key findings and recommendations resulting from DNV's evaluation. Additional findings are presented within each program-specific section.

Commercial New Construction Grants

- **Key Finding** – The Commercial New Construction Grants (CNC) program is achieving 85.4% of tracked electricity savings and 94.9% of tracked natural gas savings. These realization rates are primarily driven by changes outside of PSE's control.
- **Key Finding -** Many of the new construction whole building projects have installed water source heat pumps (WSHPs) along with natural gas fired condensing boilers. The natural gas boilers exist to provide required supplemental heat. The installed boiler provides heat to the WSHP loop when the ground heat is not adequate and usually comes on based on a loop water temperature setpoint. The eQuest simulation modelling tool was used for these whole building projects, but the tool does not have ability to model this type WSHP configuration. Only one of the project applicants (P_545412) identified this issue and adopted an out-of-box approach to determine the correct measure savings.

  Recommendation - PSE should require a savings adjustment outside eQuest for buildings using WSHPs with back up natural gas boilers as the standard procedure or develop a consistent calculation method to estimate savings for these projects.

  Program Response: PSE will establish a best practice methodology based upon the identified project and the out-of-box approach that was taken. PSE's third-party vendor will either request the documentation from the customer or develop a model that appropriately accounts for the systems.
- **Finding** – Lighting measures are performing well and are the primary contributors to program electric savings. The primary variance drivers were adjustments to the facility operating hours for two large-savings projects (>2.5GWh). The changes occurred after PSE completed their final inspection, so PSE would not have been able to know at the time of the inspection that the facility would reduce operating hours at some point in the future.

  Consideration – PSE could include a review of the expected growing cycles with the customer during each project, especially for projects expected to save over 1 GWh annually and/or those expecting to use grow lights 8,760 hours per year. PSE could review each growth stage along with outside air conditions, discuss lighting during the expected flowering cycle, and assess if the facility will have sufficient HVAC throughout the year. This review would create an opportunity for PSE to discuss non-lighting equipment and savings opportunities with the customers.

  Program Response: PSE already considers growing cycles in project lighting hours. The indoor agriculture industry runs much like a commodity market and is responsive to rapid changes in demand. Unpredictable growing cycles or light utilization changes are

likely a part of this industry. But this is the first time the indoor agriculture component has been evaluated, and we will take DNV's consideration under advisement as we continue to develop the program.

- **Finding** – The PSE standard lighting calculation tool allows for different methods to estimate hours of use for the baseline and as-built case. For example, in lighting project P_1031184 the baseline operating hours were different for different spaces, but the same (3796 hr/year) in the as-built case. Consistent calculation methods are best practice for lighting programs and PSE should consider the following program changes.

  Consider requiring the baseline and as-built calculations to use identical space types and associated floor areas.

  Consider adjusting the calculation so that the baseline lighting power (kW) for each space type is determined by multiplying the WSEC specified LPD (W/sq. ft.) and specific space area (sq. ft.). The as-built lighting power (kW) for each space type is determined by multiplying the actual installed lighting fixture power (kW) and number of fixtures for the same space. The baseline operating hours should be consistent with the deemed annual hours provided in tab 'LTG-INT-SPACE' for different space types. The as-built operating hours should be consistent with the actual operating hours.

  Program Response: Both of these considerations have been addressed by switching to the Business Lighting workbook for CNC lighting projects. PSE uses deemed hours if the customer is unsure; otherwise, PSE uses actual hours as reported by the customer.

- **Finding** – Whole building measures are performing well as the weighted realization rate for evaluated projects is close to 100% for both electricity and gas. As a result, no immediate changes to the program are recommended. DNV offers the following considerations to improve consistency and evaluability of this measure type.

  Consider using TMY3 weather for all projects going forward. This will provide consistency and align with program best practices.

  Consider creating a baseline model checklist for participants to follow and program staff to verify. This will help ensure consistent modeling of baseline assumptions throughout the program. In many cases, this should simplify the baseline models used by providing modelers with clear guidelines. Specific recommendations for this list include.

  - Baseline schedules that match WSEC Appendix B.
  - Baseline schedules for multi-family new construction not covered by WSEC. This should include schedules for occupancy and lighting, cooling and heating setpoints, water heater setpoints, receptacle and refrigeration assumptions, etc.
  - Checks to prevent the use of the Building Area Method and the Space-by-Space method to calculate lighting savings in the same building. Some reviewed projects used one method for the baseline and one method for the as-built case.
  - Expected baseline internal load densities, such as those found in Table B102 in Appendix B of 2015 WSEC.

Consider developing a uniform approach to variable refrigerant flow (VRF) savings estimation. Reviewed projects used different approaches, such as i) custom spreadsheet calculation outside the whole building simulation and ii) use of a custom performance curve in the eQuest simulation. PSE can suggest a uniform approach for applicants claiming VRF savings.

