MEMO

Date: February 14, 2015
To: Board of Directors
From: Philipp Degens, Evaluation Manager
Spencer Moersfelder, Sr. Program Manager
Subject: Staff Response to the Building Performance Tracking and Control Systems Pilot Evaluation

The Building Performance Tracking and Control Systems (BPTaC) Pilot came to a successful conclusion at the end of 2013. Evaluation results to date, which included data and document review, interviews, and billing analysis, provided Energy Trust with the information needed to move forward with offering support for these types of projects under the Existing Buildings custom track.

The control systems and performance tracking service are now offered through the Existing Buildings program as custom projects. The Automated Optimization Software (AOS) system is focused on chillers that are typically found in larger facilities, and is being addressed as a custom controls project with a 10 year measure life.

In 2014 the program served Energy Information Systems (EIS) and Energy Management Systems (EMS) projects under the custom track using the original assumed deemed savings multipliers to quantify savings. This evaluation suggests revising the estimated savings. However, the current set of participating buildings are not expected to be representative of the future building types. As a result, in 2015, the program will continue to serve these projects under the custom track and will calculate savings for each project on a case-by-case basis.

There is a growing market interest in the offering and vendors have learned how to successfully sell projects with Energy Trust incentives. Energy Trust aims to grow the pool of projects in an effort to amass more data in order to establish a foundation to develop deemed savings multipliers that will simplify program implementation. The program requires projects to work with vendors that will provide a service that supports the customer in the ongoing control and management of their energy consumption. The measure life that the program is using for the offering is based on this requirement and the program assumes a measure life of 5.4 years for EIS and 9 years for EMS based on an initial 3-year subscription and a 5 year subscription respectively with an assumed 80% renewal rate.

The estimates of savings will be updated over time. One of the program requirements will allow Energy Trust to access the energy consumption and savings reports from the vendors. These reports will be analyzed periodically to determine if savings change over time, as well as to update the estimated savings for use in future projects.

PROCESS EVALUATION OF BUILDING PERFORMANCE TRACKING AND CONTROL SYSTEMS PILOT

May 2014

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Acknowledgements

Cadmus thanks the staff members of Energy Trust for their support over the past years during the BPTaC pilot evaluation. Phil Degens (the evaluation manager) and Spencer Moersfelder (the program manager) provided valuable insights about the pilot. We also appreciate the support and the pilot updates provided by Lockheed Martin and ICF, and we thank the BPTaC system vendors and participants for sharing their time and experiences with us.

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Executive Summary

Energy Trust of Oregon's Building Performance Tracking and Control Systems (BPTaC) Pilot offers incentives for installing any of the following building monitoring systems, each of which comes with a three-year subscription for consulting services provided by the system vendor:

- Energy Management System (EMS)
- Energy Information System (EIS)
- Automated Optimization Software (AOS) for chiller systems

This report describes the results of a process evaluation conducted by Cadmus from June 2011, when the program was initiated, through the end of November 2013. Our evaluation examined the following questions:

- What motivated participation in the Pilot?
- What features proved critical to participants using the systems?
- Do the systems lead to additional investments/actions towards energy efficiency? What types of improvements do participants pursue?
- What benefits do the systems provide?
- What participant characteristics influence savings and persistence of savings?
- How do the systems track and lead to savings? If so, are these tracking procedures sufficient for Energy Trust's analysis and evaluation purposes?

To conduct a process evaluation that answered these research questions, the Cadmus evaluation team performed these key activities:

- Collected and reviewed Pilot and project documentation such as the reports that system vendors generated for customers;
- Interviewed program staff, vendors, and Pilot participants twice; and,
- Reviewed information displayed on online facility tracking dashboards.

Conclusions and Recommendations

In this section we first discuss conclusions and recommendations at the overall Pilot level. We then highlight similarities and differences between the EIS and EMS systems.

Program-Level Findings

Conclusion 1. The Pilot did not meet its installation goals for any of the eligible systems. The main reasons for these shortfalls are: (a) the long decision-making time frame that can be needed for these projects; (b) the slow economy; and (c) businesses' unfamiliarity with the Pilot measures.

Recommendation 1. Pilots often take a long time, especially those testing products or practices that are not commonly found in the target market sector. Allow vendors ample time to recruit participants, especially for more costly projects. In particular, decision-making in large organizations typically requires time to obtain management approval and to earmark funds. Depending upon when a proposal comes forward in a budget cycle, decisions about such systems could take a year or more.

