2012-2013 Commercial HVAC Program Impact and Process Evaluation Final Report

Contents:

- Navigant Impact and Process Evaluation Report
- PSE Evaluation Report Response

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

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

Please note that this is an evaluation of the program as it operated during the 2012-2013 program years, and does not necessarily reflect the program as currently implemented, or measures currently deployed by the program.

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

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[1] (6)(c.) Approved Strategies for Selecting and Evaluating Energy Conservation Savings, Proposed Conditions for 2016-2017 PSE Electric Conservation.

[2] PSE 2016-2017 Biennial Plan, Exhibit 8: Evaluation, Measurement & Verification (EM&V) Framework, revised August 6, 2015.

[3] Ibid.

COMMERCIAL ENERGY EFFICIENCY PROGRAM EVALUATION

Commercial HVAC

Final Report

Prepared for:
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Executive Summary

This report describes the impact and process evaluation activities related to Puget Sound Energy's (PSE) Commercial and Industrial (C&I) HVAC measures stratified across four measure categories
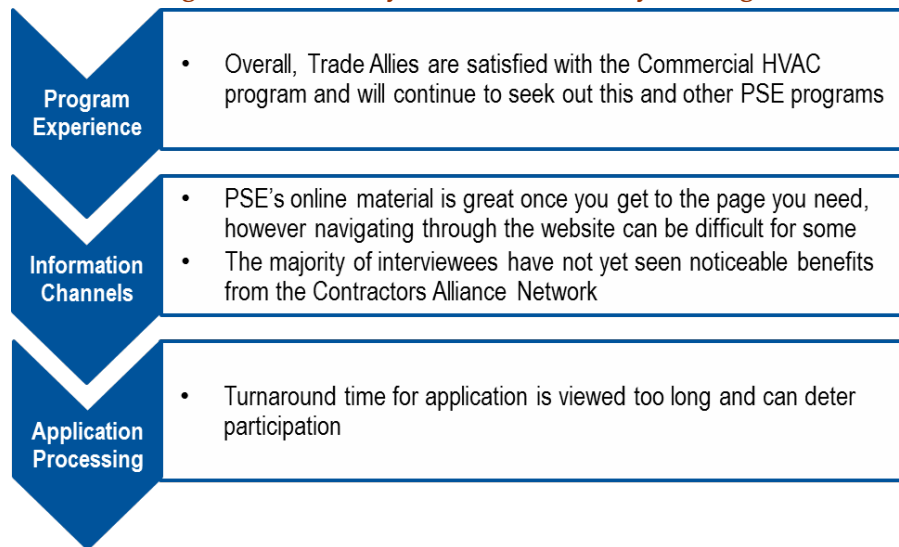
- HVAC Upgrades – Electric

- HVAC Upgrades – Gas

- HVAC Controls – Electric

- HVAC Controls – Gas

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

Process Evaluation

Process evaluation activities consisted of logic model creation, Trade Ally Interviews, and creation of a program process flow diagram. Logic models are developed as a graphic presentation of the (program) intervention – what occurs and clear steps as to what change the activities undertaken by the intervention are expected to bring about in the targeted population. Navigant relied upon PSE program documentation, marketing materials and application forms to create a logic model. The draft logic model was then reworked with program managers in a day-long meeting at PSE's Bothell facility to ensure it aligned with current program structure. The resulting logic model is shown in section 2.1. Key findings from the trade ally interviews can be found in section 2.2 and are summarized in Figure 1 below.

Figure 1. Trade Ally Interview Summary Findings

Program Experience
- Overall, Trade Allies are satisfied with the Commercial HVAC program and will continue to seek out this and other PSE programs

Information Channels
- PSE's online material is great once you get to the page you need, however navigating through the website can be difficult for some
- The majority of interviewees have not yet seen noticeable benefits from the Contractors Alliance Network

Application Processing
- Turnaround time for application is viewed too long and can deter participation

Impact Evaluation

Key Impact Evaluation Findings

The impact evaluation addressed both overall and strata-specific realization rates (*ex-post* relative to *ex-ante* savings) as follows:

- Total Electric
  - HVAC Upgrades – Electric
  - HVAC Controls – Electric
- Total Gas
  - HVAC Upgrades – Gas
  - HVAC Controls – Gas
- Overall

As shown in **Error! Reference source not found.**, the stratum-level realization rates range from 92 to 103%, yielding a total weighted average realization rate of 98%. This is a clear indication that PSE's *ex-ante* project analyses are mathematically sound and representative of *ex-post* verification findings. Deviations in the operating assumptions for incented measures, along with post-installation operational changes, were the main factors causing differences between the *ex-ante* and *ex-post* savings

Table 1: Total Savings by Stratum

Stratum	Total Projects	Final Sample of Projects	*Ex-Ante* Savings (Electric - kWh, Gas - Therms)	Realization Rate	*Ex-Post* Savings (Electric - kWh, Gas - Therms)
HVAC Upgrades – Electric	82	15	3,485,728	97%	3,365,623
HVAC Controls – Electric	138	18	4,090,032	103%	4,225,677
Total Electric	219	33	7,575,760	100%	7,591,299
HVAC Upgrades – Gas	89	15	190,148	99%	188,806
HVAC Controls – Gas	151	17	137,748	92%	126,939
Total Gas	239	32	327,896	96%	315,745
Overall	460	65		98%	

Source: Navigant and Tierra analysis of M&V data

Figure 2 through Figure 5 detail the total C&I HVAC *ex-post* gross program savings, by strata, for program years 2012 and 2013. The Navigant Team and PSE determined that these program years were representative of the future program, and thus the evaluation sample relied exclusively on projects from those program years.

Figure 2. Total HVAC Program Savings (HVAC Upgrades – Electric)
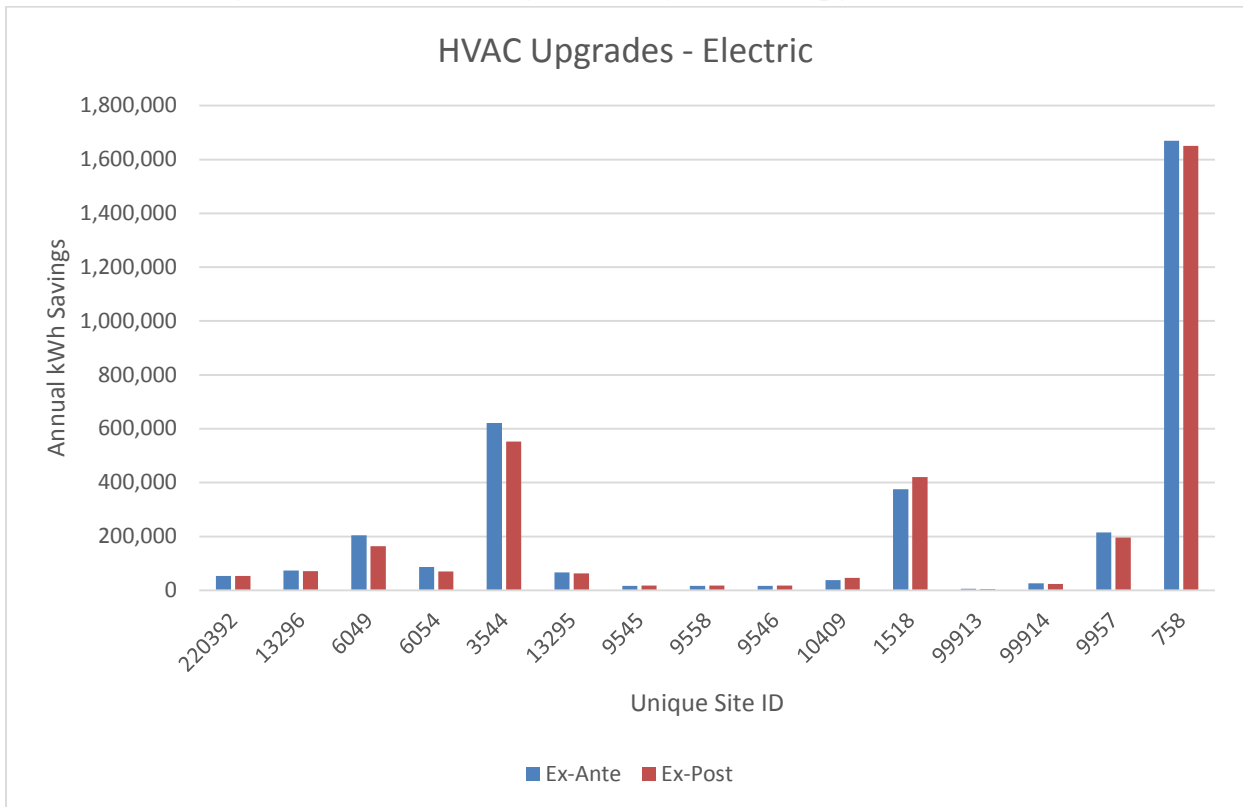
Source: Navigant and Tierra Analysis of M&V data

Figure 3. Total HVAC Program Savings (HVAC Upgrades – Gas)
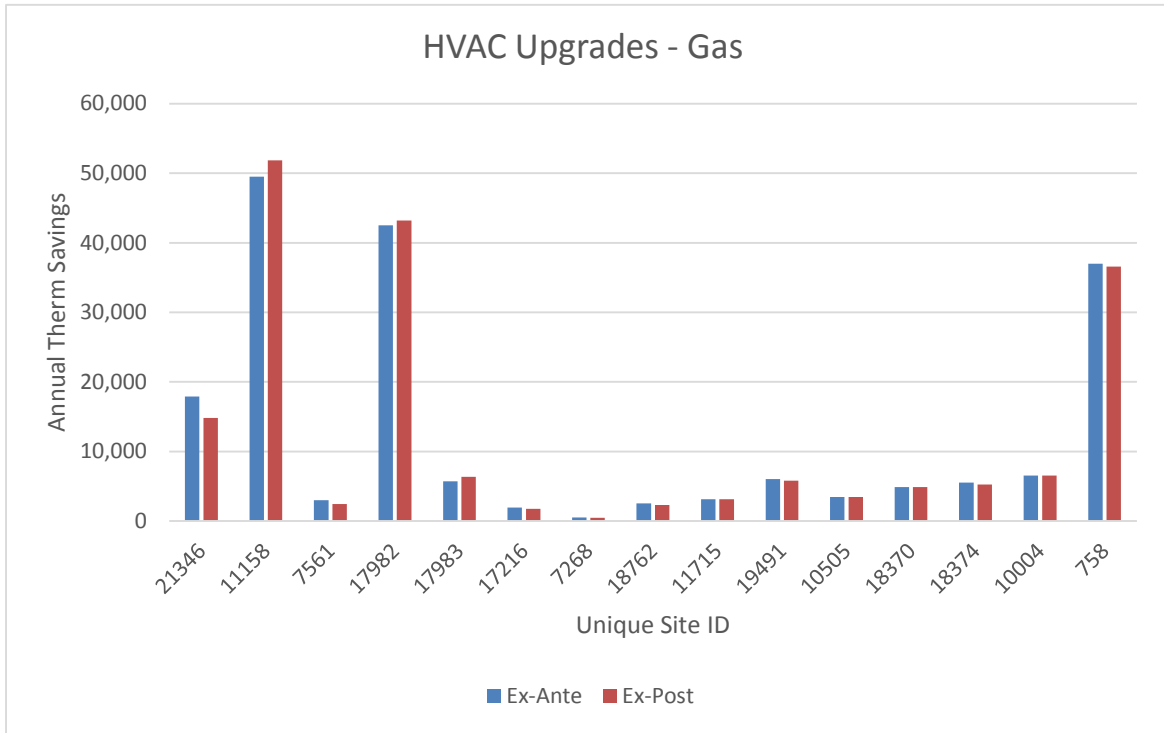
Source: Navigant and Tierra Analysis of M&V data

Figure 4. Total HVAC Program Savings (HVAC Controls – Electric)

Source: Navigant and Tierra Analysis of M&V data

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Figure 5. Total HVAC Program Savings (HVAC Controls – Gas)

Source: Navigant and Tierra Analysis of M&V data

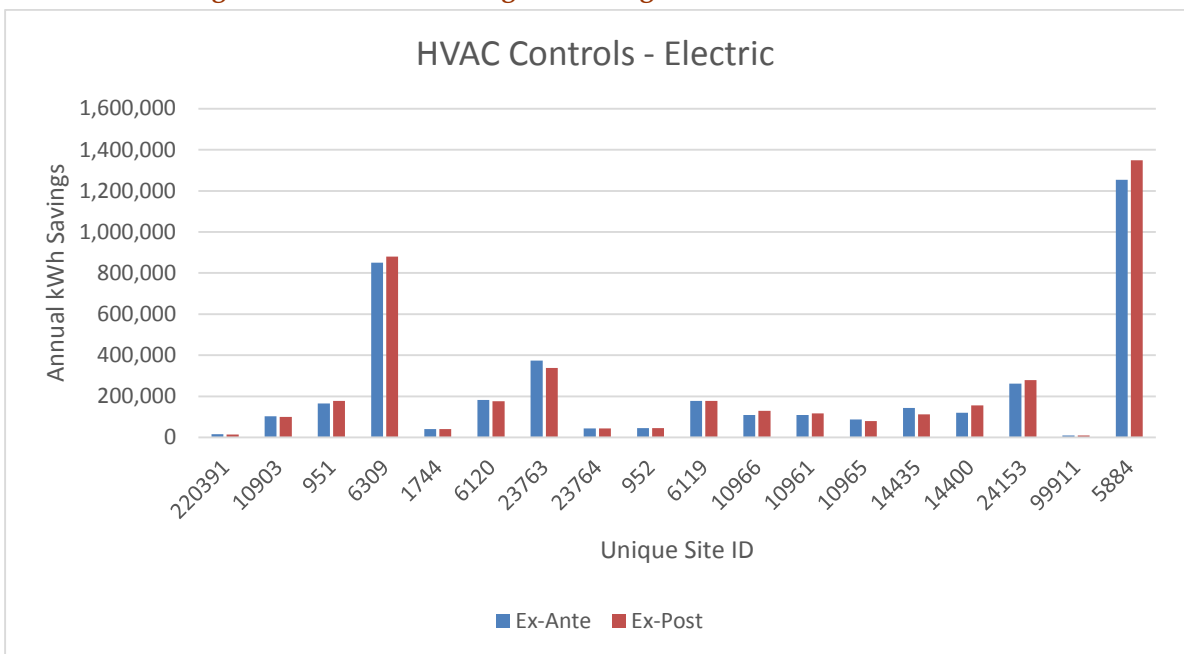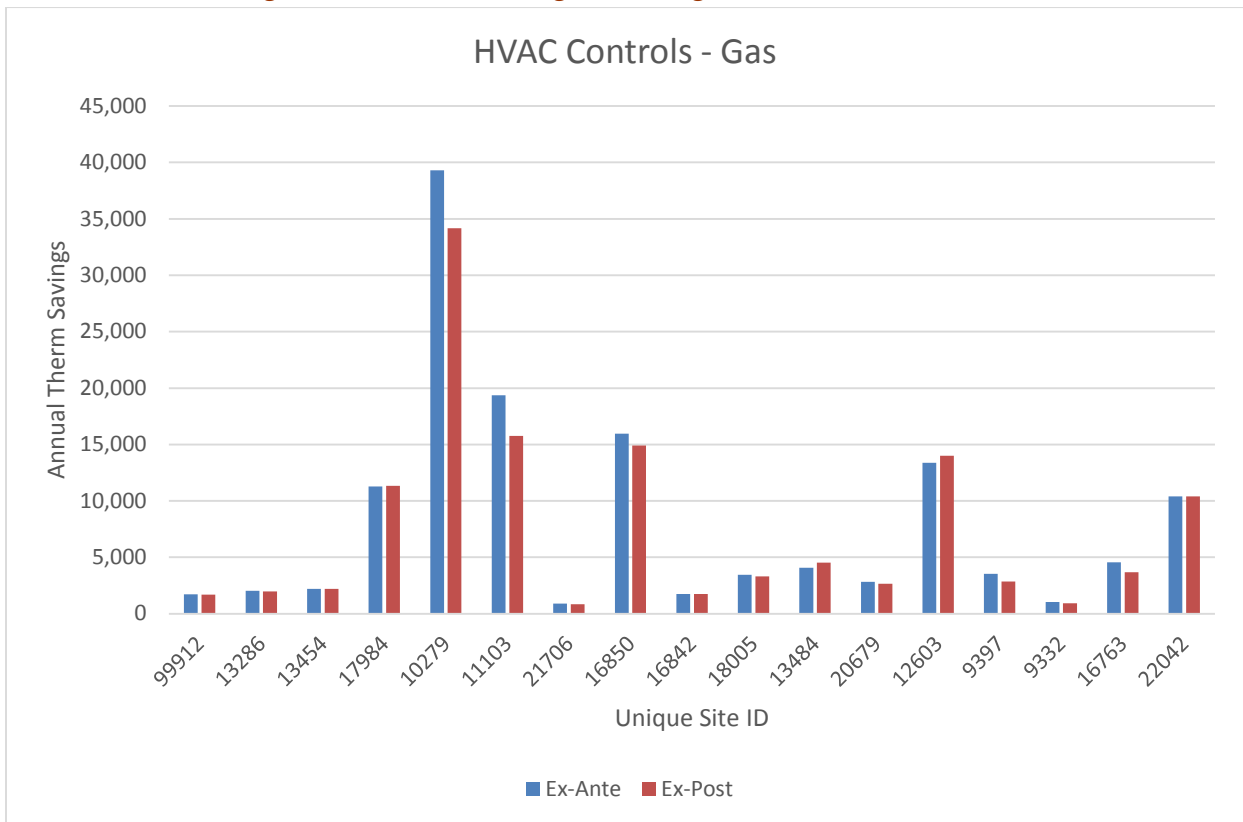Navigant developed the overall Impact Evaluation sample for this evaluation using the Stratified Ratio Estimation approach, with strata defined by HVAC measure type. The sample design targeted achieving 80% confidence and 20% precision (80/20) or better at the stratum level, and 90/10 confidence and precision across the 2012-2013 program years. Table 2 demonstrates that the final results achieved the desired precision at the program level and across all of the strata, with several of the strata achieving much greater precision than targeted. Key evaluation metrics, include:

