

# Impact Evaluation of Selected 2011-2014 New Buildings Projects

Energy Trust of Oregon

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# MEMO



**Date:** November 30, 2016  
**To:** Board of Directors  
**From:** Dan Rubado, Evaluation Project Manager  
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**Subject:** Staff Response to the Impact Evaluation of Selected 2011-2014 New Buildings Projects

Energy Trust commissioned this impact evaluation to examine the energy performance of five sites that represented a significant portion of New Buildings program savings from 2011 through 2014. The evaluated savings will be used in Energy Trust's true-up process to adjust the savings claimed for these projects. In addition to evaluating energy savings, Energy Trust wanted to learn if there were any aspects of its project analysis that could be improved to make estimation of savings more accurate in the future, and how to most effectively evaluate multi-phase projects to be more effective.

While there was variation in individual site realization rates, most projects saved more electricity than expected. In particular, one large site with three projects had realization rates of 122%, 111, and 96% between years one and three, very close to the original estimates by the final phase. The evaluated savings added more than 4.5 million kWh to the estimated savings at this facility. The program worked very effectively with the project team and successfully applied early learnings to the next two projects. This was noted by the evaluator as a program best practice.

One small-savings site with potential for a variable or phased electric load showed low load in the first two years of operation, as predicted by the program. The evaluator ultimately concluded low evaluated savings due to the information available at the time of the evaluation. The evaluator noted the program's initial estimate of savings was reasonable. The program uses capacity of a facility and other information to forecast the energy use and loading over time. There was no reason to expect lower loads and the facility could still further ramp up.

A large custom gas savings project performed very close to the program's original estimates. A prescriptive gas savings site, however, had lower than expected heating loads causing a decrease in gas savings. Ahead of this evaluation, the program had already identified and improved prescriptive gas heating measures. A heat recovery measure on one large gas savings project drove lower project savings than estimated and provided a good learning opportunity for the program, although other gas and electric measures on this project had very strong realization rates.

One issue that arose during this evaluation, which was a concern for both the evaluator and program staff, was that in a few cases the customers were uncomfortable with the

amount and detail of data requested by the evaluator. In these cases the customers were either unable to provide all of the data points requested or unwilling to provide it because they didn't have the time and resources. Because the evaluator was relying on highly detailed, customer-provided data from EMS systems for these projects, some measure details could not be verified. In these cases, the evaluator had to take a higher level look at the loads driving program assumptions for energy saved. This led the evaluator to have lower confidence in the evaluated savings for these sites compared to the others.

Another issue that arose was the timing of the site visits and concluding final, evaluated project savings. In one case, the evaluation was too late to properly verify a measure because it had already been replaced with newer equipment, since the site visit occurred around the end of that measure's expected life. In another case, program staff noted that the final evaluated savings were concluded before the facility was fully loaded. In these situations, interim check-ins might prove beneficial so that savings can be evaluated once facilities are operating as designed.

Program and Evaluation staff have created a process and set of criteria to address large or phased projects. The evaluation team will create an evaluation plan at the outset. The program team will support implementation of the evaluation plan. Key objectives of the plan address customer engagement, data collection, evaluation scope and timing.

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## 1 PROJECT SUMMARY

This document summarizes DNV GL's evaluation of the energy savings achieved by five selected projects which participated in Energy Trust of Oregon's Commercial New Buildings program between 2011 and 2014. The five project sites involved two data centers, two schools, and one hospital. The objective of this document is to only summarize the results and findings. Site-specific EM&V reports are attached in Appendix A.

### 1.1 Evaluation Goals

The primary goal for this evaluation was to develop an independent estimate of ex-post (evaluated) energy savings for each of the five selected sites. The evaluated savings estimated will be used to true up the savings recorded by the program.

In addition, the evaluation expected to achieve these additional goals:

1. Verify the installation and operation of the equipment supported by the program.
2. Document the building and system level changes that have occurred since the beginning of the project, and evaluate the impact of any changes to the scope of project measures, building operations and loads over the years. In order to account for the building operation dynamics, the evaluation reports the observed modifications for various building types and their impact on the ex-ante claimed savings.
3. Review of baseline conditions, system configurations, and control strategies considered for developing the ex-ante savings estimation for new building projects. The evaluation reviews the consistency of these baseline definitions and documents their sources for future projects.
4. Respond to requested Evaluation Questions (below).

### 1.2 Evaluation Questions

In order to provide feedback to Energy Trust on how its programs or evaluation processes could be improved in the future, this evaluation answered the following questions on a site-specific basis. A summary of DNV GL's responses to these questions is in the evaluation results section of this document. Site-specific responses are included in the attached site reports.