Conclusion 2. Vendors noted, and some participants concurred, that they lost momentum at various points in the program – for instance, after their systems were installed, their facilities inspected, or after they had taken some actions. Vendors suggested an incentive structure where the first portion of the incentive would be paid to the participant immediately after installation and inspection, and the second portion would be paid after certain level of recommended energy-saving changes were in place. This structure would provide an incentive for participants to remain responsive to the vendor's early energy saving advice.

Recommendation 2. If Energy Trust makes EMS and EIS measures a normal part of its portfolio, it should continue to offer incentives for both the system and consulting services. Energy Trust can then determine if a two-part incentive (incentives provided after system installation and inspection, and incentives provided for implementing recommended energy-saving changes) is preferable to the existing incentive structure. Although a two-part incentive would require more administrative time, the structure could influence the vendor to follow through with energy-saving recommendations and the participant to follow through with implementing those recommendations. In addition, the vendors and Energy Trust should work together to develop a variety of methods to keep participants engaged, including offers targeted to or tailored for their facilities.

Similarities Between the Systems

Conclusion 3. The commissioning process (optimizing a building's performance to maximize energy savings) can take a year or more. Both vendors of these systems explained that the implementation process entails multiple phases during which the vendor and customer work together to address seasonal issues and to fine-tune the operation.

Recommendation 3. Measure the performance of these systems and the consulting services over an extended period (at least one year, ideally two) to obtain meaningful results about the effectiveness of these systems.

Conclusion 4. Participants are busy and, hence, resistant to completing the documentation required to receive the incentives and to track system performance. Cadmus found that participants avoid filling out application forms on their own and that EIS participants often do not update the status of energy-saving measures in the online dashboard.

Recommendation 4. To prevent delays in the participation process, require vendors or implementers to help participants complete application forms from the start of a pilot program. Also, have vendors track or continue to track implementation of energy-saving measures for participants as part of their consulting services.

Conclusion 5. The participants said that the non-energy benefits of these systems were of great importance, and they specified the following advantages: providing data to better manage tenants, providing more control over building system scheduling, raising awareness of the importance of conservation, and providing information to justify investments for maintaining or improving building systems.

Recommendation 5. Have vendors highlight the non-energy benefits of these systems when promoting their capabilities to prospective customers. In addition, if these systems become part of a regular program offering, Energy Trust marketing can also emphasize these messages.

Conclusion 6. Some customers are more receptive and responsive than others regarding energy-saving measure recommendations. During the initial sales process, vendors can gauge the level and type of involvement that a potential participant is likely to have by asking questions about current maintenance practices and policies.

Recommendation 6. Rather than provide the same level of energy-saving recommendations to all customers, vendors should identify customers who are receptive to ideas and then provide them with more aggressive and frequent recommendations, including suggesting measures that require capital investments. Vendors should work with Energy Trust to determine what incentives are available to support these improvements. The program should create an incentive structure that rewards both vendors and customers for maximizing and maintaining savings.

Differences Between the Systems

Conclusion 7. With the EIS, the savings appear to be more sensitive to participants' willingness to implement energy-saving measures. With the EMS, the most significant savings likely result from effective scheduling, which does not require a high level of attention from participants.

Recommendation 7. Screen participants for characteristics that are likely to lead to significant savings based on the type of system for which they qualify. Thus, for an EIS, target customers who are engaged and willing to implement multiple recommendations, and for an EMS, target customers whose facilities are not already optimally scheduled (and carefully consider the savings potential for those with 24/7 operations).

Conclusion 8. The reporting capabilities of the EIS and EMS have different strengths and weaknesses for supporting evaluation. The (legacy) EIS dashboard tracks, in a systematic and transparent way, the

recommended energy-saving measures and the implementation outcomes. In contrast, the EMS does not have a formal way of tracking energy-saving measures, although the EMS vendor is researching ways to add this feature. The EMS vendor's energy savings spreadsheet presents calculations in a transparent, easy-to-follow manner, unlike the EIS reports and portal, which do not explicitly show how the savings are calculated. Both vendors could improve their savings reporting practices by offering additional interpretation of what is driving changes in consumption.

Recommendation 8. Energy-saving measures need to be tracked for all facilities and systems, and the associated energy savings calculations should be made transparent. Results reporting should be organized logically (e.g. in chronological order) and accompanied with explanations of what is causing changes.

To inform participants' decision making, vendors should regularly provide customers with (written) project payback or cost saving estimates for each of their energy saving measure recommendations (at the project or measure level).