- All of the strata realization rates include 100% in the error bound.

- The 92% Realization Rate for HVAC Controls (Gas) is driven by two larger projects, both of which had significant changes to baseline conditions between the time that the project was completed, and the time that the evaluation was completed (2015).

- In all strata, there were no projects that fell below the lower bound of the confidence interval. For example, in HVAC Controls (Gas), all sampled projects achieved a Realization Rate greater than 78%.

Table 2: Achieved Relative Precision by Stratum

Stratum	Total Projects	Sampled Projects	*Ex-Ante* Savings (Electric - kWh, Gas - Therms)	Realization Rate	*Ex-Post* Savings (Electric - kWh, Gas - Therms)	Coefficient of Variation (CV)	Relative Precision
HVAC Upgrades – Electric	82	15	3,485,728	97%	3,365,623	0.11	13.60%
HVAC Controls – Electric	138	18	4,090,032	103%	4,225,677	0.11	14.50%
Total Electric	**219**	**33**	**7,575,760**	**100%**	**7,591,299**	**0.12**	**14.05%**
HVAC Upgrades – Gas	89	15	190,148	99%	188,806	0.08	14.00%
HVAC Controls – Gas	151	17	137,748	92%	126,939	0.09	14.30%
Total Gas	**239**	**32**	**327,896**	**96%**	**315,745**	**0.09**	**14.15%**
Overall	**460**	**65**		**98%**		**0.10**	**7.70%***

* The overall relative precision was calculated at 90% confidence
Source: Navigant and Tierra Analysis of M&V data

Key Impact Evaluation Recommendations

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

Figure 6. Recommendations from the Impact Evaluation of PSE's C&I Program (HVAC Measures)

Program Data Requirements
- Require participants to provide context on occupancy / operational changes that may impact measure performance.

Program Data Tracking
- Track additional project-level information within lthe CSY tracking database.
- Ensure project and analysis files are maintained in a spreadsheet format.
- Track changes in revenue meters assigned to Premise IDs.
- Track specific project milestones and completion dates.

Saving Calcs & Documentation
- Ensure that changes in savings methodologies are accounted for before final payment is issued.

1   Introduction

1.1   Scope of the Evaluation

PSE offers an array of energy efficiency (EE) services to their electric and natural gas customers in all market segments. The Company is committed to ensuring that all customers have access to these services by offering a mix of programs that address all major end uses. The Navigant team evaluated all HVAC projects in the evaluation period as part of this assessment of PSE's C&I EE programs.

The goal of these programs is to encourage existing C&I customers to use energy more efficiently by installing cost-effective Energy-Efficient (EE) equipment, using energy-efficient operations at their facilities and adopting energy-efficient designs. Incentives are available for various HVAC measure and control upgrades including chillers, Variable Air Volume (VAV) retrofits, and advanced Energy Management Systems (EMS). Navigant assessed the program energy savings impacts and implementation processes during the 2012 and 2013 tariff years. Table 3 below shows the ex-ante performance of these programs:

Table 3. Summary of PSE's C&I Program Performance for HVAC Measures, 2012-2013

Sampling Stratification	CSY Reported Savings (Electric - kWh, Gas - Therms)	No. of Projects
HVAC Upgrades – Electric	12,366,566	82
HVAC Controls – Electric	10,828,939	138
Total Electric	**23,195,505**	**220**
HVAC Upgrades – Gas	943,950	89
HVAC Controls – Gas	491,596	151
Total Gas	**1,435,546**	**240**

Source: Navigant and Tierra Analysis of PSE tracking database.

The evaluation team's process evaluation activities included development of a program logic model, Trade Ally interviews, and creation of a program process flow diagram.

1.2   Organization of This Report

This report is divided into four sections:

- **Executive Summary:** Top line findings and key recommendations

- **Section 1: Introduction** (this section) frames the research undertaken by outlining the scope of the evaluation activities

- **Section 2: Process** evaluation covers the following activities; program manager interviews, document review and logic model creation, trade ally interviews and creation of a program process flow diagram. Methodologies and findings of the process activities are presented within each section.

- **Section 3: Impact** evaluation begins with a discussion of the methodology employed in the review of the tracking data and project files, then continues with a description of the sample design and finally presents the on-site measurement and verification data collection and analysis approach. Next the impact evaluation findings are presented at the annual, stratum, and project levels. This is followed by a discussion of the drivers of the realization rates, and the statistical validity of the findings. The section concludes with recommendations for PSE based on the impact evaluation findings.
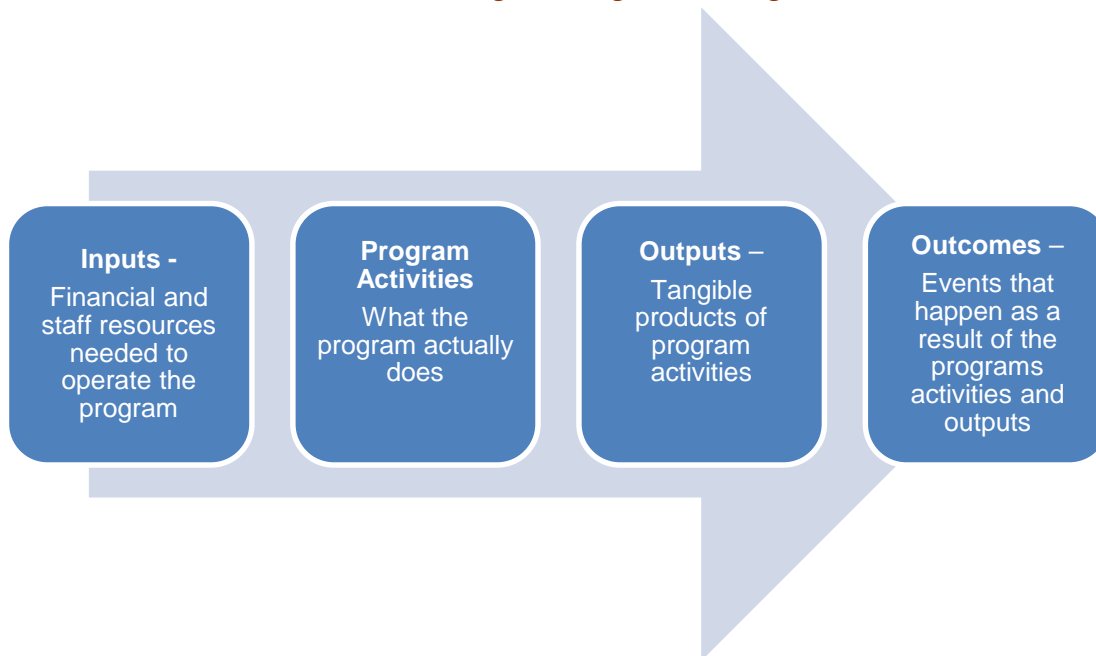
2   Process Evaluation

This section discusses the Navigant team's process evaluation methodology and findings on PSE's Commercial HVAC Program. Process evaluation activities consisted of logic model creation, trade ally interviews and creation of a program process flow diagram.

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

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

The nodes in a logic model represent a specific event, and arrows point from cause to effect. Nodes are typically arranged in four rows: activities, outputs, short-term outcomes and long-term outcomes, from top to bottom, and the causal logic flows downward. In this framework, an activity is any program component requiring allocation of the agent's resource. An output is a measurable consequence of primary programmatic activities. If a node describes an event that couldn't readily be enforced by contract, it's generally not an output. Outcomes describe the realized intentions of the program, and generally do not describe contractually enforceable events. A high level summary of the program aspects represented in logic model development are shown in Figure 7:

Figure 7. Logic Modelling

Inputs - Financial and staff resources needed to operate the program

Program Activities What the program actually does

Outputs – Tangible products of program activities

Outcomes – Events that happen as a result of the programs activities and outputs

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

Logic models are useful both for the evaluator to understand a program holistically; and also for program administrators to scrutinize the contributions of individual priorities within a complex program. The iterative logic model process between PSE and the Navigant team identified several logical pathways to achieve desired program outcomes for PSE's Commercial HVAC Incentive Program, including:

1. Reliance on trade ally networks to achieve long-term market transformation
2. Collection of interval data to benefit contractors in the evaluation of projects
3. Marketing activities, such as creation of case studies, thank you packets to participants and large check presentations to increase program participation

Figure 8 depicts the logic model developed in collaboration with PSE:

Figure 8. HVAC Program Logic Model
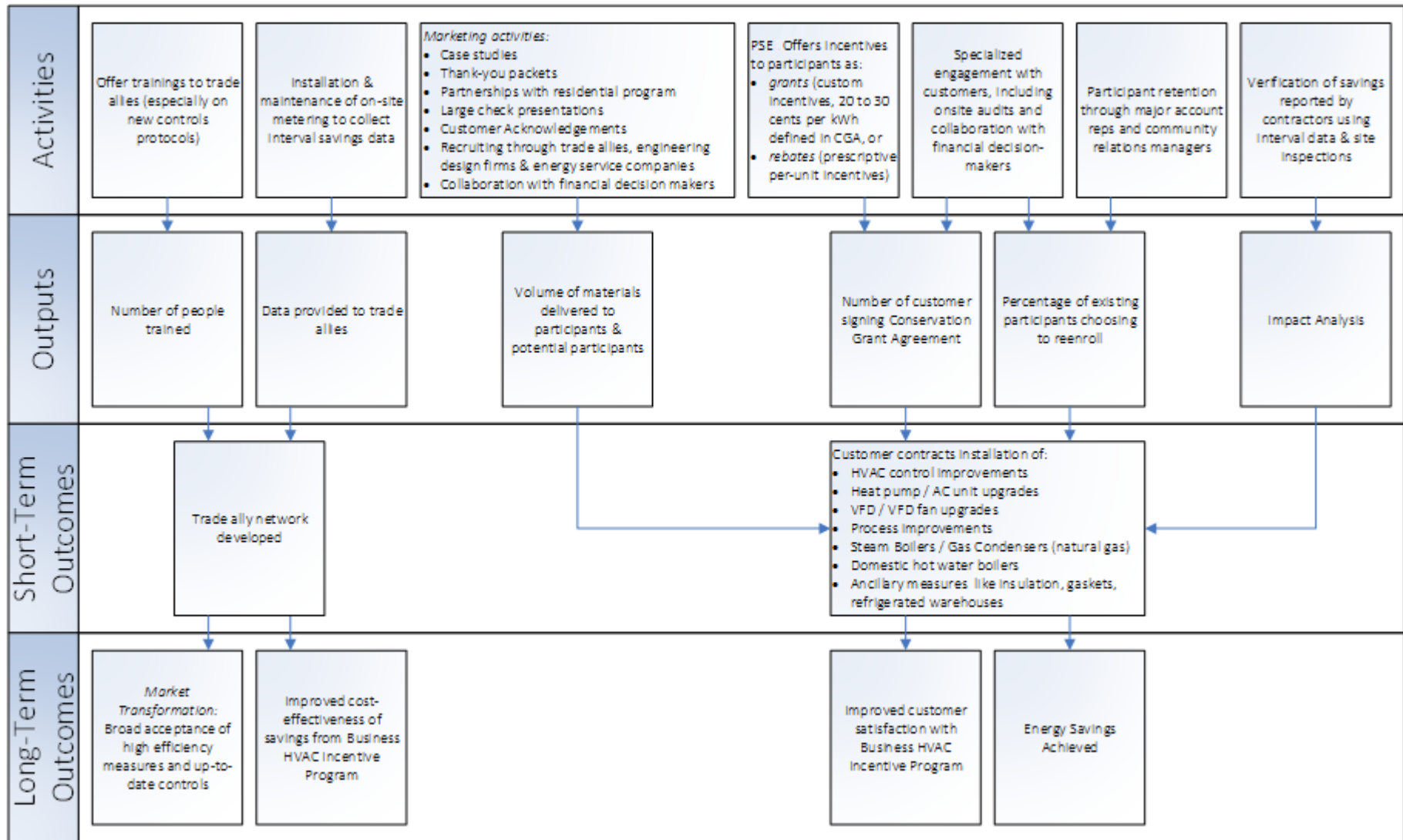
2.2 Trade Ally In-depth Interviews

Methodology

PSE provided the Navigant team with a list of six trade allies participating in the Commercial HVAC Program. Five of the six responded to our request for an interview. Following approval of the interview guide by PSE program administrators, we interviewed the five trade allies and documented program experience and opportunities for improvement. Each was guaranteed anonymity to ensure candid and accurate responses. Verbatim quotes have been provided in the following section to exemplify themes found through the interview process. These passages represent prevailing views among interview respondents only; it may not be accurate to draw population-wide conclusions considering the small sample size. Trade ally responses are grouped by theme as follows:

- Program experiences
- Drivers and barriers
- Information channels
- Trade ally suggestions and summary findings

Trade Ally Experiences

To learn about contractor's experience with the program, questions were posed on four specific areas; experience with PSE staff, experience with the application process, application processing time and overall impressions. Contractor responses to these areas of inquiry are summarized in Figure 9 below.