- Are there any aspects of the models used in the energy savings analyses by the Program Management Contractor (PMC) or program allies that may be of concern to Energy Trust?
- Are there any obvious errors in any of the assumptions used in energy savings analyses, either in the original savings estimates or in verification of energy savings?
- What factors result in large variances in measures savings (assumptions too conservative, incorrect hours of operation, loads differ from expectations, etc.)?
- How can Energy Trust most effectively evaluate projects that involve multiple phases or commissioning that takes place over multiple years?
- Do you have any recommendations regarding energy savings analysis approaches and assumptions, or customer behavior or decision-making that would be helpful to Energy Trust in designing, implementing or evaluating its programs in the future?

## 1.3 Technical Approach to Site Evaluation

DNV GL followed a standard approach to evaluate gross savings at projects' site level or for measures that require a site-specific M&V analysis.

Figure 1 shows the five basic steps in this process.

Figure 1. Site-Specific Project M&V Process



The following section summarizes the objectives and activities of each step:

- 1. Project Review:** DNV GL completed a thorough engineering review of the project files, in particular the energy savings calculations and assumptions, feasibility study reports, and other supporting documentation. This review identified the key uncertainty parameters and any concerns with the original estimation methodology. This review of the engineering estimates helped the evaluation team identify relevant project data, and key parameters.
- 2. Project EM&V Plan:** DNV GL created site-specific EM&V plans. These plans documented the project: the baseline and expected installed conditions, the data to be collected through the evaluation process, and the anticipated analysis method. In general, our M&V plans followed the framework provided in the International Performance Measurement & Verification Protocol (IPMVP). In support of these site-specific EM&V plans, DNV GL also prepared site-specific communication plans, building type data collection forms, and building type interview questions.
- 3. Data Collection:** DNV GL collected data during this evaluation to verify equipment installation, understand equipment operating conditions and control sequencing, and estimate achieved energy savings. The following data collection activities were completed:
  - DNV GL interviewed all sites on the telephone prior to our site visit.
  - DNV GL visited four of the five sites to observe equipment and complete additional interviews.
  - DNV GL utilized email communication with all sites to acquire additional information. In multiple cases, sites provided documentation of current and historical operation through email.
  - DNV GL received monthly utility meter data for each site and logs of biomass consumption from applicable sites.

- DNV GL received “blessing memos” documenting the estimation of deemed savings. However, in some cases only current blessing memos were received instead of the memos in place at the time of each project.
4. **Analysis:** DNV GL utilized the data collected and documentation review to develop site-specific estimates of achieved savings. In general, the analysis methodology followed the calculation approach utilized for the claimed savings estimation unless DNV GL determined that there were major flaws in the ex-ante savings methodology or the data collected supported a different approach.
  5. **Site Reporting:** DNV GL produced one report for each site. The site report documents the data collected through the evaluation, the methodology used to estimate savings, and the results of the analysis. These reports are attached in Appendix A. Draft site reports were commented on by Energy Trust evaluation staff, Energy Trust Program staff, and the PMC. Included in the site reports are site-specific answers to the evaluation questions.

## 2 EVALUATION RESULTS

Overall, the reported equipment was verified to be installed and operating at each of the five sites evaluated. The differences between the claimed savings and evaluated savings are primarily due to differences between the actual load served by the operating equipment and the load assumed by the program. In one case, the load was much lower than would have been reasonable for the program to assume. In another case, the program claimed deemed savings associated with equipment that exists as back-up during normal operations. In another case, the actual load was higher than originally assumed. In all cases, DNV GL found the program's original estimates to be reasonable within the context of the program, projects, and measures involved.

Table 1 shows the site-specific results of the evaluation for electricity savings. Table 2 shows the site-specific results of the evaluation for natural gas savings. Site 01 was completed in phases across multiple years. Each phase was documented as a unique project within the program.

**Table 1: Evaluation Results, Electricity Savings**

Evaluation Site	Claimed Savings (kWh)	Evaluated Savings (kWh)	Realization Rate (kWh)
Site 01, Phase 1, Part A & B	15,975,049	19,495,698	122%
Site 01, Phase 1, Part C & D	25,862,615	28,734,595	111%
Site 01, Phase 2	42,247,919	40,348,233	96%
Site 02	4,238,118	1,889,082	45%
Site 03	160,814	114,746	71%
Site 04	N/A	N/A	N/A
Site 05	390,833	390,833	100%

**Table 2: Evaluation Results, Natural Gas Savings**

Evaluation Site	Claimed Savings (Therms)	Evaluated Savings (Therms)	Realization Rate (Therms)
Site 01, Phase 1, Part A & B	N/A	N/A	N/A
Site 01, Phase 1, Part C & D	N/A	N/A	N/A
Site 01, Phase 2	N/A	N/A	N/A
Site 02	N/A	N/A	N/A
Site 03	37,619	14,556	39%
Site 04	51,240	55,006	107%
Site 05	47,339	22,470	47%



## 2.1 Evaluation Questions

DNV GL provided site-specific answers to the evaluation questions within each site report. The following responses are provided here are relevant to more than one of the projects reviewed or include recommendations to improve programs and evaluations in the future.