Introduction and Evaluation Approach

Energy Trust of Oregon launched its Building Performance Tracking and Control Systems (BPTaC) Pilot in June 2011. This Pilot tests the feasibility and persistence of obtaining energy savings when businesses operate their buildings and facilities using three different monitoring systems and their associated consulting services:

- Energy Management System (EMS), intended for smaller buildings.
- Energy Information System (EIS), targeting large buildings with direct digital controls (DDCs).
- The Automated Optimization Software (AOS), applicable to buildings with chiller plants.

Lockheed Martin initially implemented the Pilot, with ICF International taking over implementation in 2013. Due to this change, in 2013 the Pilot accepted applications only during April and May. Energy Trust will not continue the BPTaC Pilot in 2014 and is exploring how to incorporate these measures into its existing incentive programs.

This report describes the methods and results of a process evaluation that Cadmus conducted of the Pilot's operation between November 2011 and October 2013.

Evaluation Goals and Researchable Issues

The goals for the BPTaC process evaluation were to help Energy Trust determine the following: (1) How the Pilot can be improved; and (2) Whether the measures should be incorporated into the overall Existing Buildings Program. The main researchable questions for this evaluation were these:

- What motivated participation in the Pilot?
- What features proved critical to participants using the systems?
- Do the systems lead to additional investments/actions towards energy efficiency? What types of improvements do participants pursue?
- What benefits do the systems provide?
- What participant characteristics influence savings and persistence of savings?
- How do the systems track and lead to savings? If so, are these tracking procedures sufficient for Energy Trust analysis and evaluation purposes?

Summary of Evaluation Methods

The Cadmus evaluation team (evaluation team) researched these questions through the following activities:

- Attending a project kick-off meeting with Energy Trust and Lockheed Martin staff (2011).
- Attending a product overview meeting with the EIS, EMS, and AOS vendors (2011).
- Collecting and reviewing program documentation, including project tracking updates.

- Reviewing online project dashboards.
- Reviewing building performance reports from Pilot vendors.
- Designing, conducting, and analyzing interviews with Pilot stakeholders and participants at two points in time: within one to two months after installation of a monitoring system and approximately one year later.

Table 1 shows the interviews conducted for this evaluation and their timing. The implementer provided Pilot participation update reports, which enabled us to schedule participant and vendor interviews once projects were installed.

Table 1. Interviews Conducted

Organization	Type	System*	Interview 1 Date	Interview 2 Date
Energy Trust of Oregon	Administrator	All	7/25/2012	N/A
Lockheed Martin	Implementer	All	12/15/2011	No longer implementer
ICF International	Implementer	All	2/18/2013	9/10/2013
EMS Vendor	Vendor	EMS	12/14/2011	10/15/2013
EIS Vendor	Vendor	EIS – N	8/8/2012	10/15/2013
AOS Vendor	Vendor	AOS	4/18/2013	No AOS systems installed
Family Fun Center	Participant	EMS	11/21/2011	4/10/2013
Chain Restaurant (3 installations)	Participant	EMS	3/15/2012	8/7/2013
Municipality (2 installations)	Participant	EIS – N	7/19/2012	7/30/2013
Property Development Group	Participant	EIS – N	7/19/2012	7/23/2013
Office Park	Participant	EMS	7/20/2012	8/20/2013
Municipality (2 installations)	Participant	EIS – N	8/1/2012	Did not respond
Municipality	Participant	EIS – N	8/1/2012	8/7/2013
Restaurant	Participant	EMS	9/9/2013	Not reached 1 year
Office Park	Participant	EMS	8/8/2013	Not reached 1 year
University (2 installations)	Participant	EIS – S	Not included in study	Not included in study
Travel Organization	Participant	EIS – S	Not included in study	Not included in study

*Two vendors supplied EIS systems, which we differentiate using EIS – N and EIS – S. Projects using the EIS from vendor S were not included in the evaluation study due to their late installations.

Organization of Report

The report is organized into the following sections:

- BPTaC Pilot Description
- Pilot Participation
- System Tracking and Reporting Capabilities
- Early BPTaC Pilot Interview Findings
- Conclusions and Recommendations

BPTaC Pilot Description

Energy Trust staff members believe that that there are significant opportunities to obtain energy savings through improved operation of commercial buildings. Thus, Energy Trust is testing two approaches to reach operations-based savings:

- The BPTaC Pilot, a technology enabled approach, covered in this report; and
- The Strategic Energy Management Pilot, targeting building operators at large real estate management firms (not evaluated in this report).