Program Response: PSE will take these considerations under advisement and discuss whether any program changes are required. It is important to note that PSE already has a modeling guideline for projects permitted under the 2018 WSEC. Customer may submit existing models to PSE's third-party energy model reviewer, who updates the baseline model to meet PSE's standards and provide consistency across all projects.

- **Finding** - The 5 of 10 custom/component projects evaluated with significant variance required due to as-found operating parameters such as air compressor load, hours of use, or return water temperature. These projects have minimal impact on the program realization rates, but adjustments to program processes should be able to reduce the savings variance in the future.

  Consider adding additional quality assurance checks when significant energy savings are expected due to a boiler operating in the condensing zone. The check should ensure that the site controls and processes will provide the required return/inlet water temperatures to achieve condensing mode operation.

  Consider adding steps or adjusting the program process when savings are expected from equipment installed as part of a new process or facility expansion and tracked savings will not be achieved unless specific loading or production volumes are achieved. In these cases, PSE could request additional assurance that the operating conditions are expected to occur or mitigate the savings risk by adjusting the calculations to reduce anticipated savings. This could include requiring the receipt of production data or actual operating parameters before the final incentive is paid.

  Program Response: Required return/inlet water temperature checks are already standard procedure for boiler projects. PSE will ensure that this requirement is extended to CNC projects. PSE will take the other considerations under advisement and discuss whether any program changes are required.

- **Findings – EM&V cooperation rates.** The evaluation team found participant willingness to cooperate / ability to reach a decision-maker lower than expected for a program of this type (at 65%). This reduces the evaluability of the program and results may not represent the full range of experience among the non-respondent population.

  Consideration – Identify and implement customer and stakeholder communications regarding the value of research to the program and associated requirement for participants. Two ways the program could improve the evaluability and cooperation rates are:

  - On the project application, record the owner and any design team members the program will be working with. Require the applicant to provide name, title, email, and phone.
  - PSE project staff could prepare a project close out that briefly describes who they interacted with, and major project accomplishments and decisions made.

Program Response: PSE will take these considerations under advisement and discuss whether any program changes are required.

- **Finding – source of program awareness**. Some 43% of respondents learned about the program through previous participation. The results are normal for a commercial program whereby participants who learn to navigate the process, see the benefits, and return to the program for their next project.

  Consideration - PSE should continue to monitor the share of participants who are first time vs. previous participants. Ideally, the mix of repeat participation is lower and represents 25% or less of the population. If participation exceeds 50%, these are indicators the program is not performing enough marketing and outreach to attract new participants and the program will need to make an investment in program marketing and outreach.

  Program Response: PSE will continue to monitor the share of first-time participants vs. previous participants and discuss if any program marketing or outreach changes are needed if anything changes.

- **Findings – when participation starts**. The program has generally done well at enlisting customers early in the program with the majority participating at project conception (42%). However, the evaluation team found about 25% of respondents participated too late in the process, at the construction document phase, for the program to have influenced the project.

  Consideration - PSE should continue to monitor phase of construction and establish the construction document phase as too far in the project to participate in the program.

  Program Response: PSE is expanding the Early Design Assist program for Multifamily New Construction to reach customers earlier in the design process. PSE will take the evaluators considerations under advisement and discuss whether any additional program changes are required.

- **Finding – satisfaction with program delivery**. Satisfaction with program delivery is high and the program has ratings of 90% and above for all program components. However, given the lower-than-expected response rates these opinions may not be representative of the population.

  Consideration - The satisfaction rates are lowest for timeliness and paperwork and application process. One way participants would like to see this process improve is by providing an online tracking/portal system that tracks the project and allows any member of the project team access.

  Program Response: PSE will take the evaluator's considerations under advisement and discuss whether any additional program changes are required. An online process or portal would likely be part of a larger commercial program effort, which would need to balance program costs with customer benefits.

- **Finding** – **incentive offerings**. The program found customers were satisfied with the program incentives and rebate amounts but had several suggestions for enhancements. Additionally, the evaluation found low levels of participant awareness for the full range of

incentive offers. Particularly, the post-occupancy commissioning incentive is not well known, and benefits are not understood.

Consideration - i**ncentive amount** - Participants also expressed a desire to understand what the approximate incentive will be early in the process. PSE could use past projects as a starting point to inform customers about the range of incentives and may want to develop a calculator to provide "soft" estimates.

> **Program Response**: The Early Design Assist program allows customers with energy models the opportunity to apply incentive rates to estimated savings to receive an estimated incentive payout. Additionally, customers working with the EUI Performance Method may receive a grant estimate before an agreement is signed.

Consideration – **measures rebated** - Customers would also like to see the program enhance the incentive offerings with emphasis on renewables (PV), storage, EV charging, building automation systems, water conservation, options for all electric heating in place of boiler, and customized measures for horticulture and refrigeration. PSE should consider options to integrate communications between energy efficiency programs with other PSE customer programs.