Figure 9. Contractor Feedback

PSE Staff	Application Process	Application Timeline
Four out of five trade allies say that the PSE staff is consistently good to work with "Staff is great!" "10! The staff is Excellent."	100% of contractors interviewed commented that the application is straightforward and easy to manage	The primary complaint from trade allies was the turnaround time for applications 100% of the trade allies say that the one deterrent from using PSE's Incentive programs is the application timeline "Sometimes PSE will process the work very fast but other times it is very long… just got done with one that took a year."

In addition to several open ended questions regarding program experience, Trade Allies were asked to rate their experience on a one to ten Likert scale with one being very dissatisfied and ten being very satisfied. Trade Ally experience with PSE staff was very positive. Figure 10 summarizes responses to the
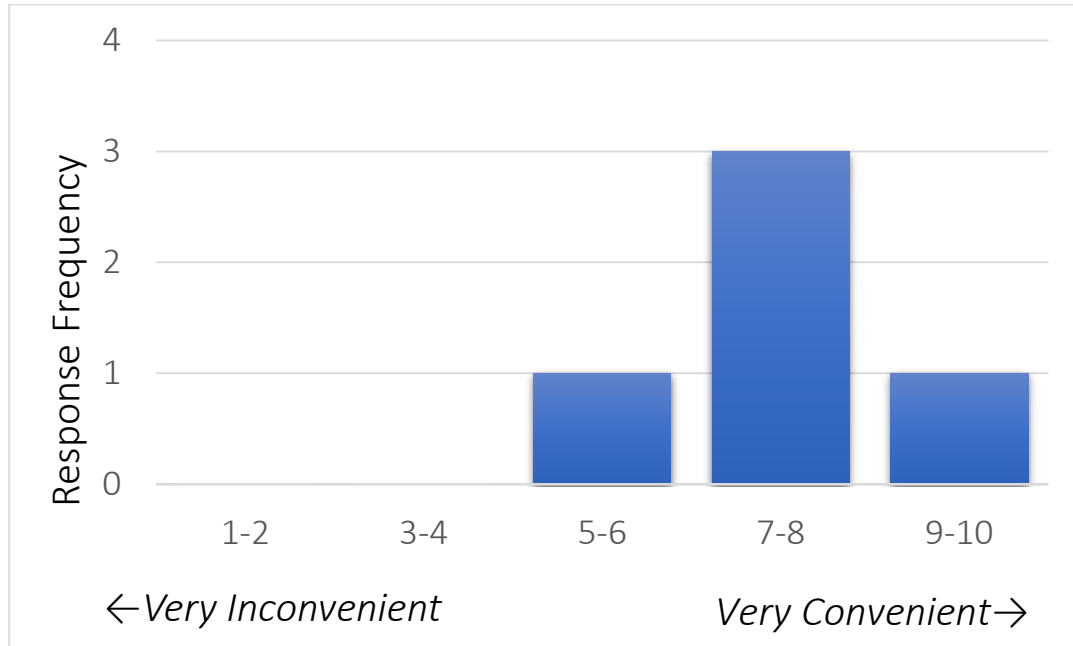
following question: On a scale from one to ten, how would you rate your experience with PSE staff? *(Average: 8.2)*

**Figure 10. Trade Ally Experience with PSE Staff**
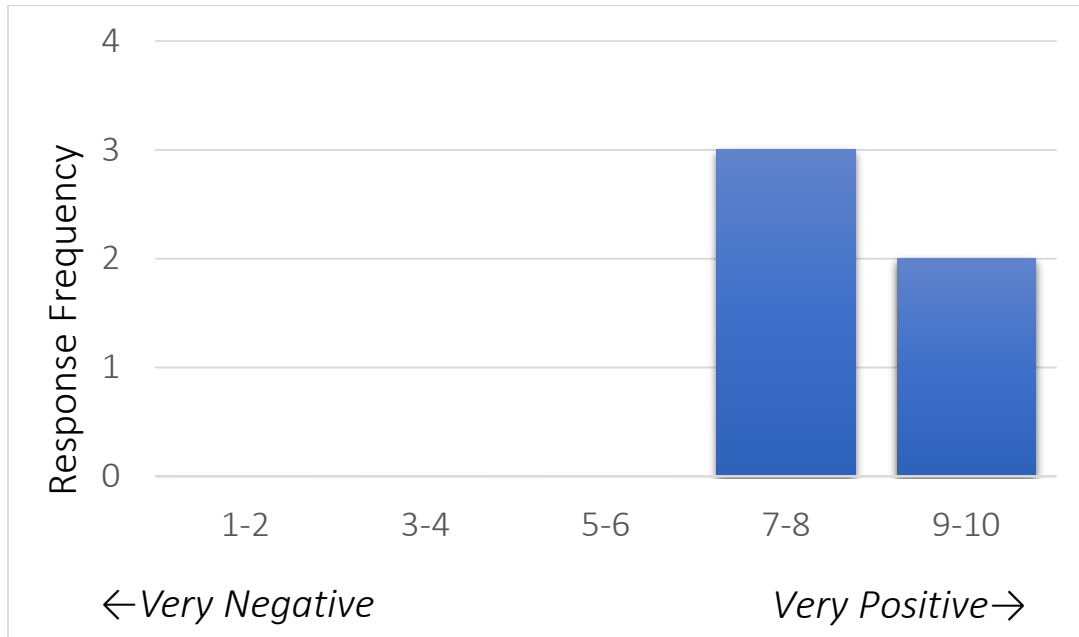
Trade Ally experience with the application process was generally positive. Figure 11 summarizes responses to the following question: On a scale from one to ten, how would you rate the convenience of the application process? *(Average: 7.5)*

Figure 11. Trade Ally Experience with Application

Experiences regarding time to process applications and receive rebate checks received the least favorable rating. Figure 12 summarizes responses to the following question: On a scale from one to ten, how would you rate the time it takes for PSE to process program applications and rebates? *(Average: 5.25)*

Figure 12. Application Processing Timeliness
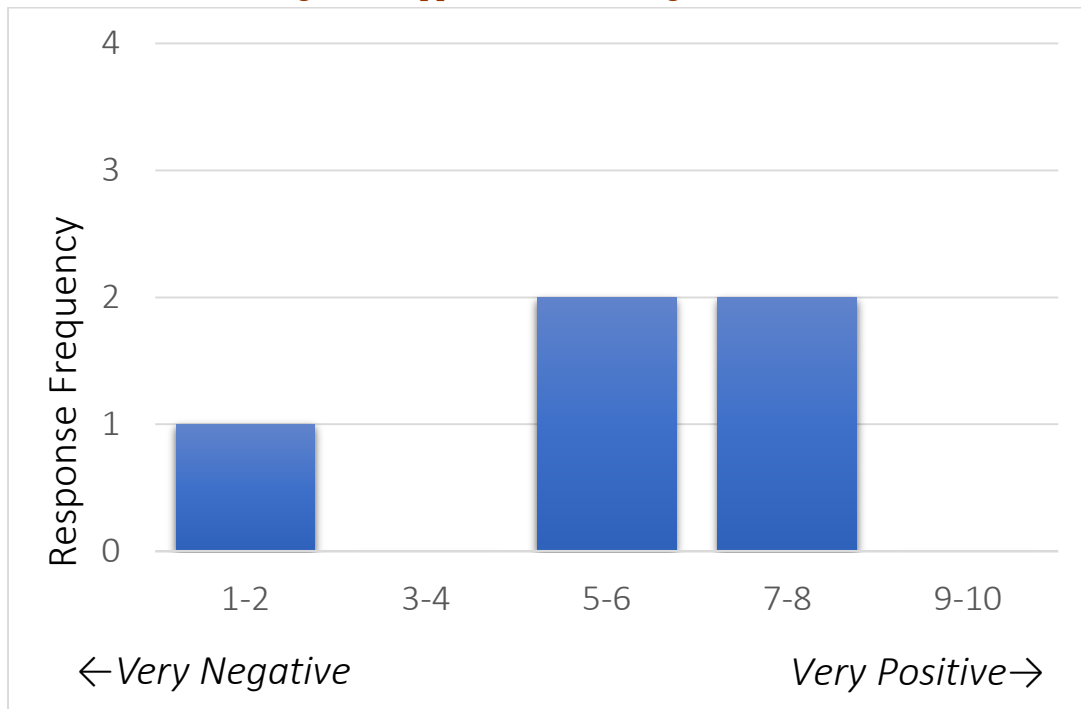
Drivers and Barriers

In this section of the interview, questions were asked regarding customer make up, what motivates participation and what prevents participation as well as what could PSE do to improve its relationship with Trade Allies. Responses to questions are summarized in Figure 13 below.

Figure 13. Drivers and Barriers

Drivers	Barriers
Trade allies define their customers as building owners and operators and facility managers	Payback criteria being too long for scope of project
Customers are motivated to participate in programs to save energy and for the financial gain	Size of project compared to effort of applying

Information Channels

Interview questions on information channels focused on the perceived effectiveness of PSE program and marketing materials as well as experiences with the Contractor Alliance Network. Quotes from the interviewees are shown in Figure 14 below.

Figure 14. TA Feedback on Program Information Channels

Online Offerings	Contractor Alliance Network
"Online material is fairly good. It gets difficult because there is so much information out there but once you find what you need, it is straightforward"	"Have not received benefits yet. Took a while to get signed up"
"Website is quite good. One of the better ones I've seen!"	"Good, always appreciate training"
	"Service department deals with CAN, not sure if it has helped us yet"

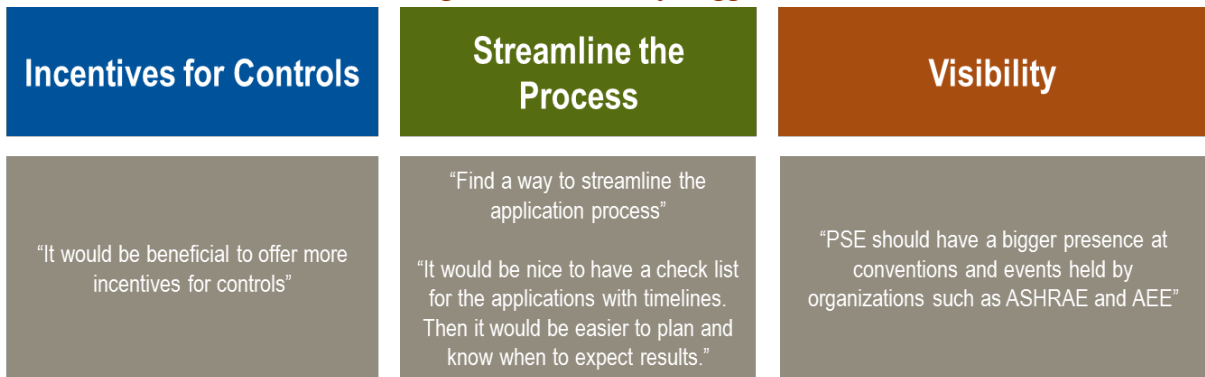TA reported experiences with the PSE web site were generally positive. Trade Allies generally reported that they were either unaware of the CAN or did not see the benefits of CAN membership. Two trade allies knew that they were a part of the Contractor Alliance Network (CAN). Three trade allies were unsure of their CAN status. Of the two who are a part of the CAN, one said their experience was "good" while

the other had not yet seen any benefits from the network. Contractors not using the CAN reported this was due to lack of perceived benefits.

Trade Ally Suggestions and Summary Findings

Trade Allies interviewed had several suggestions for ways to improve the program as summarized in Figure 15 below.

Figure 15. Trade Ally Suggestions

Incentives for Controls	Streamline the Process	Visibility
"It would be beneficial to offer more incentives for controls"	"Find a way to streamline the application process" "It would be nice to have a check list for the applications with timelines. Then it would be easier to plan and know when to expect results."	"PSE should have a bigger presence at conventions and events held by organizations such as ASHRAE and AEE"

Overall satisfaction with the program was favorable. Figure 16 summarizes responses to the following question: On a scale from one to ten, how would you rate your satisfaction with the program overall? *(Average: 7.7)*

Figure 16. Overall Program Satisfaction
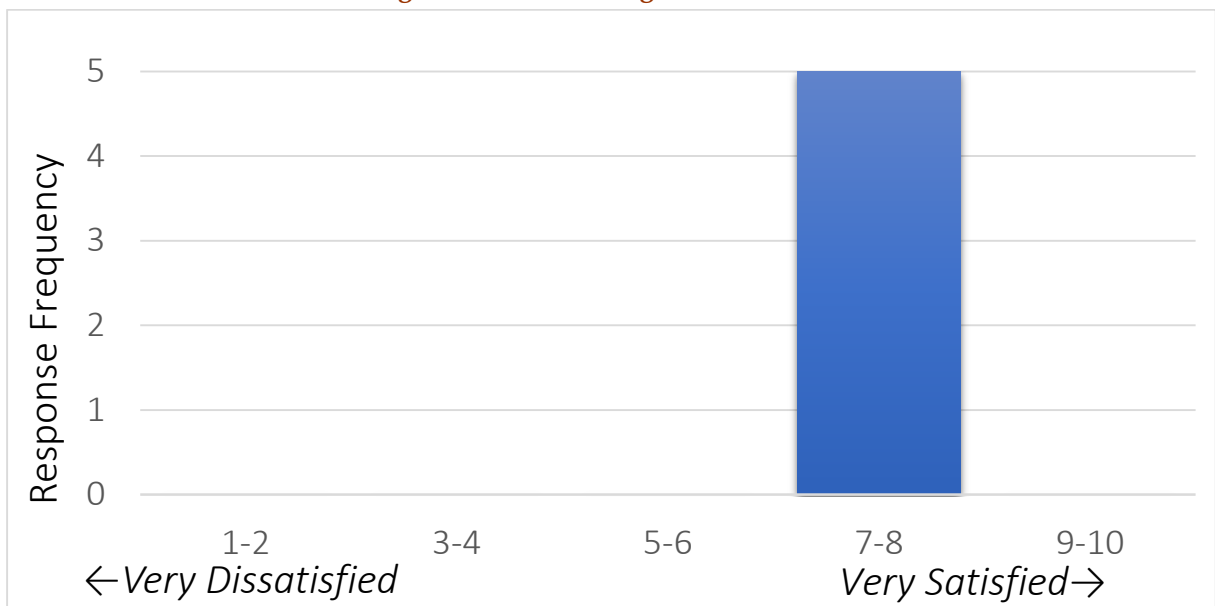
Summary Findings:

1. Overall, contractors are satisfied with the Commercial HVAC program and will continue to seek out this and other PSE programs
2. PSE's online material is great once you get to the page you need, however navigating through the website can be difficult
3. Turnaround time for application processing is longer than trade allies and customers would prefer and can deter customers from participating
4. The majority of interviewees have not yet seen noticeable benefits from the Contractors Alliance Network