Pilot Program Logic

The BPTaC Pilot offers incentives to commercial utility customers who install monitoring systems that provide real-time feedback about their buildings' energy use and system performance, and who then receive active consulting support from system vendors. This combined approach is designed to supply participants with the information, guidance, and support they need to make and sustain changes in building operations that lead to energy savings. Specifically, the key components of the Pilot are:

- The monitoring systems enable customers to access information about their building's energy use through a Web-based dashboard that displays energy use and trends. The systems also generate alerts that notify participants of manual overrides and mechanical failures, so operators can make instant corrections.
- The consulting services provide continuous technical support and recommendations for improving performance. Vendors also send periodic reports summarizing various performance metrics and descriptions of work performed at each facility.

To minimize variations in the technologies offered and to simplify vendor management, the Pilot worked with a limited number of systems and vendors.

Pilot Objectives

Engineers at Lockheed Martin designed the Pilot to meet achieve these objectives:

- Verify the savings each system achieves;
- Verify persistence of savings over the course of the Pilot; and
- Identify product specifications that would result in a cost-effective program, should Energy Trust choose to integrate the Pilot measures into its program portfolio.

Energy Trust conducted a preliminary cost-effectiveness screening of each system, using these criteria: vendor savings claims, case studies, and data from Energy Trust's Existing Buildings program. After the systems were determined to be cost-effective for the Pilot's purposes (in June 2011), Lockheed Martin, the implementer, began to work with Energy Trust and the vendors to recruit and qualify participants.

Pilot Incentive and System Offerings

The pilot incentive covers 50% of the BPTaC system's purchase and installation costs and up to 50% of the three-year subscription fee.[1] Table 2 contains detailed information about each of the building monitoring systems eligible for incentives.

Table 2. BPTaC Pilot Offerings

Technology Approach	EMS	EIS	AOS
Target Building Type	Between 50,000 and 100,000 sq. ft. (e.g. Small office, retail)	Greater than 100,000 sq. (e.g. Hotels)	Buildings with chiller plants over 600 tons (e.g. Hospital)
Requirements	Building shell, HVAC, and ductwork must be in reasonable condition	Must have direct digital-controls (DDC)	Chiller plants with variable speed drives, networked controls, and automation sequencing capabilities
Real Time Energy and Performance Monitoring	Yes, at whole building level	One hour or one day delay depending on utility	Yes, chiller plant only
Controls optimization	Building wide HVAC and lighting controls	No because there are already controls	Software optimizes the entire chiller plant system using relational controls.
Energy Trust Cost-Effectiveness Assumptions			
Estimated Energy Savings*	15% of total baseline	5% of total baseline	22% of HVAC baseline
kWh Levelized Cost	$0.05	$0.04	$0.03
Measure Life**	3 years	3 years	3 years

* Based on Energy Trust's cost-effectiveness screening analysis.
**The measure life reflects the Pilot's requirements that participants subscribe to vendors' consulting services for three years. The systems have a much longer expected lifetime. Energy Trust will accept a measure life of up to five years in order to pass the Pilot's cost-effectiveness screen.

The EMS and AOS include controls optimization. The EIS is installed in buildings that already have controls, and it does not alter existing direct digital-control (DDC) systems.

Pilot Recruitment and Participation Process

The implementer and vendors sought customers who employed a dedicated staff member willing to do the following:

- Complete the training for using the system;
- Be responsible for any additional equipment installations, operations and maintenance actions, and/or behavioral changes recommended by the vendor; and
- Cooperate with efforts to evaluate, measure, and verify the impacts of the Pilot system.

Each participant's building also had to be compatible with the proposed system.

[1] The AOS has a fee capped at $0.25/kWh.