Additionally, if the program intends to continue offering a post occupancy commissioning incentive it will need to both upsell benefits and ensure representatives relay program offering as part of the delivery of services as it is not well known nor understood as a valuable resource.

> **Program Response:** While PSE's energy efficiency programs cannot provide incentives for non-efficiency measures such as PV, water savings, battery storage, and EV charging, CNC will work with other relevant departments to improve communication pathways and provide relevant information and resources to customer where appropriate.

- **Finding** – **program delivery** – The evaluation found customers' experience with the program was relatively seamless and barriers to participation were minimal. However, if the program wants to have deeper energy savings across projects, changes will be necessary. We expect these changes would increase the overhead cost to run the program but what customers are asking for will result in high satisfaction and a better understanding of benefits.

  Consideration – PSE could improve its online presence in the following ways: make the application process entirely online, develop a program manual or guide that outlines the steps in the process, incentive tracks, incentive amounts, a comprehensive list of services, etc., and improve the application to collect more information about the customers and designers. Each project should have a project close out that briefly describes the project, who was involved and what their role was. Give respondents access to an online portal that allows them to track their project. Customers expressed a need for a subject matter expert to collaborate with them early in the design process. Consider adjusting incentives to design team members to help offset the cost to improve design.

  > **Program Response:** PSE has already developed and posted a program manual to outline the steps in the incentive process. An online process or portal would likely be part

of a larger commercial program effort, which would need to balance program costs with customer benefits. PSE will take the evaluator's other considerations under advisement and discuss whether any additional program changes are required.

Commercial Rebates – Lighting to Go

- **Key Finding** – The Lighting to Go program achieved a gross realization rate of 97.4%. Evaluated savings were slightly lower than tracked savings because of inconsistencies in rounding when calculating savings for a few measures and because PSE did not apply the assumed 20% reduction to the number of units installed for the omnidirectional A-lamp measure.

  Recommendation – Update measure calculations for measures identified. Review new measures and ensure consistent rounding.

  Program Response: If PSE did not apply the 20% reduction to the above-referenced lamp, it was inadvertent. In the meantime, this has been rendered moot by House Bill 1444, which resulted in PSE retiring this measure in 2020.

- **Key Finding** – The Lighting to Go program significantly changed the key parameter assumptions for TLED lamps between 2020 and 2021. The change more than doubled the per unit savings and aligned the assumptions with historic participants in the Business Lighting program. Further investigation is required to assess this change which will likely increase the total program savings in the near future.

  Recommendation – PSE should include review of Lighting to Go TLED input parameters in their next evaluation of the Business Lighting program. This review should include an assessment of the annual hours of use for these lamps, the baseline equipment, and a comparison to savings assumptions used in other midstream or upstream commercial lighting programs.

  Program Response: The change to the fixture was based on a review of lighting data across our programs, a review that we PSE undertakes every two years. We believe the data we analyzed and the assumptions we incorporated are solid and reflect the realities of PSE's market.

- **Key Finding** – The following findings are specific to the current program design element to not collect installation address or contact information for purchases of 50 lamps or less.

  - During 2020 and 2021, more than 88% of all sales transactions of LTG incentivized lamps or fixtures were for purchases of 50 or fewer units. Less than 12% of the transactions required the collection of installation location (business address where units were installed) and customer contact information. Because of the program design and the relatively low share of units whose installation locations are tracked, the Lighting to Go program is inherently difficult to evaluate.
  - Purchases of 46-50 units represent more than 12% of all transactions. This indicates to DNV that some contractors and business customers are aware of program rules and may be intentionally avoiding purchases of lighting products over 50 units so that they aren't required to provide customer address and contract information.

- Responding distributors stated that collecting installation location under the current rules was easy, collecting information for purchases of 10+ units would be harder but not difficult, and collecting information for all transactions would be difficult.

Recommendation – DNV believes that the evaluability and reliability of this program is too low. PSE should lower the threshold for the collection of the installation address, to a minimum of purchases of more than 15 units. This should result in the capture of the installation address for 50% of transaction and 80% of savings. This change will significantly increase the reliability of the program by reducing the cost to fully evaluate and verify savings in the future.

Program Response: The Lighting-to-Go program has always attempted to strike the right balance between collecting enough data to evaluate the program and the administrative requirements that may discourage participation. As the DNV survey indicated, our distribution partners are largely satisfied with the data collection as it exists now, but their perceived satisfaction lowers significantly when lower data collection thresholds are proposed. While some distributors expressed that it would not change their opinion, we've also found from our experience that distributors with less volume find increased requirements less onerous than the high-volume distributors that are important to our program. Because distribution is regional, PSE shares distribution channels with our neighboring utilities, and we have an interest in aligning data collection as much as possible. Increasing data collection puts us out of alignment with said neighboring utilities, which makes it harder on our distributors. In fact, Seattle City Light recognized this and recently moved to eliminate detailed customer information collection for customers purchasing less than 50 units. While we understand and appreciate the recommendation that arose from DNV's survey, based on our data and experience, we strongly believe that lowering the threshold for detailed data collection is not in the interest of PSE or its ratepayers who fund our EE efforts, and we respectfully disagree with this recommendation.