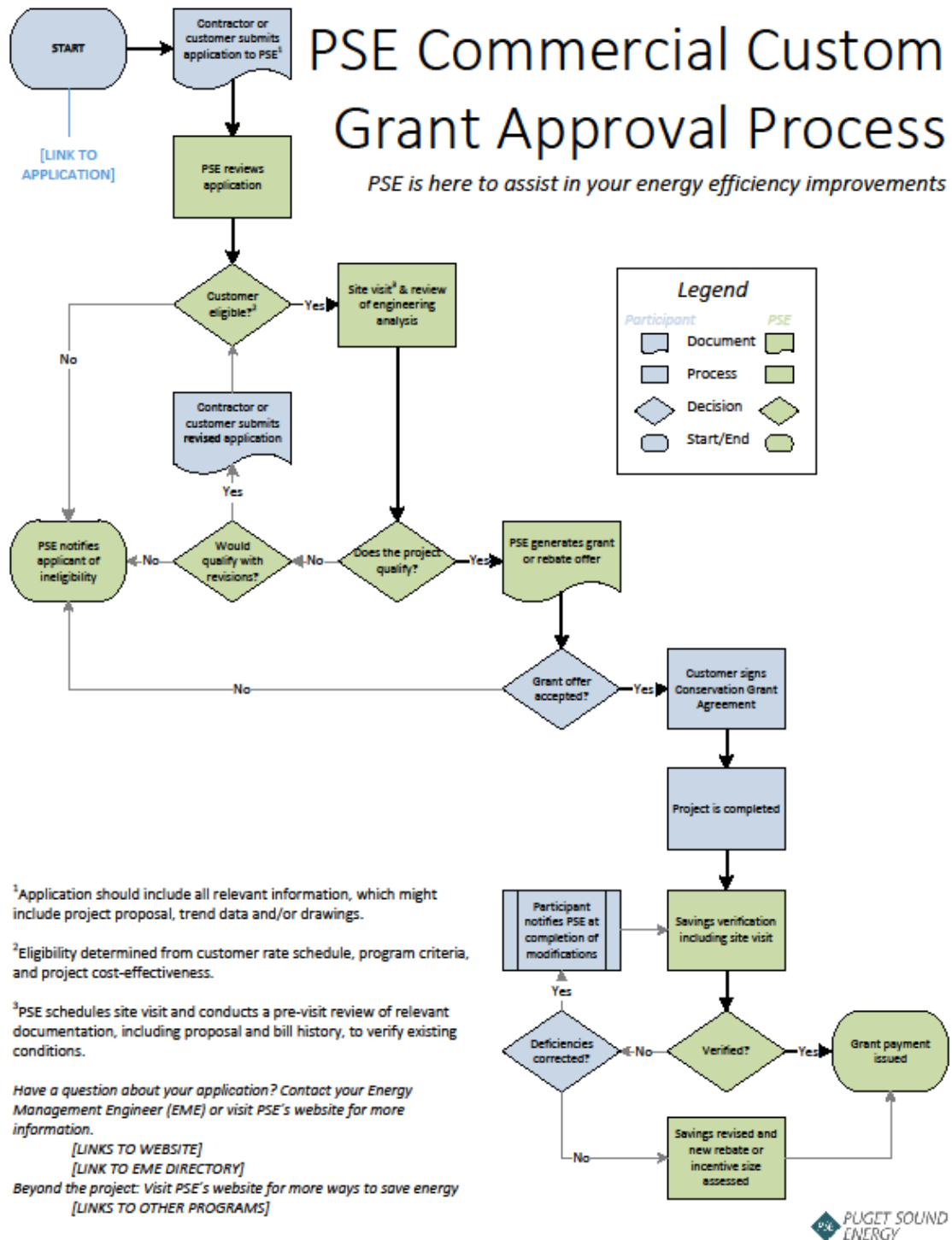## 2.3 Program Process Flow Diagram

Navigant was tasked by PSE to develop a process flow diagram of the commercial Custom Grant approval process. Navigant created the process flow specifically to serve as a customer-facing tool to assist participants of the Commercial HVAC program. Participants of the program must comply with several application, inspection, and approval steps in order to receive incentives. While the program runs efficiently and these steps are required to ensure savings and appropriate incentive payments, the process can be time intensive for some participants and their contractors. Therefore, Navigant worked closely with PSE to develop this tool that clarifies steps and responsible parties, and who customers can reach out to for support or questions where needed.

The following diagram represents the draft delivered by Navigant to PSE. Navigant understands that PSE's marketing and outreach department will create the final version for distribution. Navigant notes that this draft can also serve as a template or basis for developing process flows for other programs.

This exercise and the diagram can also serve future PSE process evaluation efforts. For example, an internal, annotated version can be developed by PSE or future third-party evaluators. Such a version would serve multiple investigations:

- Flag key milestones or action points for quantitative or qualitative process evaluation for the Commercial HVAC program.

  o Flagging responsible parties/departments to gauge administrative effectiveness.
  o Flagging transfer points (e.g., between departments, application goes in to PSE, rebate check goes out to participant, etc.) for observation.
  o Flagging potential bottlenecks for observation.
  o Tracking lead times (e.g., time between application submission and site visit), deviations from those times, and actions taken where there is a lag in the process.
  o Tracking the number of participant inquiries about application status at various points.
  o Tracking rejection rates at various points (e.g., customer eligibility, project qualification, and customer rejections of grant offers).
  o Tracking verification activities and number of deficiencies identified for correction at various points.

Figure 17. Commercial Custom Grant Application Approval Process

PSE Commercial Custom Grant Approval Process

PSE is here to assist in your energy efficiency improvements

[1] Application should include all relevant information, which might include project proposal, trend data and/or drawings.

[2] Eligibility determined from customer rate schedule, program criteria, and project cost-effectiveness.

[3] PSE schedules site visit and conducts a pre-visit review of relevant documentation, including proposal and bill history, to verify existing conditions.

Have a question about your application? Contact your Energy Management Engineer (EME) or visit PSE's website for more information.
        [LINKS TO WEBSITE]
        [LINK TO EME DIRECTORY]
Beyond the project: Visit PSE's website for more ways to save energy
        [LINKS TO OTHER PROGRAMS]

3   Impact Evaluation

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

- Quantifying the impacts of all projects on annual gross energy consumption.

- Establishing post-implementation performance for installed projects.

- Defining realization rates between ex-ante assumptions and ex-post findings

- Explaining discrepancies between the results of this study and the ex-ante savings estimates.

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

3.1   Impact Evaluation Methodology

Review of the C&I Program Tracking Database

The Navigant team completed a thorough review of PSE's Program Schedule Databases which store contextual project data along with *ex-ante* project savings estimates. In addition to verifying the consistency/quality of the information within these data files, the data was used to prioritize projects by their *ex-ante* savings.

We reviewed all of the HVAC projects during the 2012-13 program years, and worked closely with PSE to determine which projects and measures to include in the evaluation. Programs included through this evaluation were:

- E250 & G250 - C&I Retro

- E250 & G250 Industrial

- E258 HV Sch 40, 46, 49

- E250 Ind. System Optimization

- E_G 250 Simplified Building Tune-Up

- E258 HV Sch 449

The evaluation then employed a detailed QC process to screen out non-HVAC measures and projects from other programs, and to standardize the measure categories across all C&I HVAC measures. A summary of the HVAC projects by measure category is presented in Table 4.

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Table 4. Mapping HVAC Measures to Sampling Stratifications

Measure Name	Sampling Stratification
Boilers - steam	HVAC Upgrades – Gas
Boilers - steam GAS	HVAC Upgrades – Gas
Boilers, hot water	HVAC Upgrades – Gas
Boilers, hot water GAS	HVAC Upgrades – Gas
Chiller	HVAC Upgrades – Electric
Controls, Duct Work/ Piping	HVAC Upgrades – Electric & Gas
Drives	HVAC Upgrades – Electric & Gas
Economizer	HVAC Upgrades – Electric & Gas
Economizer GAS	HVAC Upgrades – Gas
Energy mgmt. control system	HVAC Controls – Electric & Gas
Energy Recovery System	HVAC Controls – Electric & Gas
Equipment	HVAC Upgrades – Electric & Gas
Fan, Blower, VFD	HVAC Upgrades – Electric & Gas
Fans - gas, variable frequency drive	HVAC Upgrades – Electric & Gas
Fans, variable frequency drive	HVAC Upgrades – Electric & Gas
Gas Energy mgmt. control system	HVAC Controls – Gas
Gas Process Heating	HVAC Upgrades – Electric & Gas
Heat Recovery Systems	HVAC Upgrades – Electric & Gas
Heat recovery systems GAS	HVAC Upgrades – Gas
HVAC Central equip - GAS	HVAC Upgrades – Gas
HVAC Central equipment	HVAC Upgrades – Electric & Gas
HVAC controls only	HVAC Controls – Electric & Gas
HVAC controls only - GAS	HVAC Controls – Gas
HVAC Unitary equip. GAS	HVAC Upgrades – Gas
HVAC Unitary equipment	HVAC Upgrades – Electric & Gas
Industrial Plant HVAC	HVAC Upgrades – Electric & Gas
Industrial Plant HVAC Gas	HVAC Upgrades – Gas
Motors, efficient	HVAC Upgrades – Electric & Gas
Variable Air Volume Box	HVAC Upgrades – Electric & Gas
Variable Frequency Drive and Controls	HVAC Upgrades – Electric & Gas
VFD - fans	HVAC Upgrades – Electric & Gas
VFD - pumps	HVAC Upgrades – Electric & Gas

Source: Navigant and Tierra Analysis of PSE tracking database.

Impact Evaluation Sampling Framework

The Navigant team developed a sampling framework that provides a realistic level of statistical accuracy, effectively address impact evaluation objectives, and made most efficient use of evaluation resources. Furthermore, feedback from PSE staff ensured that the subsequent sample design was consistent with both industry[1,2] and PSE's internal standards of statistical veracity.

Specifically, the sampling strategy relied upon the Stratified Ratio Estimation approach.[3] Stratified ratio estimation sampling can achieve increased precision and reliability by taking advantage of a relatively stable correlation between an auxiliary variable and the variable of interest (i.e., the ratio of actual savings to program reported savings). This ratio is the *realization rate* for gross verified savings and a core objective of this Impact Evaluation. Our experience has demonstrated that a majority of customers in this type of program will have a realization rate between 70 – 110%, regardless of the *magnitude* of each individual project's energy savings. As such, the sample sizes required to achieve a specific confidence/precision threshold are greatly improved[4] by estimating the realization rate instead of total energy savings and serves to reduce the overall variation within the population.

Per the 2004 California Evaluation Framework,[5] sample sizes developed using the Stratified Ratio Estimation approach comply with the following equation:

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

Where:

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

Upon finalizing the sample, the Navigant tea, reviewed each of the sampled project files to tighten the accuracy of calculated measure savings, demand reductions, etc.; thereby ensuring that they were

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[1] TecMarket Works Team. *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*. April 2006.

[2] National Renewable Energy Laboratory. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 11: Sample Design Cross-Cutting Protocols*. April 2013.

[3] The data meet the two primary requirements for stratified ratio estimation: (a) there is substantial variation in the size of the projects in the program, and (b) the tracking system provides fairly accurate estimates of the savings of each project.

[4] The method achieves efficiency compared to simple random sampling, because the variability of the estimated realization rates is generally lower than the variability of the estimated project savings.

[5] TecMarket Works. *The California Evaluation Framework*. June 2004.

representative of installation conditions. This was accomplished through a prioritized approach in which the most common and complex measures were afforded a commensurate level of effort. Similarly, the review of project files *complemented* the on-site M&V sample to ensure that measures of interest to PSE were adequately addressed.

The evaluation team also documented any data gaps, consistency issues, and the accuracy of the information used to estimate project level savings in the *ex-ante* analysis. For example, checks were made for possible biases in the data (e.g., potential for some customers to be excluded due to the absence of eligibility data for a particular group of customers). Navigant also assessed the variability/uncertainty between PSE's input assumptions and secondary studies along with the relative impact on energy and demand savings. This type of sensitivity analysis was crucial in prioritizing and aligning task resources; the results of this effort were used to develop recommendations for input assumption revisions based on prior evaluation studies, upcoming policy requirements, and geographic factors.

The final Impact Evaluation Sample established stratifications across four measure categories:

- HVAC Upgrades – Electric
- HVAC Upgrades – Gas
- HVAC Controls – Electric
- HVAC Controls – Gas

These measure stratifications were developed in collaboration with PSE to capture any differences in program performance across HVAC project fuel types and measure types. Figure 18 provides an overview of each sampling stratification along with the percentage of total HVAC savings (2012-2013) represented through the final Impact Evaluation sample.

Figure 18. Distribution of Sampled *Ex Ante* Savings by HVAC Sampling Stratification
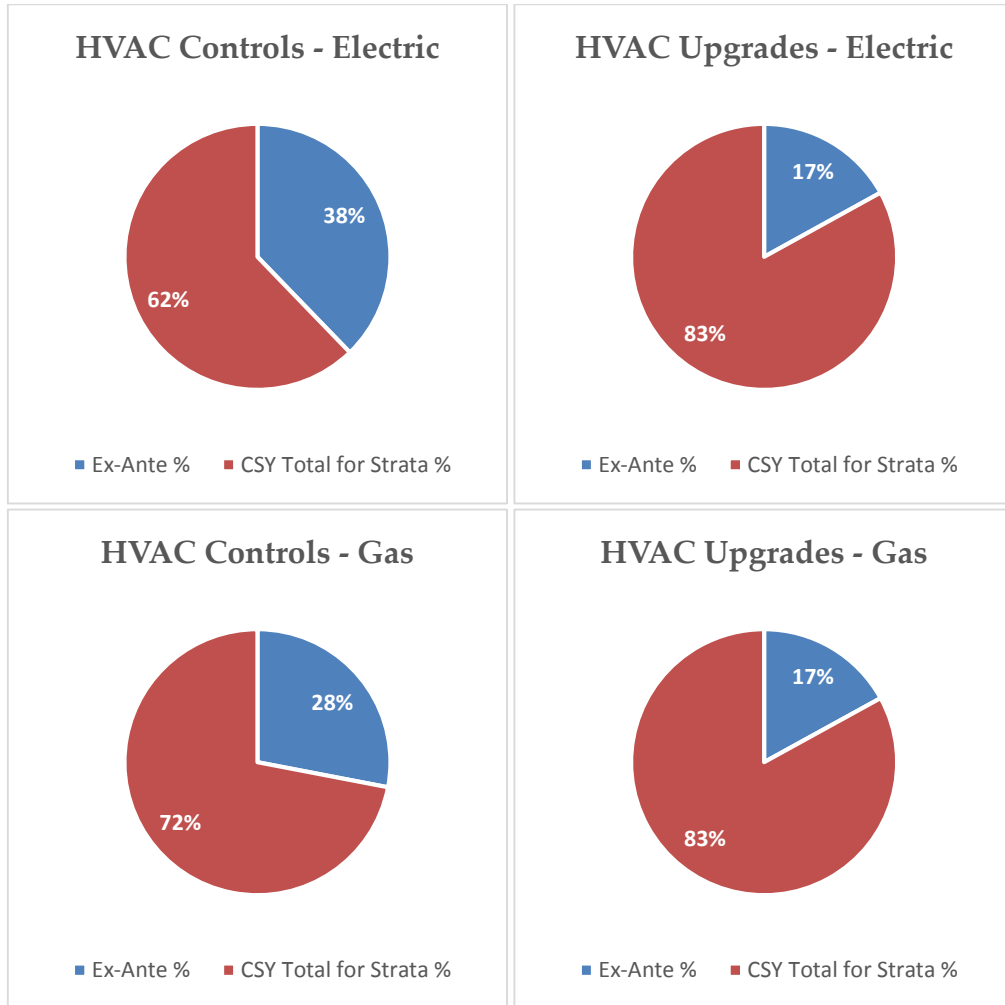
Source: Navigant and Tierra Analysis of PSE tracking database.

Additionally, Table 5 provides further context on the Impact Evaluation sample, including the total number of projects implemented by PSE in the 2012-2013 tariff years.