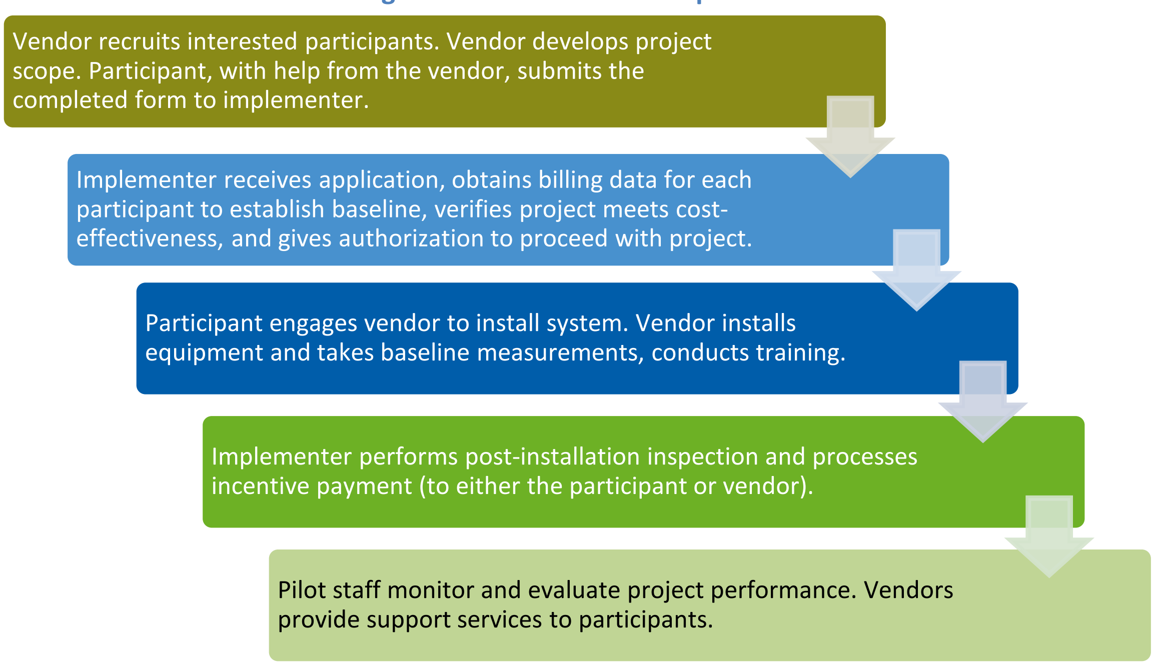
As shown in Figure 1, after an interested customer is identified, the vendor pre-screens the customer's facility, develops a project scope and bid, and provides the application form to the customer.

Once the implementer receives the customer's project application and cost bid, it obtains three years of billing data to establish the customer's baseline energy usage. The implementer then determines whether the proposed project passes the combined societal cost-effectiveness test with a benefit-cost ratio of 0.08 or higher. If the project does not pass, the implementer asks the vendor to submit a lower bid. If the project fails to pass the cost-effectiveness screen after the second bid, then the project is abandoned. If it passes, the implementer approves the project's installation, allowing the customer to take the next step and engage the vendor who will install the system and conduct training.

After the implementer receives the invoice from the vendor following the installation of the system, an implementer staff member conducts a walk-through inspection and asks the participant for feedback on the system.

During the term of the consulting contract, the Pilot vendors are expected to submit recommended energy-saving measures to Energy Trust for approval before presenting them to the participant. The vendors also need to provide Pilot staff with a dashboard login for each project.

Figure 1. BPTaC Pilot Participation Process



Pilot Participation

At the beginning of the Pilot, which began in the middle of 2011, Energy Trust and Lockheed Martin sought to recruit: 20 organizations to install the EMS; 10 organizations to install the EIS; and 5 organizations to install the AOS by the winter of 2011. In addition, as BPTaC systems are considered custom measures, Lockheed Martin sought to use the Pilot to develop a deemed savings value for these systems so that measure savings could be standardized.

In the interim report to Energy Trust on July 24, 2012, Lockheed Martin revised the EMS target downward to reflect their expectation of a lower uptake of this technology. Lockheed Martin also decreased the goal for the number of AOS installations to two, as projected costs generally ran twice as high per system as originally thought, and Lockheed Martin was concerned that the Pilot budget would cover incentives for only two AOS installations. Table 3 shows the original and revised Pilot goals, along with the number of installations completed by the end of 2013. Ultimately, no AOS installations were completed during the Pilot period, so AOS systems receive limited attention in this report.

Table 3. Pilot Goals and Completed Installations

System	Original Goal	Revised Goal	Completed as of November 2013
EMS	20	15	7
EIS*	10	10	9
AOS	5	2	0

* Some participants installed systems in multiple buildings; these counts are on a per-building basis. Additionally, there were two EIS system vendors. The three EIS installations completed in 2013 belonged to a different vendor than the other EIS installations; we did not include these installations in our evaluation because there were no long-term results to report.

The BPTaC Pilot began more slowly than originally planned, completing its first project—an EMS—in November 2011. In August 2012, nearly a year after Pilot recruitment began, it was not fully subscribed and Energy Trust decided to extend the Pilot recruitment period through May 31, 2013 in order to have six months of data for the new projects by the close of 2013. Between August 2012 and May 2013, no new systems were installed due to the new implementer coming on board. Between May and August 2013, four participants installed BPTaC systems—three participants installed one each and one participant installed two systems.