- **Finding** – Overall satisfaction with the program was high among participating business customers surveyed for the evaluation (n=19) with an average satisfaction rating of 4.6 on a 5-point scale.
- **Finding** – Distributors expressed above average satisfaction with the Lighting to Go program (n=14), but average ratings trended downward from 2019 (4.1) to 2020 (3.7). Because of changes in codes and standards for lighting products in Washington in 2020, most screw-base lamps are required to be LEDs or compact fluorescent lamps. Thus, many lamps discounted by the program in 2019, such as omni-directional A-lamps, reflectors, and decorative lamps, were no longer eligible for utility discounts in 2020. DNV believes this may help explain the decline in satisfaction among distributors in 2020. PSE did provide distributors with information on the changes at the time.

  Consideration – Program staff and implementers should continue to provide information to distributors on changes in lighting codes and standards and the impact those changes have on PSE's ability to incentive different lighting products. This should temper distributor expectations on which lighting products are eligible for program discounts. However,

changes that reduce the number of products or sales volume eligible for incentives should be expected to reduce satisfaction with the program.

Program Response: PSE will continue to provide timely information about program changes through our vendors, but lighting codes and standards are largely out of our control. In the last couple of years, PSE has needed to make changes to program requirements due to changes in lighting standards. PSE enlists a third-party vendor to communicate program changes including impacts from codes and standards.

Commercial Rebates – Small Business Direct Install

- **Finding** – The evaluation team verified the quantity and equipment type installed and in use for all of the evaluated projects. The measure case savings algorithms for all measures are appropriate. The realization rates reflect adjustments to the measure case savings for reported hours of use at each evaluated project. The SBDI program is achieving 93.7% of tracked electricity savings. This realization rate is primarily driven by differences between the actual facility operating hours and PSE's assumptions for this program.
- **Finding** – The program operating hours assumptions are reasonable even though there is considerable variation in operating hours at the site level savings. There was significant variation in site hours of use within the projects evaluated, but the overall program realization rate demonstrates that current program assumptions are accurate.

  Recommendation – PSE should continue to use the same methodology and assumptions for estimating operating hours.

  Program Response: PSE will continue to utilize this methodology moving forward.

Commercial Rebates – Kitchens

- **Key Finding** – The evaluation team verified the quantity and equipment type installed and in use for all of the evaluated projects. The measure case savings algorithms for all measures are appropriate. The realization rates reflect adjustments to the measure case savings for hours of use and installed equipment efficiency. The Commercial Kitchens program is achieving 104.0% of tracked electricity savings and 79.4% of tracked natural gas savings. This realization rate is primarily driven by differences between the actual facility operating hours and PSE's assumptions for this program.
- **Key Finding** – The Commercial Kitchens program is achieving 97% of tracked site energy savings, when electric and gas projects are combined. This realization rate demonstrates the operating hours assumptions used by the program are reasonable when all participants are combined.
- **Finding** – The primary adjustment made to savings resulted from reported hours of use. The measure case hours of use are consistent with other sources and reasonable as an average across a large sample of kitchen equipment. However, there is considerable variation depending on the facility type. Schools, senior care facilities, catering, and one grocery store chain reported considerably lower hours of use than the measure case assumptions.

Consider a more conservative hours of use assumptions that better represents the mix of facility types in the program.

Program Response: These facility types (schools, senior care facilities, catering, etc.) are more of the exception than the rule. Generally, PSE does not build UES values around specific exceptions if more common facility types have different reported hours of use.

- **Finding** - The combination oven measures make up a large percentage of energy savings in this program. During the review of the measure cases for this product type, it was revealed that dated sources are the basis for baseline and efficient equipment types. The difference between a new standard efficiency oven and high efficiency option available on the market may be comparable to the implied measure case change in efficiency. However, there is little information available to indicate what standard efficiency oven performance specifications are.

  Consider revising the measure case baseline and efficient cases performance specifications. This includes the steam mode idle power, convection mode idle power, and cooking efficiency. Once supply chain disruptions from the COVID-19 pandemic normalize, consider a market study of the baseline case for lost opportunity measures installed through this program.

  Program Response: PSE will continue to align with California utilities, supported by Fishnik, and update our UES as they update their UES. California did have an update recently and PSE has incorporated this. PSE will continue to watch for these updates closely, as we do every year.