NAVIGANT

Table 5. Project Size Stratification Boundaries for 2013-2014 C&I HVAC Projects

Sampling Stratification	CSY Reported Savings (Electric - kWh, Gas - Therms)	No. of Projects	% of total 2012-2013 HVAC Savings Represented
HVAC Upgrades – Electric	12,366,566	82	53%
HVAC Controls – Electric	10,828,939	138	47%
Total Electric	**23,195,505**	**220**	**100%**
HVAC Upgrades – Gas	943,950	89	66%
HVAC Controls – Gas	491,596	151	34%
Total Gas	**1,435,546**	**240**	**100%**

Source: Navigant and Tierra Analysis of PSE tracking database.

Sample Design Framework and Iterative Sampling

The Navigant team's sample design and statistical calculation relies on a Microsoft Excel tool that utilizes Excel's built-in optimization software. The tool:

- is based on the stratification methodology discussed above and weights each stratum according to its approximate contribution to the total mean,[6] and

- selects the optimal number of projects needed to determine a population mean based on statistical characteristics of the sample and the desired confidence and precision criteria.

It should be recognized that throughout this evaluation, Navigant and PSE continued to explore opportunities to streamline and optimize the sample. Initially, the Impact Evaluation sampling methodology used a two tailed test, along with a Coefficient of Variation equal to 0.45, to establish a total Impact Evaluation Sample of 93 projects across the four sampling stratifications. However, by closely monitoring the resulting CV's of evaluated projects, the Navigant team was able to update the associated Coefficient of Variation for each stratum. The performance of the evaluated HVAC projects was less variable than initially anticipated, and the resulting updates to the sampling framework resulted in smaller sample sizes that still achieved the required confidence and precision (i.e., (80% confidence for strata; 90% confidence for overall; 10% precision).

Table 6 presents the final stratification for the evaluation and the corresponding sample sizes:

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[6] In this case, the strata weights were defined by the relative percentage of ex-ante energy savings.

Table 6. Final Impact Evaluation Sampling Framework

Stratum	Population (# of Projects	Sample Size	Coefficient of Variation	Relative Precision (80% confidence for strata; 90% confidence for overall)
HVAC Upgrades – Electric	82	15	0.11	13.6%
HVAC Upgrades – Gas	88	15	0.08	14.5%
HVAC Controls – Electric	138	18	0.11	14.0%
HVAC Controls – Gas	151	17	0.09	14.3%
Overall	460	65	0.10	7.7%

Source: Navigant and Tierra Analysis of PSE tracking database.

Site Selection

The participant sample for on-site verification was drawn at random from the list of projects in the tracking database using the RAND() function in Excel. The projects were sorted in increasing order by the RAND() output and the first projects were selected until each stratum allocation was met. Navigant selected the required number of projects for each stratum, as well as up to three additional projects to facilitate recruitment. After selecting the projects, the evaluation team reviewed the distributions within each stratum and confirmed the sampled projects sufficiently represent their respective stratum populations without any sources of bias.

Project File Reviews

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

The evaluation team also compiled a detailed tracking database from the project files for the sampled sites, extracting all relevant data for each line item on measure characteristics, quantity, capacity, efficiency, and supporting documentation (cut sheets). Using this data, Navigant completed a detailed review of project file savings, identifying and fixing any errors in the data entry, and making notes of any line items for which the savings was calculated incorrectly. Figure 19 provides a screenshot of the standardized project file review template developed for each evaluated measure:

Figure 19. Screenshot of HVAC Measure Workbook Front Page with Photos

PSE C&I On-Site Evaluation Review	
Database Project Name	Confidential
Database Customer Name	Confidential
Database PSE Project ID	869668
Database Sample Project ID	18762
Project File *Ex-Ante* Savings (kWh)	N/A
Evaluated Ex-AnteSavings (kWh)	N/A
Project kWh Realization Rate	N/A
Project File Ex-Ante Savings (Therms)	2,532
Evaluated Ex-Post Savings (Therms)	2,287
Project Therm Realization Rate	90%
Database Measure Category	HVAC - Commercial and Industrial
Database Measure	Boilers, hot water GAS
Weather Station	Renton Municipal Airport NOAA Weather File
Notes	Insulation was verified to be fully installed and present. Boiler was confirmed to be operating and functioning as intended. Facility staff noted that insulation and boiler were performing consistent with expectations. Note that only the boiler retrofit is considered in CSY under 18762.

On-Site Verification Photos

We compared the re-calculated savings for each project to what was claimed in the project file, to determine if there were significant errors in the project savings values that PSE is tracking in their database. All *sampled projects had total error rates of 1% or less, indicating that PSE is accurately representing project performance in their ex-ante analyses and program tracking databases*. Based on this finding, Navigant decided that it would not be necessary to present findings with the tracking data error impacts indicated separately from the overall realization rates.

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

On-Site Measurement & Verification Analysis

Navigant contacted each site included in the evaluation, either with the support of PSE program personnel, or directly, to arrange a site visit and to request data from the site. The IPMVP Protocols served as a guide to on-site data collection and evaluation strategies. While on-site, field auditors addressed the following technical issues to determine gross project/program impacts and realization rates for HVAC upgrades and controls:

1. Determining the pre-installation technology performance baseline.
2. Verifying that the HVAC mechanical and HVAC control measures listed for projects were properly installed and developing an accurate characterization of installed measures.
3. Verifying the baseline and measure performance characteristics of the measures installed, and revising or computing performance variables (e.g., operating hours) that affect project savings.
4. Determining the demand and energy savings performance of the HVAC mechanical and HVAC control measures installed.

Technical tasks associated with determining HVAC program impacts included assessing the quality of the data that was available to work with from program files and databases, and determining what data tracking systems and supplemental analyses are required to produce reliable estimates of program impacts.

Table 7 provides a direct mapping of the IPMVP options to the Commercial HVAC program's mechanical and control measures. The Navigant team collaborated with PSE on a project-by-project basis to ensure the measure categories are comprehensive, and to confirm the most appropriate on-site data collection/analysis strategy by measure type (along with establishing a comprehensive set of information to inform each analysis).

Table 7. Overview of M&V Options

Measure Category	Description	IPMVP Option
HVAC	HVAC measures are highly weather-dependent, so long-term billing data is frequently used along with metered data, combining M&V Options B and C to determine energy usage. These data are typically normalized to weather in a typical meteorological year (TMY) to determine savings in a typical year. Because these measures are temperature dependent, it is desirable to obtain as much long-term operational data as possible, along with local weather records, in order to provide a reasonable degree of accuracy in savings estimates.	B/C
Chillers	Chillers can be used as part of HVAC and refrigeration systems or to provide water for industrial processes. Depending on the application of the chilled water, these measures can be analyzed like HVAC or refrigeration measures, using metered and weather data alone, or by employing facility production records as with some process improvements. In all cases a combination of M&V Option B is typically used with either Option C or D depending on the extent of available data and the portion of the facility energy usage affected by the chiller.	B/C/D
EMSs	EMSs can affect a significant portion of systems at a facility. Controls can include lighting, HVAC, refrigeration, boilers, and, less commonly, process equipment. Because of the extensive nature of these controls, and because they typically provide long-term operational data with their controls, M&V Option C or D is used to analyze these savings. Depending on the systems affected, weather data may be combined with system records and utility billing data to determine energy savings from these systems.	C/D
Boilers	Boilers often account for a significant portion of the natural gas load at a facility, so it is frequently straightforward to employ billing data for the facility to use M&V Option D in the analysis of savings. System measurements of system temperature and operation as in Option B can be used to enhance the accuracy of these evaluations.	B/D

And Table 8 provides a more detailed overview of these IPMVP Options:

Table 8. Overview of M&V Options

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

Verification Data Analysis

The Navigant team initiated the verification process by creating a line-item-level database with all of the HVAC measures for all sampled projects to verify that the *ex-ante* calculations had been performed correctly. This also served to ensure that all line items for each project were included in the on-site verification. Project files were reviewed for accuracy, consistency, and completeness while the PSE-provided billing data were reviewed against on-site findings, measurements, and direct logging. Two primary methods were applied to the billing data in order to visualize and evaluate the program measure impacts to-date:

1. Linear Regression
2. Polynomial Regression

The models generated for this evaluation were normalized against temperature and heating degree days (HDD) for each site evaluated by weather station or at the meter. Most sites showed close correlation to the ex-ante predicted savings over time with some exceptions due to the following circumstances:

1. Occupancy Changes
2. Building Use-Profile Changes
3. Building Characteristic Changes
4. Equipment "Swap Outs"

All exceptions were reviewed and considered on a site-by-site basis. Some commonly found differences from the ex-ante projections were changes in vacancy levels, longer run-times of equipment due to scheduling changes, building additions, and equipment swap outs as standard maintenance or for comprehensive system upgrades. EMS trend data were also retrieved on-site or from corporate site representatives via data request and compared against project file assumed operational characteristics and operational characteristics found on-site. To thoroughly catalog and analyze the sampled projects a site and measure-level workbook was generated for each of the projects evaluated which are organized in the following primary manner:

1. Result Summary – Contains the CSY reported values assessed against evaluation findings and high-level assumptions. Site-level pictures from on-site verification are also included to show the measures implemented through the program.

2. PSE Billing Data – The primary analysis tab where PSE billing data are presented and analyzed against weather and building-level profile data.

3. Additional Billing Data – Any additional billing data received is post processed and merged with the primary analysis in the PSE Billing Data tab at this location.

4. NOAA Weather Station Data – Localized weather data from the National Oceanic and Atmospheric Administration (NOAA) are compiled and rolled into the analysis in the PSE Billing Data tab from this location.

5. Bin Analysis – Additional QC checks via the Bin Method of evaluating building-level energy consumption were performed against the primary analysis in the PSE Billing Data tab.

6. TMY3 Updated Data – Data from the National Solar Radiation Data Base which were compiled and updated on January 19, 2015 were used for the QC Bin Analysis tab.

Some workbooks may also contain additional tabs used to house and record site-level EMS trend data which are used to inform the primary analysis contained in the PSE Billing Data tabs. These additional layers of analysis were included to ensure the evaluated savings and any adjustments which were performed were adequately linked to their respective source data.

Realization Rate Calculations

The Navigant team identified the following technical issues that were addressed in order to accurately determine *gross program impacts and realization rates*:

1. Determining the pre-installation technology performance baseline.

2. Verifying that the DSM measures listed for projects were in fact installed and developing an accurate count of installed measures.

3. Verifying the baseline and measure performance characteristics of the measures installed, and revising or computing performance variables (e.g., operating hours, equipment power) as needed.

4. Determining the demand (kW) and energy savings (kWh) impacts of the DSM measures installed.

5. Estimating the long-term persistence of the program's impacts. Less than 100% of the measures' impacts will generally persist over time due to customer removal, tenant or occupant changeover,

and other changes. This is necessary for the benefit/cost analysis over the life of the measures installed.

Other technical issues associated with determining *gross program impacts* included assessing the quality of the data that is available to work with from program files and databases, and determining what data manipulation systems and supplemental analyses are required to produce reliable estimates of program impacts.[7]

The Impact Evaluation revealed that in many situations, the baseline conditions change between *ex ante* and *ex post* cases, often due to non-programmatic factors. The evaluation team's ongoing discussions with PSE have allowed the team to develop a standardized approach to characterizing project baselines used in both the Impact Evaluation, and subsequent tasks that are informed through evaluated project performance. The standardization of project baselines serves to tighten the accuracy and consistency of future evaluation studies (while distinguishing between *systematic* errors and *random* errors).[8,9]

Consistent with PSE's evaluation objectives, the Navigant team calculated gross project-level savings leveraging the following methodology:

__Ex Post Realization Rate__ = (Ex-post baseline usage [3] - Ex-post post usage [4]) / (Ex-ante baseline usage [1] - Ex-Ante post usage [2])

1. The *ex-ante* savings provided by PSE *([1] - [2])* is constant and maintained through PSE's program tracking database.
2. However, the *ex-post* savings (*[3] and [4]*) are adjusted based on on-site verification findings; both of which may change based on an adjusted baseline.
3. The evaluation team documented what factors are driving the baseline, and what factors are causing deviations in realization rates.
4. In the event that *non-programmatic* (e.g., economic factors, short term changes in occupancy and demand, etc.) factors are influencing project-level realization rates, Navigant adjusted the project baseline to control for these factors and establish a corrected baseline / realization rate that was reflective of the project's long term performance in the absence of these non-programmatic factors.

The team has also reviewed the aforementioned approach against regional best practices, PSE's EM&V Framework,[10] and industry-accepted methodologies to ensure that the evaluation methodology addresses project baselines in a way that is mathematically astute. Our review found the aforementioned evaluation

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[7] Some premises had revenue meter swap outs occur between project completion and evaluation for which the revised meter data proved problematic to procure. We have continued to work closely with PSE to identify more efficient methods for aligning meter numbers and meter data to premise IDs stored in the CSY Database.

[8] Systematic errors (input assumptions, measurement error, bias) and random errors

[9] *Exhibit 8: Evaluation, Measurement & Verification (EM&V) Framework*, Puget Sound Energy, Revised August 6, 2015

[10] Ibid.

methodology to be representative of regional evaluation standards, as an example, PSE's EM&V Framework specifically documents the following approach to characterizing program savings:

"Program savings are calculated by comparing baseline energy use to post-implementation energy use, controlling for non-programmatic factors."
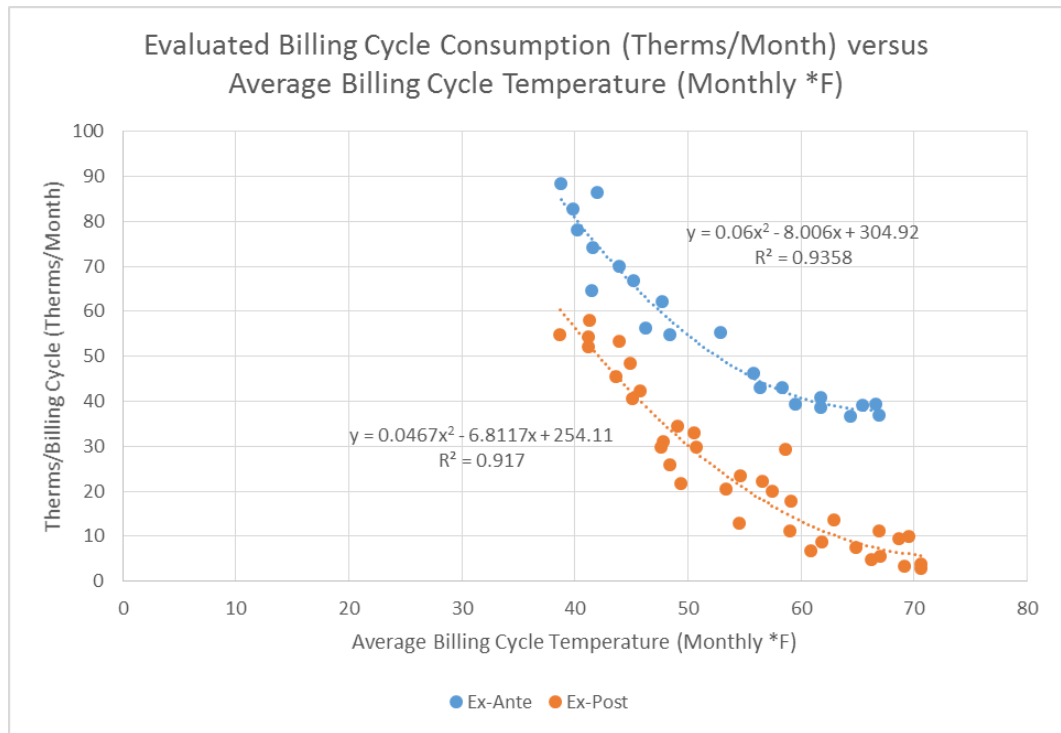
Figure 20 provides an illustration of the Evaluation Team's approach to calculating realization rates with adjustments to the project baseline:

Figure 20. Impact Evaluation Analysis (Regression Example)
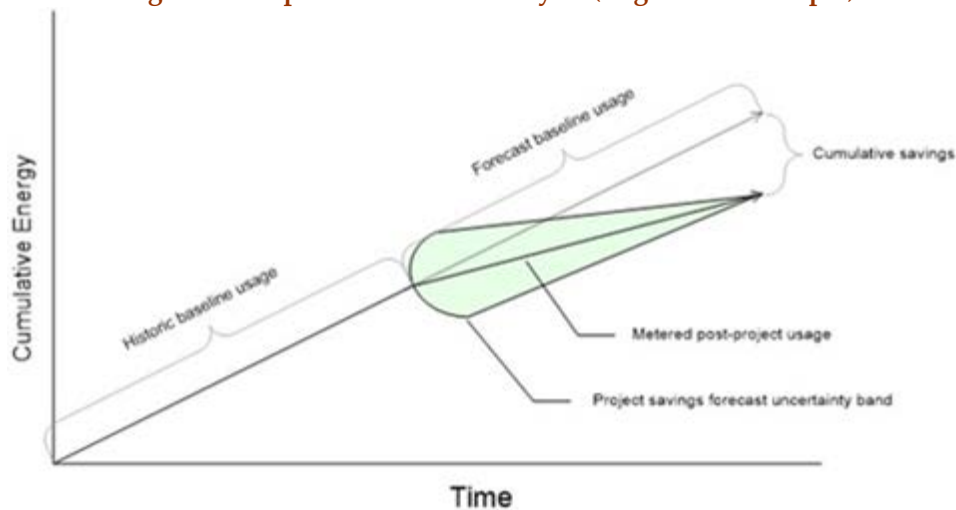
Similarly, Figure 21 provides an example of the Impact Evaluation analysis methodology used to characterize measure performance through a combination of on-site verification data and billing usage history pre-/post-measure installation:

Figure 21. Impact Evaluation Analysis (Regression Example)

Evaluated Billing Cycle Consumption (Therms/Month) versus Average Billing Cycle Temperature (Monthly *F)

$y = 0.06x^2 - 8.006x + 304.92$
$R^2 = 0.9358$

$y = 0.0467x^2 - 6.8117x + 254.11$
$R^2 = 0.917$

● Ex-Ante ● Ex-Post

3.2   Impact Evaluation Findings

Program-Level Savings

Table 9 details the total C&I HVAC *ex-post* gross program savings and realization rates for program years 2012-2013. The realization rates range from 92 to 103%, and average 98% overall. This is a clear indication that PSE's *ex-ante* project analyses are mathematically sound and representative of *ex-post* verification findings. Deviations in the operating assumptions for incented measures were the main factors causing differences between the *ex-ante* and *ex-post* savings.

Table 9: Total Savings by Stratum

Stratum	Total Projects	Final Sample of Projects	*Ex-Ante* Savings (Electric - kWh, Gas - Therms)	Realization Rate	*Ex-Post* Savings (Electric - kWh, Gas - Therms)
HVAC Upgrades – Electric	82	15	3,485,728	97%	3,365,623
HVAC Controls – Electric	138	18	4,090,032	103%	4,225,677
Total Electric	**219**	**33**	**7,575,760**	**100%**	**7,591,299**
HVAC Upgrades – Gas	89	15	190,148	99%	188,806
HVAC Controls – Gas	151	17	137,748	92%	126,939
Total Gas	**239**	**32**	**327,896**	**96%**	**315,745**
Overall	**460**	**65**		**98%**	

Source: Navigant and Tierra Analysis of M&V data

Verified Savings by Sampled Project

Table 10 below shows the verified savings for each of the 65 projects which were included in the sample:

## Table 10: Verified Savings by Sampled Project

Project ID	Sampling Stratification	Project Number	*Ex-Ante* Savings (Electric - kWh, Gas - Therms)	Realization Rate	*Ex-Post* Savings (Electric - kWh, Gas - Therms)
220391	HVAC Controls - Electric	839910	14,920	98%	14,690
10903	HVAC Controls - Electric	850932	102,684	97%	99,342
951	HVAC Controls - Electric	856205	165,500	108%	178,378
6309	HVAC Controls - Electric	857784	850,678	104%	880,872
1744	HVAC Controls - Electric	859156	39,975	101%	40,560
6120	HVAC Controls - Electric	864394	182,500	96%	175,996
23763	HVAC Controls - Electric	864399	373,395	90%	337,707
23764	HVAC Controls - Electric	867674	44,140	100%	44,140
952	HVAC Controls - Electric	867675	44,639	100%	44,639
6119	HVAC Controls - Electric	867676	177,308	100%	177,308
10966	HVAC Controls - Electric	876047	108,392	120%	130,013
10961	HVAC Controls - Electric	876049	109,246	107%	116,506
10965	HVAC Controls - Electric	876050	87,586	91%	79,786
14435	HVAC Controls - Electric	888741	143,746	78%	111,483

Project ID	Sampling Stratification	Project Number	*Ex-Ante* Savings (Electric - kWh, Gas - Therms)	Realization Rate	*Ex-Post* Savings (Electric - kWh, Gas - Therms)
14400	HVAC Controls - Electric	889042	120,135	130%	156,065
24153	HVAC Controls - Electric	894475	262,541	106%	279,390
99911	HVAC Controls - Electric	850934	9,304	109%	10,128
5884	HVAC Controls - Electric	850707	1,253,343	108%	1,348,674
99912	HVAC Controls – Gas	975294	1,708	100%	1,704
13286	HVAC Controls – Gas	843375	2,044	96%	1,970
13454	HVAC Controls – Gas	846891	2,201	100%	2,193
17984	HVAC Controls – Gas	858525	11,281	100%	11,326
10279	HVAC Controls – Gas	867521	39,296	87%	34,165
11103	HVAC Controls – Gas	867853	19,375	81%	15,747
21706	HVAC Controls – Gas	873600	884	94%	828
16850	HVAC Controls – Gas	878142	15,954	93%	14,913
16842	HVAC Controls – Gas	878143	1,743	100%	1,746
18005	HVAC Controls – Gas	878144	3,438	96%	3,299
13484	HVAC Controls – Gas	878146	4,083	111%	4,520
20679	HVAC Controls – Gas	879985	2,826	94%	2,650
12603	HVAC Controls – Gas	883109	13,372	105%	14,013
9397	HVAC Controls – Gas	900842	3,538	81%	2,858
9332	HVAC Controls – Gas	846949	1,045	88%	924
16763	HVAC Controls – Gas	872724	4,566	81%	3,688
22042	HVAC Controls – Gas	829746	10,394	100%	10,394
220392	HVAC Upgrades - Electric	839910	53,575	98%	52,748
13296	HVAC Upgrades - Electric	855433	73,380	97%	71,342
6049	HVAC Upgrades - Electric	856056	204,026	80%	163,663
6054	HVAC Upgrades - Electric	856056	87,184	80%	69,936
3544	HVAC Upgrades - Electric	870127	621,914	89%	552,563
13295	HVAC Upgrades - Electric	873916	65,872	95%	62,895
9545	HVAC Upgrades - Electric	874139	16,739	102%	17,105
9558	HVAC Upgrades - Electric	874140	16,739	102%	17,105

Project ID	Sampling Stratification	Project Number	Ex-Ante Savings (Electric - kWh, Gas - Therms)	Realization Rate	Ex-Post Savings (Electric - kWh, Gas - Therms)
9546	HVAC Upgrades - Electric	874141	16,739	102%	17,105
10409	HVAC Upgrades - Electric	883016	38,020	121%	46,018
1518	HVAC Upgrades - Electric	859809	374,839	112%	420,542
99913	HVAC Upgrades - Electric	912161	5,658	90%	5,065
99914	HVAC Upgrades - Electric	912161	26,132	90%	23,395
9957	HVAC Upgrades - Electric	856321	215,263	91%	195,785
758	HVAC Upgrades - Electric	881136	1,669,648	99%	1,650,354
21346	HVAC Upgrades - Gas	813387	17,918	83%	14,796
11158	HVAC Upgrades - Gas	847818	49,507	105%	51,845
7561	HVAC Upgrades - Gas	857421	2,998	82%	2,456
17982	HVAC Upgrades - Gas	858525	42,519	102%	43,205
17983	HVAC Upgrades - Gas	858525	5,710	112%	6,375
17216	HVAC Upgrades - Gas	863936	1,927	91%	1,763
7268	HVAC Upgrades - Gas	865944	491	95%	465
18762	HVAC Upgrades - Gas	869668	2,532	90%	2,287
11715	HVAC Upgrades - Gas	881558	3,140	100%	3,136
19491	HVAC Upgrades - Gas	886165	6,046	96%	5,821
10505	HVAC Upgrades - Gas	888709	3,436	100%	3,436
18370	HVAC Upgrades - Gas	894847	4,858	100%	4,858
18374	HVAC Upgrades - Gas	859255	5,501	95%	5,226
10004	HVAC Upgrades - Gas	869422	6,558	100%	6,558
758	HVAC Upgrades - Gas	881136	37,007	99%	36,579

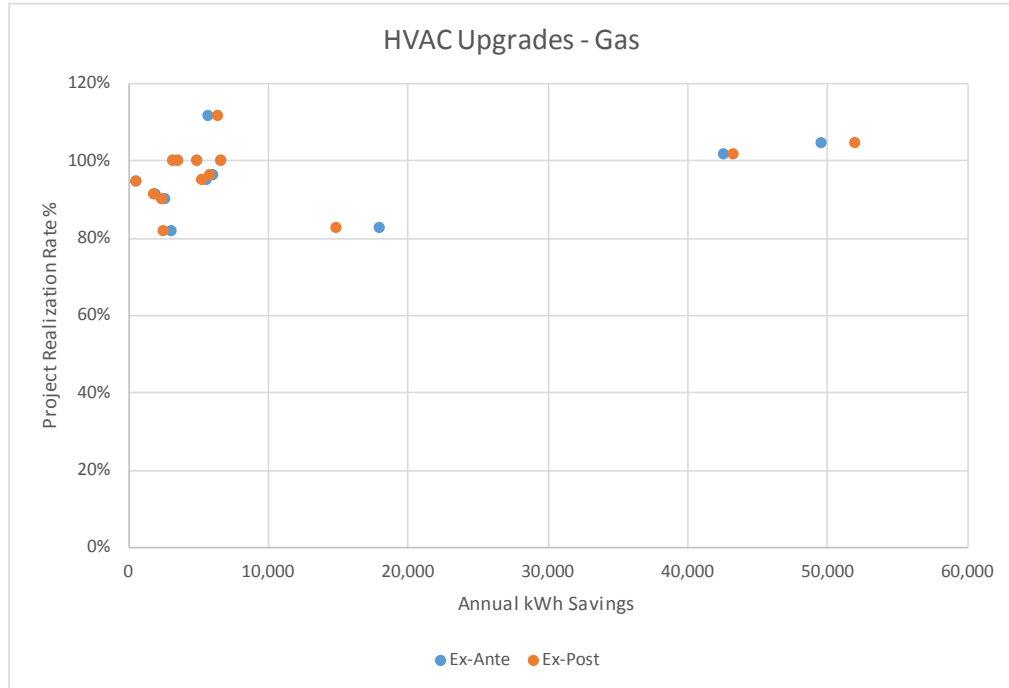*Source: Navigant and Tierra Analysis of M&V data*

As noted earlier, Figure 2 through Figure 5 (Executive Summary) detail the total C&I HVAC *ex-post* gross project realization rates, by strata, for program years 2012 and 2013. Additionally, Figure 22 through Figure 25 provide a scatter diagram of realization rates relative to project size for each sampling stratification. The objective of these charts is to demonstrate that projects performed consistently, and that there is not a bias in project performance due to project size.

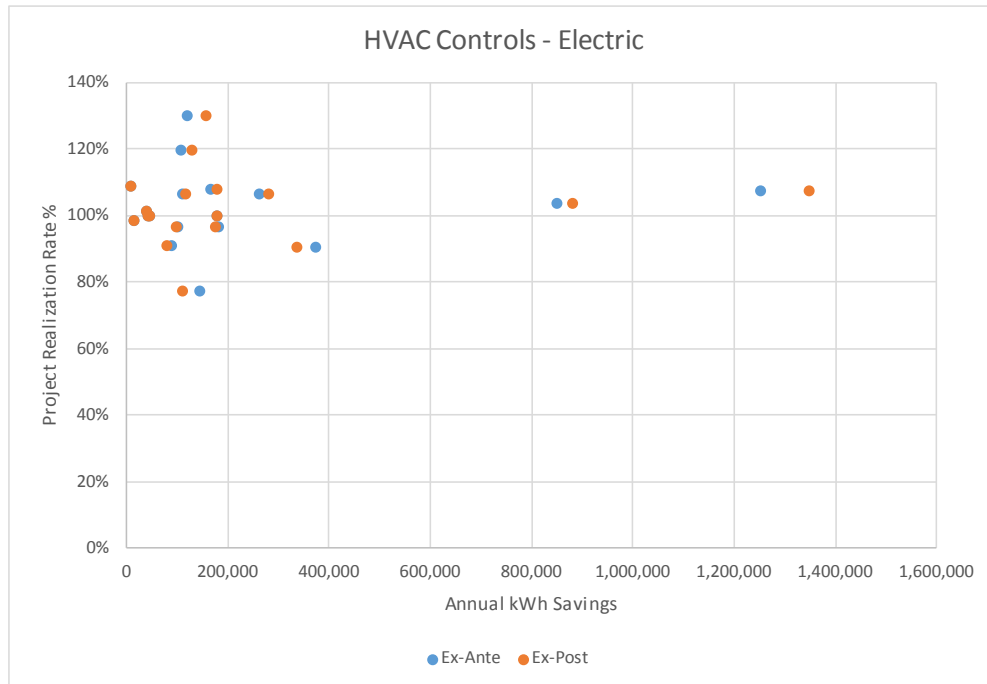**Figure 22. Project Savings and Realization Rates (HVAC Upgrades – Electric)**
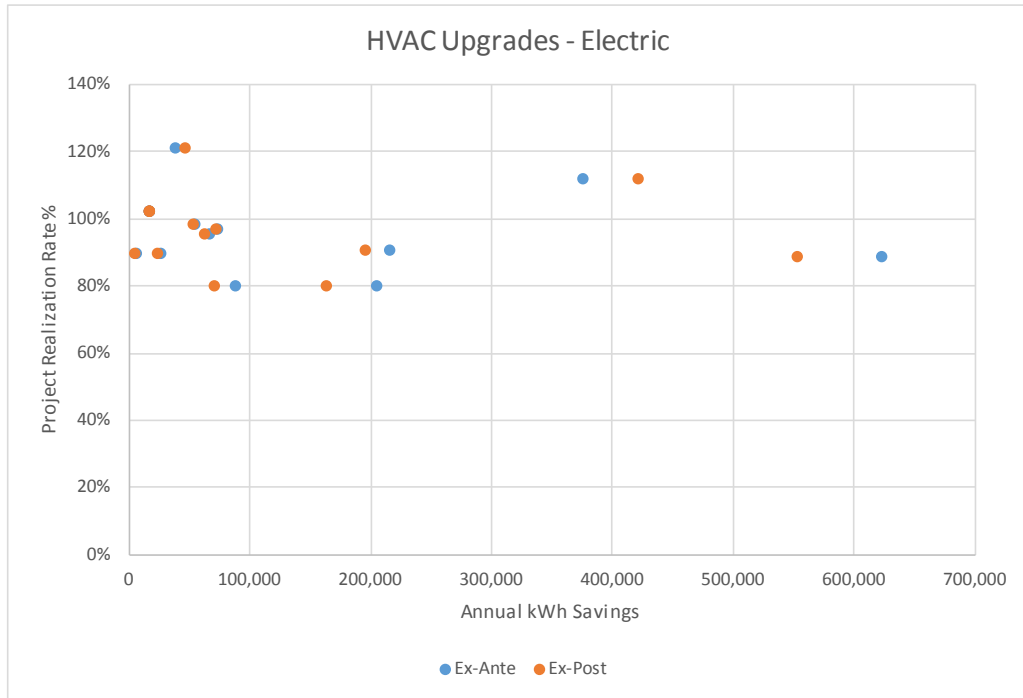
Source: Navigant and Tierra Analysis of M&V data