During the time Lockheed Martin was the implementer, the Pilot had seven unique participants (several participants installed more than one system). The evaluation team conducted post-installation interviews with all seven participants shortly after Lockheed Martin conducted its post-installation inspection. We then conducted follow-up interviews with these participants in 2013, reaching all but one participant. We also conducted post-installation interviews with two of the four participants who installed EMS systems in 2013. The two participants we did not interview either had a late installation date and/or had installed a system from a vendor that joined the Pilot in 2013.

Pilot staff believed that the slow uptake of this Pilot resulted from these factors:

- The difficult economy
- The target customers not understanding the value of these systems
- The customers being unfamiliar with the vendors and their systems
- The customers being concerned about a system that locked them into a subscription service.
- The need for vendors to resubmit EIS bids because they often failed to meet the cost-effectiveness criteria (based on the assumptions inherent in the Pilot's design), which added time to the process.

Both the Lockheed Martin staff and Energy Trust Pilot staff said the main lesson learned from the Pilot's first year is that Pilot programs can take more time to recruit participants than expected. The EMS vendor corroborated this observation, noting some customers took a year to proceed with an installation.

Participants also reported it was time consuming to procure management buy-in. One participant said the application process was drawn out because they needed the vendor to help them complete the paperwork.

The Pilot also experienced a minor setback during its beginning due to an error in the cost-effectiveness calculation. Specifically, the calculation used for the initial Pilot was based on 42 months of estimated savings rather than 36 months (three years) as intended. For many of the projects considered at the time, the reduction in the number of months meant that the system would not meet the cost-effectiveness criteria and would not qualify. Ultimately, Energy Trust decided to extend the length of the measure life to five years, which would be a more reasonable lifetime for such systems.

Energy Trust decided not to continue the BPTaC Pilot in 2014, but is working with ICF to incorporate these measures into their standard or custom incentive program offerings. At the time of this writing, one Portland area hospital was completing an AOS project through the Energy Trust's Custom Incentive Program.

System Tracking and Reporting Capabilities

This section of the report describes each system's online dashboard interface and the reports provided from the vendors.

EMS Dashboard

As shown in Figure 2, the EMS dashboard contains these elements: a meter in the upper right corner that shows instantaneous energy usage, usage throughout the day, and historical usage. The main part of the screen shows a map of the building equipment as it relates to the actual building layout.

Figure 2. EMS Overview Screen

The dashboard relays parameters for temperature, lighting levels, and the status of various pieces of equipment. The EMS uses open-source software and communicates wirelessly to a variety of sensors and controllers installed at the facility. For example, current draw is detected by a shadow meter placed on the mains with a current transducer around the wires.

By clicking on an icon, users can schedule and adjust setpoints for individual systems. A high level reporting screen provides average parameters for all control points over a user-specified time period. Alerts can be set to notify users of building issues, such as a refrigerator door left open or if the demand is above a present limit.

The EMS does not measure therms directly, nor does it log behavior changes or measure installations. However, the vendor logs known system changes in its reports.

EMS Reports

The evaluation team reviewed three types of reports provided to participants as part of the EMS service. The first, a HVAC/Field Diagnostic report, was designed as a startup guide to identify fixes to improve operations. Separate from the online portal, it summarizes the following:

- Work performed at each facility;
- Average operating parameters and performance for each HVAC unit;
- Articles on how to prevent premature unit failure;
- Recommendations for improving HVAC unit performance; and
- Maintenance alerts (as shown in Figure 3).

Figure 3. Summary Diagnostics Report*

Unit	Date	Diagnosis	Circuit	EI (%)	CI (%)	Savings ($)
A/C 1 D1	6/29/12	ACCEPTABLE: Safe and reasonable performance.	1	90	97	$127
	6/29/12	ALERT: Recover charge.	2	88	>98	$67
A/C 2 D2	6/29/12	ALERT: Add charge.	1	88	90	$205
	6/29/12	DANGER: Recover charge.	2	78	93	$173

*EI = Efficiency Index score; CI = Capacity Index score

The recommendations include a calculation (shown in Figure 4) of free cooling cost savings.