### 1) Are there any aspects of the models used in the energy savings analyses by the PMC or program allies that may be of concern to Energy Trust?

- a) None of the models used in the energy savings analysis should be a matter of concern for Energy Trust. The savings analyses used custom spreadsheet calculations, deemed measure savings or simulation models and utilized transparent inputs and assumptions for baseline and installed conditions.

### 2) Are there any obvious errors in any of the assumptions used in energy savings analyses, either in the original savings estimates or in verification of energy savings?

- a) No obvious errors were observed during our review of the energy savings. The baseline and installed case energy consumptions were estimated using standard engineering formula.

### 3) What factors result in large variances in measures savings (assumptions too conservative, incorrect hours of operation, loads differ from expectations, etc.)?

- a) The primary driver of large savings variance was differences between the actual load (heating, cooling, and/or IT) and the load assumed for claimed savings calculations. In all cases, the site-specific loads assumed by the program were reasonable given the information available to the program.
- b) Two projects involved the operation and conditioning of IT equipment. In neither case was the actual load determined through this evaluation the same as the load estimated by the program. In both cases, the program used the reasonable estimate of 50% of design capacity for the initial estimate. The program improved the accuracy of its estimate at one site as additional phases were completed by using the load in earlier phases to forecast the load in phases under construction. This evaluation further demonstrates the difficulty in forecasting IT load at facilities.

### 4) How can Energy Trust most effectively evaluate projects that involve multiple phases or commissioning that takes place over multiple years?

- a) In the future, Energy Trust program documentation should clearly state the basis for the baseline assumptions used in each phase, especially if the baseline or measure mix changes from one phase to the next. Future evaluation costs should be controlled if a more concise set of documentation was collected specific to the final assumptions and calculations used to estimate claimed gross energy savings for each phase.
- b) Evaluation of projects completed in phases should pay attention to the measure life assumed and the evaluation should be completed before the measure life ends. This is especially relevant in technology sectors where equipment improvements occur regularly. One of the measures installed had a three year measure life and was already removed by the time this evaluation began. Program administrators often do not want to overburden customers with evaluation when they are already involved in program activity. This will be a constant issue when projects are completed in phases or new projects are initiated each

year. Evaluation activity requirements should be prioritized over other program activity if the measure life is nearing completion and the acquisition of primary data is at risk.

**5) Do you have any recommendations regarding energy savings analysis approaches and assumptions, or customer behavior or decision-making that would be helpful to Energy Trust in designing, implementing or evaluating its programs in the future?**

- a) Energy Trust should consider the volume and organization of project files compiled for new construction projects. When there are a large number of project files it can be time consuming to go through and determine the final as-built specifications compared to design iterations. Reducing the volume of documents and creating a consistent structure to identify final specifications and calculations will lower evaluation costs and shorten timelines for M&V planning and analysis. This evaluation received over 500 files supporting the five projects. A number of these files were found to be duplicates or associated with non-final estimates of claimed savings. The time required to review files and understand each project was longer than originally anticipated and resulted in project delays.
- b) Energy savings estimation for deemed measures delivered by the program were documented in “blessing memos”. These memos documented the sources and methodology of the measures’ savings estimates. While the blessing memos did provide meaningful and consistent information for the measure savings, DNV GL recommends that Energy Trust invest time to improve the structure of the measure documentation and supplemental calculation workbooks. Multiple memos reviewed for this evaluation did not provide the criteria for measure qualification and calculation methodology for measure savings in a transparent and easily understand manner. Additionally, the supplemental calculation workbooks could be updated to provide a repository for all sources used in the savings calculation and clearly document (using cell equations and formulas) the method used to calculate deemed savings. These changes to the deemed measure documentation will provide improved measure transparency for stakeholders and evaluators alike. The goal should be to create a consistent medium for Energy Trust to update the measures when appropriate. For this evaluation, Energy Trust was able to provide a memo for each measure reviewed, but in some cases the memo associated with the program year could not be found and only the current memo was provided.
- c) This evaluation, along with many others before it, demonstrated the difficulty associated with estimating the future operating load (kW) of data centers. Energy Trust should consider options that reduce the uncertainty in claimed savings estimates, especially when projects are large within the program’s portfolio. Opportunities to more accurately estimate savings and incentives levels may exist.
- d) Energy Trust should consider requiring improved documentation of baseline decisions made by the program for site-specific analyses. Often, site-specific new construction baseline assumptions are based on an interpretation of the energy code, but in some cases are end-user or technology specific. This evaluation suggests that the program is appropriately developing baselines, especially when a site-specific alternative baseline must be created, but the documentation of these decisions is difficult to follow. The program and evaluation process should improve if project summary documentation includes information on the applicable code or baseline, any relevant interpretation of the code, and why the assumed baseline is an appropriate alternative for the project.