Figure 23. Project Savings and Realization Rates (HVAC Upgrades – Gas)
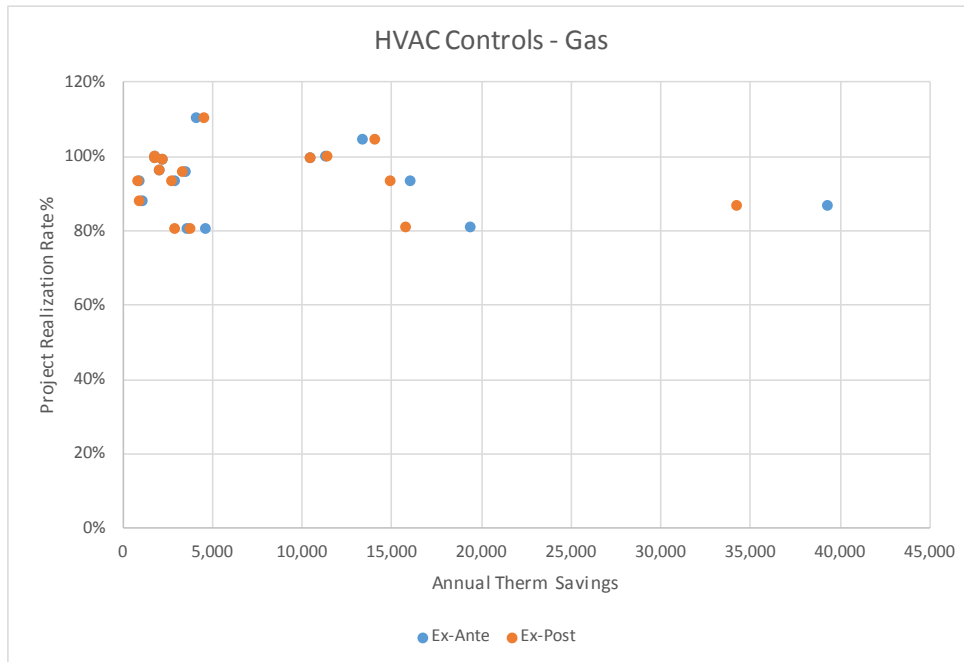

Source: Navigant and Tierra Analysis of M&V data

Figure 24. Project Savings and Realization Rates (HVAC Controls – Electric)

Source: Navigant and Tierra Analysis of M&V data

Figure 25. Project Savings and Realization Rates (HVAC Controls – Gas)

Source: Navigant and Tierra Analysis of M&V data

3.3   Impact Evaluation Recommendations

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

Program Data Requirements

- *Require program participants to provide estimates of building occupancy and/or operational changes over time.* Currently, building occupancy and/or equipment operational changes are only tracked in the time frame between the initial project QC and final incentive payment. However, approximately 30% of the evaluated projects in the Impact Evaluation sample required adjustments to the baseline in the *ex-post* analysis due to occupancy and equipment operational changes that occurred after this period. Going forward, consider tracking whether the participants foresee any changes in occupancy, product demand, measure operating characteristics, etc., This will allow PSE to more accurately calculate *ex-ante* savings, or at the very least, keep an eye on projects that have a uncertainty surrounding their savings.

Program Data Tracking

- *Track line-item-level program data in the tracking database.* Currently, PSE only tracks data aggregated by project and measure category, although Microsoft Excel® workbooks containing

detailed data are submitted for HVAC measures as part of the program documentation. Maintaining additional line-item-level data in the detailed program tracking database would allow PSE to more readily check for errors in the submitted project data, while streamlining future evaluation efforts.

- ***Ensure project and analysis files are maintained in a Spreadsheet format.*** Although many of the project files received from PSE were quite detailed, many spanned multiple projects and required additional time to identify the *final* project savings values, and align the *ex-ante* calculators with the program tracking databases. In some cases, HVAC project files needed to be manually translated from a *.PDF format into a spreadsheet format so that the data could be analyzed and used during the site visits. Future evaluation efforts will be streamlined and effective if PSE maintains all analysis files in a spreadsheet format.

- ***Track specific program project milestones and completion dates.*** Currently, estimated project completion dates are being tracked in the project documentation but specific dates pertaining to project completion and commissioning are not adequately documented. Consider implementing database fields which document specific project milestones, project commissioning, and project completion.

Energy Savings Calculations and Documentation

- ***Ensure that any suggested changes in savings methodology are accounted for before final payment is issued***. In reviewing the sampled projects, it was discovered that a small subset of sites had notes in the payments file regarding occupational or operational profiles which had changed since the projects were initially proposed. Ensure all comments are reviewed and accounted for in the savings and grant amounts before finalizing the numbers in the CSY Database.

NAVIGANT

Appendix A. Factors Influencing Program Realization Rates

As noted earlier, although stratum-level realization rates were fairly consistent and close to 100%, the individual projects showed considerably more variability in their realization rates. Most of this variability was due to differences between reported and field-verified measure operating characteristics (discussed below), but a few projects' realization rates were affected by closure or demolition of portions of the site itself. These exceptional findings are summarized in Table 11**Error! Reference source not found.**:

Table 11: Exceptional Findings by Project

Project Number	Finding
839910	Facilities staff were happy with the project and the EMS controls were verified to be installed and operational via review of the EMS frontend at a physical terminal. The facility was fully utilized at the time of the site visit.
850932	Both the on-site staff and corporate representative were satisfied with the incented EMS System. The on-site manager noted that there were HVAC Performance issues during the billing cycles following project inception which anecdotally included heating or cooling when neither were necessary.
856205	There are 3 buildings in this campus for which controls improvements were implemented; 6120 (CSY# 864394) - Building 3 951 (CSY# 856205) - Building 4 23763 (CSY# 864399) - Building 5 Note that the first year savings for the project exceeded the QC and Payment assessments as does the to-date assessment.
857784	Site survey confirmed controls were operating as intended. Review of the EMS system with the Program Participant verified that set points were consistent with project files. The participant was satisfied with PSE's Program and outreach.
859156	The building was completely vacated in early 2014 and the building is currently for lease. The existing HVAC RTU is being periodically cannibalized for parts and run in maintenance mode when operational. The program rebated equipment is still installed in the building. The analysis has been adjusted to show only the 7 months post-retrofit for business as usual for which the operational characteristics closely follow the original savings estimates as will be the case once the building is occupied again in the future.

864394	There are 3 buildings in this campus for which controls improvements were implemented; 6120 (CSY# 864394) - Building 3 951 (CSY# 856205) - Building 4 23763 (CSY# 864399) - Building 5 The original project savings were calculated to be 135,800 kWh which were then raised to 182,500 kWh per PSE-post billing analysis. Per the 3 billing regression analysis, it is apparent that the baseload of the building has increased over time. The payment file outlines that the load began to increase between the QC and payment portions of the project cycle. Thus the baseline was adjusted to-date to account for the increased baseload. Facility staff were happy with the project and reported no issues. Review of their EMS systems showed that the project was still operational and functioning as-intended.
864399	There are 3 buildings in this campus for which controls improvements were implemented; 6120 (CSY# 864394) - Building 3 951 (CSY# 856205) - Building 4 23763 (CSY# 864399) - Building 5 The original project savings were calculated to be 154,000 kWh which were then raised to 373,395 kWh per PSE-post billing analysis. Per conversations with facilities staff who were active at the time of the retrofit and to-date, occupancy use profiles of tenants are the primary drivers of differences in consumption over time. The EMS system is functioning as-intended and facilities staff are happy with project.
867674	Facilities staff were happy with the project and noted that the fans rarely turned on due to the new CO monitoring system. An interview with the manufacturer revealed that the current model of system installed did not have data logging capabilities thus Hobo state loggers were deployed over a 3 week period. The findings of the logging were in-line with the EMS vendor, which is lower runtime hours than originally anticipated. Facilities staff also noted that the fans were run overnight for parking garage cleaning at least quarterly. Thus as a conservative estimate, 5% savings were applied to the baseline which is consistent with the findings of EMS vendor from direct logging as well in the payment file.
867675	Facilities staff were happy with the project and noted that the fans rarely turned on due to the new CO monitoring system. An interview with the manufacturer revealed that the current model of system installed did not have data logging capabilities thus Hobo state loggers were deployed over a 3 week period. The findings of the logging were in-line with the EMS vendor, which is lower runtime hours than originally anticipated. Facilities staff also noted that the fans were run overnight for parking garage cleaning at least quarterly. Thus as a conservative estimate, 5% savings were applied to the baseline which is consistent with the findings of EMS vendor from direct logging as well in the payment file.

867676	Facilities staff were happy with the project and noted that the fans rarely turned on due to the new CO monitoring system. An interview with the manufacturer revealed that the current model of system installed did not have data logging capabilities thus Hobo state loggers were deployed over a 3 week period. The findings of the logging were in-line with the EMS vendor, which is lower runtime hours than originally anticipated. Facilities staff also noted that the fans were run overnight for parking garage cleaning at least quarterly. Thus as a conservative estimate, 5% savings were applied to the baseline which is consistent with the findings of EMS vendor from direct logging as well in the payment file.
876047	The comprehensive controls and damper project was verified to be present and operational via operator interviews, onsite verification, and desk review of trend data. Site savings were adjusted down based on increased load via site contact-provided meter trend data.
876049	The on-site survey confirmed the presence and operation of the system controls project. The participant facility was operational and occupied; however, occupancy has changed since project inception and thus the baseline was adjusted over time to reflect the occupancy changes.
876050	The controls project is still active an operational with no reported issues. Note that the original project file savings was 117,705 with an adjustment to remove the optimal start savings resulting in 117,705-30,119 = 87,586 kWh/Year which is consistent with the savings reported in CSY.
888741	Program participant noted that controls were functional and operating as intended and was able to achieve Energy Star certification for this building due to their comprehensive efficiency upgrades which included the program implemented controls. Occupancy and load has remained relatively constant since the project was completed and thus no adjustments were performed.
889042	Program participant noted that controls were functional and operating as intended. Occupancy and load has remained relatively constant since the project was completed. The participant noted that while the other building which received the same program controls was able to receive Energy Star certification, this building unfortunately was not due to higher vacancy rates although the building itself is technically qualified.
894475	This project was executed through the prior property management company. No major changes to scheduling or controls since project was executed in 2013 and the facilities staff noted no issues with the current controls or building systems.
850934	The controls system was verified to be installed and operating as intended. Review of EMS trend data from the corporate efficiency manager verified the operational characteristics were consistent with the project file documentation. Both the facilities staff and the corporate efficiency manager were both pleased with the subset of projects performed through PSE.

850707	Original savings conservatively assigned as 322,818 Annual kWh (5% of baseline). Final savings in payment file is 1,253,343 Annual kWh (19.5% of baseline) based on bill analysis. Baseline consumption of 6,414,800 Annual kWh which is the 3 year average from 6/24/2008 to 5/25/2011. The baseline was established from backdating consumption to combined billing history data as used for the QC and final analysis Payment files. The payment file notes: "Building profiles were developed for pre and post upgrade by adding trend lines to the respective data sets on the kWh/day vs. temperature bill history graph. To minimize the potential for over estimating energy savings, the post trend line was artificially inflated based on the lack of confidence the building profile would remain at the current level is likely to increase over time." The evaluation findings are consistent with the project file documentation.
975294	This project showed increasing consumption trends over time. Both the store manager and corporate efficiency manager were interviewed without explanation for the uptrend in consumption. Review of 2 weeks of trend data for the store showed the correct set points and system specifications which from interviewing the corporate efficient manager were reportedly unchanged. Thus based on the engineering review, the systems appear to be functional and the uptrend in consumption may be related to the other 50% of consumption unaccounted for by the system and any interactive effects associated. Both the store manager and corporate efficiency manager could not provide additional insight into these items and additional data was not available before, during, or after the site visit. The resultant savings are based on the average evaluated savings across the other stores which received the same controls system (99.8%).
843375	The on-site survey confirmed the presence and operation of system controls. The participant facility was operational and occupied and the customer was pleased with the controls retrofit noting no operational or building-level issues.
846891	The CO2 DCV System was verified to be operation via EMS review on-site. The program participant confirmed that system has been functioning well since project completion and is also interested in upgrading their current EMS system while retaining the CO2 DCV functionality which was added through the program.
858525	The Heat Recovery Chiller (HRC) was verified to be installed and functional on-site. The EMS set points were reviewed on-site and trend data were reviewed off-site to ensure the project was operating as-intended. Site staff were happy with the HRC and its performance noting that while occupancy does change due to events, their HVAC loads are fairly consistent due to requirements for humidity and temperature control within the building.

867521	Site engineers noted that the boiler controls have been an excellent project. There is also an intertie between 2 buildings operating under the following strategy: When 1 building is being used to run both buildings valves are opened and transfer pumps run. During winter, the intertie is closed and 2 separate plans are run for each building. Hot Water Boilers are utilized for the HVAC only while the Steam Boilers are for washers, autoclaves, and shell & tube heaters for DHW heating through HX. Fuel oil used for backup is also sub-metered at this site but not the natural gas.
867853	The controls project was well received by county staff. Review of EMS trend data shows systems are working as-intended. The project savings were adjusted based on changes in occupancy profiles for the building which occurred in 2012. Based on review of the project files and interviews with site staff, it is likely that additional occupancy changes had occurred but it was unclear from the site-interview what other wings in the building would have changed largely over time.
873600	Both the store manager and corporate representative were happy with the project noting that the automation of scheduling for the controls were beneficial for day-to-day operations.
878142	The facilities personnel spoke highly of the projects performed and did not note issues with the projects implemented. Post-project implementation, additional wings were added to a few buildings resulting in pressurization issues in the buildings for which the measures were implemented. External to this project, the facilities staff are looking into these issues currently. The rebated controls strategies and equipment were verified via EMS frontend and trend data review to be present and operational. A facility walkthrough verified the rebated green energy fume hood equipment to also be present and operational with labs concurrently in session.
878143	The facilities personnel spoke highly of the projects performed and did not note issues with the projects implemented. Post-project implementation, additional wings were added to a few buildings resulting in pressurization issues in the buildings for which the measures were implemented. External to this project, the facilities staff are looking into these issues currently. The rebated controls strategies and equipment were verified via EMS frontend and trend data review to be present and operational. A facility walkthrough verified the rebated green energy fume hood equipment to also be present and operational with labs concurrently in session.