Figure 4. Unit Performance and Free Cooling Savings

UNIT/STAGE	PERFORMANCE	AVERAGE .5° CHANGE IN MINUTES (TARGET 6 MIN)	AVERAGE SUPPLY TEMP	AVERAGE SET-POINT	AVERAGE DAILY RUN TIME/HRS	TOTAL RUN TIME/HRS	AMPS	kWh/HR	OPERATING COST @.08kWh/HR	TOTAL OPERATING COST @.08kWh	TOTAL FREE COOLING HRS	FC SAVINGS
										0.08		
K1-F					24	1680	3.5	0.728	$0.06	$97.84		
K1-1	0%	84	55	69.6	8.7	607	16.5	3.432	$0.27	$166.66	310.1	$85.14
									$0.33	$264.50		$85.14
D1-F					18	1260	4.6	0.9568	$0.08	$96.45		
D1-1	0%	20.6	59.6	73.5	0.88	61.6	11	2.288	$0.18	$11.28	3.10	$0.57
D1-2	0%	20.6	59.6	73.5	0.75	52.5	11	2.288	$0.18	$9.61		
									$0.44	$117.33		$0.57

The evaluation team also reviewed a semiannual report for a project completed before the start of the Pilot. This report contains a six-month utility summary of this information:

- Energy savings and/or waste;
- Causes for savings or waste (summarized on a cover sheet);
- An HVAC/CRAC performance efficiency summary; and
- Recommended actions—with utility incentives for equipment replacement or tune-ups noted—for lighting, HVAC, food service, and refrigeration end uses.

The semiannual report's utility summary has separate sections for electricity and gas, and the results for each month are summarized in a box, as shown in Figure 5 (the specific values have been removed to ensure participant confidentiality). Because these boxes are not always in chronological order, understanding the report can be challenging. Alternatively, gas and electric information could be presented in a table, with a column for each month.

The report displays kWh and dollar savings for individual months and for the entire six-month period. Although it does not include peak kW savings, these could be included if the building's electric utility provides additional information.[2] The reported savings have been normalized, based on the number of days in the billing period and relative to baseline energy usage from the previous year.

Figure 5. Excerpt from Semi-Annual Report (EMS)

Period
From Through
3-Mar-11 1-Apr-11
Number of days this period
Same period last year
kWh consumptin this year
Same period last year
Average kWh per day this year
Same period last year
Percentage savings per day [redacted]

Average kWh cost this period [redacted] Per day

Total Amount billing
Estimated daily savings
Estimated Monthly Savings
Estimated 6 mo Savings [redacted]

Period
From Through
30-Nov-10 3-Jan-11
Number of days this period
Same period last year
kWh consumptin this year
Same period last year
Average kWh per day this year
Same period last year
Percentage savings per day [redacted]

Average kWh cost this period [redacted] Per day

Total Amount billing
Estimated daily savings
Estimated Monthly Savings
Estimated 6 mo Savings [redacted]

Six month total
Six months electrical savings [redacted]

[2] Demand savings are not a high priority in Oregon, due to low demand charges, but may be important for this type of software when deployed in other parts of the country.

The semiannual report's last section contains a lighting retrofit package proposal prepared by an electrical supply company that sells these products. This company maintains a business relationship with the vendor and provides lease financing for EMS systems. The proposal specifies these items: investment amount; incentives; estimated energy and carbon savings; simple paybacks; annual returns on investments; and the costs of waiting to perform the retrofit. The proposal also provides lease financing options, with estimated monthly cash flow amounts for each option.

The evaluation team also reviewed an energy-savings report, provided as an Excel spreadsheet from the vendor. This report aggregates monthly billing data for all electric and gas meters on the premises, and it includes the costs and usage for both the current year and the baseline year, adjusted for weather and calendar days. Figure 6 shows the structure of the reported savings (the specific values have been removed to ensure participant confidentiality) savings reported on a summary sheet.

Figure 6. Energy Savings Report

	A	B	C	D	E	F	G	H
1	**Energy Savings Summary**							
2								
3	**Electricity**							
4	Usage Period	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Average
6	Avg kWh/Day Change	[redacted]						
7	Total kWh Change							
8	Pecentage Change							
11								
12	Gross Cost per kWh							
13	Impact of kWh Change							
15								
16								
17	**Natural Gas**							
18	Usage Period							
20	Avg Therms/Day Change							
21	Total Therms Change							
22	Pecentage Change							
23	Weather-adjusted Therms Change							
24	Weather-adjusted % Change							
27								
28	Gross Cost per Therm							
29	Impact of Therms Change							
30	Weather-adjusted Impact of Change							
32								
33								
34	**Total Energy Cost Impact**							
36								
37	Avg. Daily Temp % Change							
38								
39								

A note in the spreadsheet said that impacts do not account for tenant occupancy changes.