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879985	The business owner who was also the site contact is very pleased with the project and considering it for another local Planet Fitness facility. The project is working as-intended with no control issues reported.
883109	Site surveys verified presence of kitchen DCV and trend data confirmed system fluctuations between 25% - 100%. The system is working as-intended to date and the customer is pleased with the project performance.
900842	The restaurant owner noted that the energy management system was working well for them to-date noting that their sales had increased approximately 12% since the project completion (27 months) which represents a 0.44% monthly revenue increase from project completion to-date. The original baseline for the project per the QC file is 15% savings based on empirical data applied to the entire gas bill. Baseline adjustments were performed to account for this as the EMS system affects HVAC and lighting while other gas loads such as water heating and cooking would account for >50% of the consumption understanding that there is an interplay between ventilation and cooking.
846949	Facilities staff were happy with the project and EMS trend data reviewed on-site at a EMS terminal showed the system was operating as-intended with the set points outlined in the project files. Maintenance staff noted that special events would occasionally require longer runtimes for equipment and system demand changes with the school calendar.

872724	The store showed a significant (20%) uptrend in consumption between the pre and post ECM cases. Per restaurant owner and manager interviews, there has been an increase in cooking activity over time although the exact magnitude of the change could not be determined. The system was verified to be installed and operational on-site with the store manager and owner both happy with the system performance noting no issues. Accordingly, savings are based on an average of the same controls system installed for other projects in the sample (81%).
829746	On-site interviews with staff and review of EMS frontend at the maintenance staff terminal showed system set points consistent with the project documentation. No issues were reported and on-site measurements of the boilers showed excellent working order. Facilities staff were pleased with the project and noted no issues. Due to difficulty in locating the billing data for gas account, an engineering desk review was performed for this site which revealed no issues.
839910	Facilities staff were happy with the project and the VAV boxes were verified to be installed and operational via review of the EMS frontend and physical verification at the building via spot checking above the ceiling tiles. The facility was fully utilized at the time of the site visit.
855433	The on-site survey verified the installation of VFDs on Pump SMD-CHP-01, 02, and 03. Trend data confirmed operational characteristics of chilled water pumps. Facilities staff noted no issues with the pumps or controls and were pleased with the project performance.
856056	Per interview the facilities manager, the old chiller was replaced in August 2015 with a new Trane unit. The rebated Economizer and VFD remains although the FanMaster controller was replaced with all new Johnson Controls units. A full LED lighting retrofit was also performed through PSE in December 2015. The customer is happy with the project and is looking to install additional VFD's for process equipment this year and is currently engaging PSE to implement the projects. Database customer name should also be updated as the two original partnering companies split up and the assets are now solely owned by one company. The lower realization rate is likely due to performance issues for the original chiller from which the original savings estimates were produced. However, the magnitude and duration of these changes were not able to be concretely established based on site interviews and thus no additional adjustments were performed although the chiller was swapped out which would substantiate the claim. The site contact although very knowledgeable and helpful was fairly new to the site and was not around at the time of project completion.

856056	Per interview the facilities manager, the old chiller was replaced in August 2015 with a new Trane unit. The rebated Economizer and VFD remains although the FanMaster controller was replaced with all new Johnson Controls units. A full LED lighting retrofit was also performed through PSE in December 2015. The customer is happy with the project and is looking to install additional VFD's for process equipment this year and is currently engaging PSE to implement the projects. Database customer name should also be updated as the two original partnering companies split up and the assets are now solely owned by one company. The lower realization rate is likely due to performance issues for the original chiller from which the original savings estimates were produced. However, the magnitude and duration of these changes were not able to be concretely established based on site interviews and thus no additional adjustments were performed although the chiller was swapped out which would substantiate the claim. The site contact although very knowledgeable and helpful was fairly new to the site and was not around at the time of project completion.
870127	The SMARDT chillers, chilled water pump and condenser water pump VFDs were verified to be installed and operational. The savings are more in-line with the payment file indicated annual savings of 586,915 kWh as opposed to the projected savings of 621,914 which is reported in the CSY database. Savings were scaled based on the discrepancy between payment file indicated savings and the CSY reported savings as on-site interviews with staff did not reveal any major operational changes.
873916	The site survey confirmed the operation and trend data was used to verify the Sequence of Operation for the installed VFD.
758	Ex-Ante calculations indicated that the VFDs would run the fans at 80% during periods of high occupancy and 40% during periods of low occupancy. Logging and calculations found that the fan speeds were consistent with the ex-ante assumptions. Savings were applied to each RTU proportionally based on the RTUs percentage of the baseline load.
874139	The VFDs were verified and equipment was spot-measured on-site. A review of trend data confirmed that the fans are being run at reduced speeds during off hours.
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883016	On-site monitoring of the systems verified that the ALM condenser water pump VFD's were installed and fully operational which varied based on the loop static pressure supplied by the Honeywell controller. The site contact was pleased with the project and the savings were adjusted down to account for the 6 months of vacancy earlier this year.

859809	The SMARDT chillers, chilled water pump and condenser water pump VFDs were verified to be installed and operational. Review of the EMS frontend and trend data with the facilities EMS staff showed all system operational at the time of the site visit with some scheduled downtime for pump maintenance. Adjustments were performed to account for outlying data points in the base case resulting in a better fitting regression model to the CSY reported values.
912161	At the time of the site visit, the VSDs and heat pumps were verified to be installed and operational. Some equipment was locked out at the time of the site visit due to ventilation upgrades on the roof. The participant was pleased with the projects noting no operational issues to date.
912161	At the time of the site visit, the VSDs and heat pumps were verified to be installed and operational. Some equipment was locked out at the time of the site visit due to ventilation upgrades on the roof. The participant was pleased with the projects noting no operational issues to date.
856321	For this site, the boiler is operated based on the loop temperature set point for the water source heat pumps. Thus even when there is no call for hot water, the boiler is still in standby mode. The site maintenance staff reported no issues with the boiler which was controlled via their EMCS.
813387	Interviews with site staff revealed that the lagging boiler had a cracked manifold which was repaired earlier last year. Flue gas analysis showed the boilers operating in the >90% efficiency range and the facilities staff were happy with the project and performance. Savings were not adjusted due to uncertainty over when the damage occurred and how large the magnitude of impact seen at the meter was as detailed occupancy information was not readily available.
847818	The building was recently fully renovated and customer was satisfied with the scope and performance of measures installed at the facility. The site survey confirmed that controls and boilers functioned properly, and flue gas measurements verified that boilers were operating at 90% efficiency.
857421	Per the project files, although the total savings were calculated as 5,048 Therms/Year for both the school and the church only 2,998 annual Therms were rebated in the payment file for the school. Thus only the school boiler savings are reported for this project. On-site spot measurements showed both boilers are operating at >90% efficiency and the school representative was very happy with the project outcome to-date.
858525	The condensing boiler was verified to be installed and functional on-site. Trend data and combustion data results were reviewed to ensure the project was operating as-intended. The boiler is operating at >90% efficiency. Site staff were happy with the new boiler and its performance noting no performance or maintenance issues.
858525	Interviews with site staff revealed that the controls were working well for the unique needs of the building. Site staff were happy with the new controls and project performance to-date.

863936	The on-site survey confirmed that the boiler was operating as intended. The customer was satisfied with program participation process and flue gas measurements verified that the boiler was operating at > 89% efficiency.
865944	The original load estimate was determined by using a regression analysis of the billing history. Since the boiler affected by this project serves 50% of the facility, the heating load was adjusted by 50% in the PSE boiler worksheet.
869668	The floor insulation was verified to be fully installed and present. The boiler was confirmed to be operating and functioning as intended as well. Facility staff noted that insulation and boiler were performing consistent with expectations to-date since the project inception.
881558	Both MOD CON 850HL boilers are installed and operational. The site personnel commented that the boilers were working well which were confirmed with flue gas measurements at an average efficiency of 89%.
886165	The purpose of the boiler replacement project was to allow the customer to operate the pool year round, which they are now doing. Prior to the PSE project the customer shut down the boiler from September through March, or 7 months of the year, and operated the pool and boiler for 5 months, from April through August.
888709	Per the PSE project files, the (2) existing 91.7% condensing gas boilers were verified to have been replaced with (2) new 350,000 BTU ASME Jandy EHE350NC Hi-E2 high efficiency condensing gas boilers. The boilers were in good operating condition during the time of the site visit and nameplate information was gathered. While the boilers are rated at 95% efficiency, the assumption of 93.7% efficiency before losses per the PSE boiler savings calculator is maintained as a conservative estimate.
894847	The on-site survey verified that the pool boiler was installed and operational. Program participants noted that the boiler was functioning well above expectations, and better than the previous unit which was difficult to modulate.
859255	The rebated measures were verified to be installed and operational at the time of the site visit. Both the site contact and maintenance staff who worked with the equipment regularly were happy with the performance and showed that one of the original boilers was still installed as a backup unit. Operationally, the only issue noted was that sometimes there have been issues with the EMS controls system when a temperature sensor fails (ex: system thinks gym is at 50*F versus 60*F) which would result in longer equipment runtimes. However, this happens maybe once or twice a year and is corrected within a day either by facilities staff or their contractors. Due to this uncertainty, a 5% decrement is applied to the realization rate.

869422	The program rebated AHU, VFD, VRF, and occupancy controls were verified to be installed and operational. From on-site reviews with the engineering manager, no problems were reported to exist from initial system commissioning-to-date (e.g. business as usual). Review of the site billing data shows a steady uptrend in consumption since project inception which could not be explained from site interviews and equipment inspection. No EMS trend data was available. Based on engineering reviews of the system details and on-site interviews and inspection the project appears to be working as intended with the increased consumption due to other building systems such as cooking equipment and perhaps increased occupancy (although the latter could not be validated with complete certainty).

Source: Navigant and Tierra Analysis of M&V data

As noted earlier, in the event of a change in a project's baseline due to non-programmatic factors, Navigant collaborated with PSE to establish a corrected baseline / realization rate that was reflective of the project's long term performance in the absence of these non-programmatic factors.

Evaluation Report Response

Evaluation Report Response

Program:	Commercial HVAC
Program Manager:	Jeff Petersen
Study Report Name:	2012-2013 Commercial HVAC Impact and Process Evaluation
Report Date:	April, 2016
Evaluation Analyst:	Michael Noreika
Date of ERR:	June, 2016

Evaluation Overview, Key Findings, Recommendations and Program Responses:

Overview:
This evaluation report documents the results of the impact and process evaluations of the PSE 2012-2013 Commercial HVAC Program. The program is designed to encourage the installation of selected cost-effective energy efficient HVAC measures in existing commercial buildings. The program provides financial incentives toward the installation of such measures.

The study's goals were to verify measure installations, quantify program level energy savings, collect feedback from trade allies, and present best practices for similar programs. Navigant developed the following as part of the process and impact evaluations of the 2012-2013 program years:

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

Key Findings:

Impact Evaluation –

- The analysis yielded the following electric gross savings realization rates:

Stratum	Ex Ante Savings	Realization Rate	Coeff. of Variation	Relative Precision[4]
HVAC Upgrades – Electric	3,485,728 kWh	97%	0.11	13.6%
HVAC Controls – Electric	4,090,032 kWh	103%	0.11	14.5%
HVAC Upgrades – Gas	190,148 therms	99%	0.08	14.0%
HVAC Controls - Gas	137,748 therms	92%	0.09	14.3%
Overall		98%	0.10	7.7%

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[4] Relative precision calculated at 80% for each stratum; 90% for the overall.

- The main drivers of realization rates were differences between reported and verified measure operating characteristics. PSE could not have predicted such differences in the ex-ante savings.

- For a few projects, the ex ante baseline was adjusted during the ex post analysis. These projects underwent significant changes, such as partial closure or demolition of portions of the site itself. In such cases, the energy savings equipment was verified as installed and operating.

Process Evaluation –

- Interviews with trade allies yielded the following:

  - Overall, trade allies are satisfied with the program and will continue to seek out this and other PSE programs.
  - Trade allies say that PSE's online material is great once they get to the page they need, however, navigating through the website can be difficult for some.
  - The majority of interviewed trade allies have not yet seen noticeable benefits from the Contractor Alliance Network.
  - Turnaround time for application processing is viewed as too long and can deter participation.

Impact Evaluation Recommendations and Program Responses

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

1. ***Require program participants to provide estimates of building occupancy and/or operational changes over time.*** Currently, building occupancy and/or equipment operational changes are only tracked in the time frame between the initial project QC and final incentive payment. However, approximately 30% of the evaluated projects in the Impact Evaluation sample required adjustments to the baseline in the ex-post analysis due to occupancy and equipment operational changes that occurred after this period. Going forward, consider tracking whether the participants foresee any changes in occupancy, product demand, measure operating characteristics, etc., This will allow PSE to more accurately calculate ex-ante savings, or at the very least, keep an eye on projects that have a uncertainty surrounding their savings (p. 40).

Program Response:

- The rapidly changing landscape of commercial and industrial building occupancy and market conditions makes it very difficult to accurately predict factors that may affect energy savings such as occupancy and product demand. To the extent possible at the time of the initial customer contact, PSE does evaluate existing operating conditions and does factor forseeable changes expressed by the customer and into energy savings calculations. Additionally, as demonstrated below, PSE does amend savings calculations and, if necessary, incentive amounts based on post-installation information collected.

- As the Commercial/Industrial Retrofit program is not performance based program, PSE does not modify savings estimates or claimed savings beyond the final site visit and project closeout unless an error in calculation has been discovered.

- PSE has incorporated measure-level protocols that contain a performance incentive element which will be tracked in order to accurately evaluate and claim the expected energy savings.

2. ***Track line-item-level program data in the tracking database.*** Currently, PSE only tracks data aggregated by project and measure category, although Microsoft Excel® workbooks containing detailed data are submitted for HVAC measures as part of the program documentation. Maintaining additional line-item-level data in the detailed program tracking database would allow PSE to more readily check for errors in the submitted project data, while streamlining future evaluation efforts (p. 40).

Program Response:

- The results of this evaluation did not indicate that errors were discovered.

- The current tracking database is designed to categorize measures at a general project-level and individual measure-level, with detailed documentation being kept in the electronic project file. Tracking measure-level would increase complexity of project tracking and possibly increase errors associated with the categorization of measures.

3. ***Ensure project and analysis files are maintained in a Spreadsheet format.*** Although many of the project files received from PSE were quite detailed, many spanned multiple projects and required additional time to identify the final project savings values, and align the ex-ante calculators with the program tracking databases. In some cases, HVAC project files needed to be manually translated from a *.PDF format into a spreadsheet format so that the data could be analyzed and used during the site visits. Future evaluation efforts will be streamlined and effective if PSE maintains all analysis files in a spreadsheet format (p. 41).

Program Response:

- At the time of the 2012-2013, PSE was still using paper folders for many projects and sending QC packages internally using printed copies. In the current program cycle, PSE's electronic file structure now has a sub-folder that contains electronic copies of the analysis (spreadsheet) that is used to generate the grant and a sub-folder containing any adjustments made to the final savings claim and grant payment.

4. ***Track specific program project milestones and completion dates.*** Currently, estimated project completion dates are being tracked in the project documentation but specific dates pertaining to project completion and commissioning are not adequately documented. Consider implementing database fields which document specific project milestones, project commissioning, and project completion (p. 41).

Program Response:

- PSE does track project completion and grant payment dates in the tracking database. PSE considers the project complete when the appropriate level of commissioning has been completed and all conditions set forth in the grant attachment have been addressed.

5. ***Ensure that any suggested changes in savings methodology are accounted for before final payment is issued.*** In reviewing the sampled projects, it was discovered that a small subset of sites had notes in the payments file regarding occupational or operational profiles which had changed since the projects were initially proposed. Ensure all comments are reviewed and accounted for in the savings and grant amounts before the numbers are finalized into CSY (p. 41).

Program Response:

- PSE will continue to review and account for any changes to the grant agreement or savings amounts prior to project close-out. The current electronic file structure includes a folder that contains the final payment package and final analysis, which will match the data in the tracking database.

Process Evaluation Recommendations

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