EIS Overview

The EIS legacy dashboard[3] (shown in Figure 7, which has specific values removed to ensure participant confidentiality) displays multiple charts, along with a menu of tools along the left side. However,

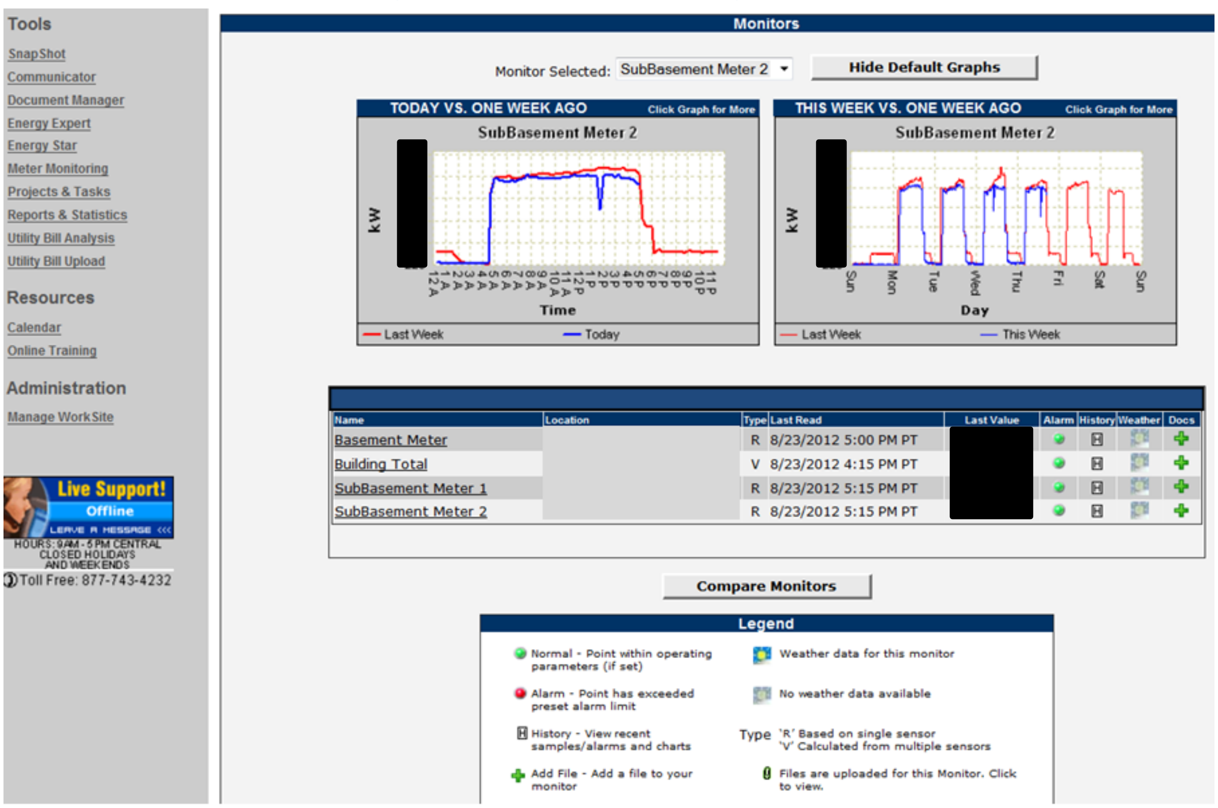
3 An EIS representative said that all of the Energy Trust Pilot participants are using the legacy platform, but this version will not be supported after January 31, 2014. The EIS vendor moved to a new platform in the summer

because the legacy system is no longer supported, many of the web portal's tools are not fully functional. Thus, the evaluation team's review covers those tools that were working at the time of the assessment.

The meter monitoring screen shows the consumption patterns for both the current week and the past week, allowing the user to detect irregularities. For example, in one facility the EIS detected a spike, and upon investigation, the customer found the overconsumption was caused by a faulty pump. Once the pump was fixed, consumption fell back to its expected range. If consumption falls outside the bounds of preset limits, an alarm notifies the user.

For facilities served by Portland General Electric (PGE), the building's usage is uploaded to the system once per day at midnight. For Pacific Power customers, the system uses a cellular data logging device, which uploads the data every half-hour.[4] Both approaches provide usage data in 15-minute intervals.

Figure 7. EIS Meter Monitoring Screen*



* This building uses the cellular data logging service.

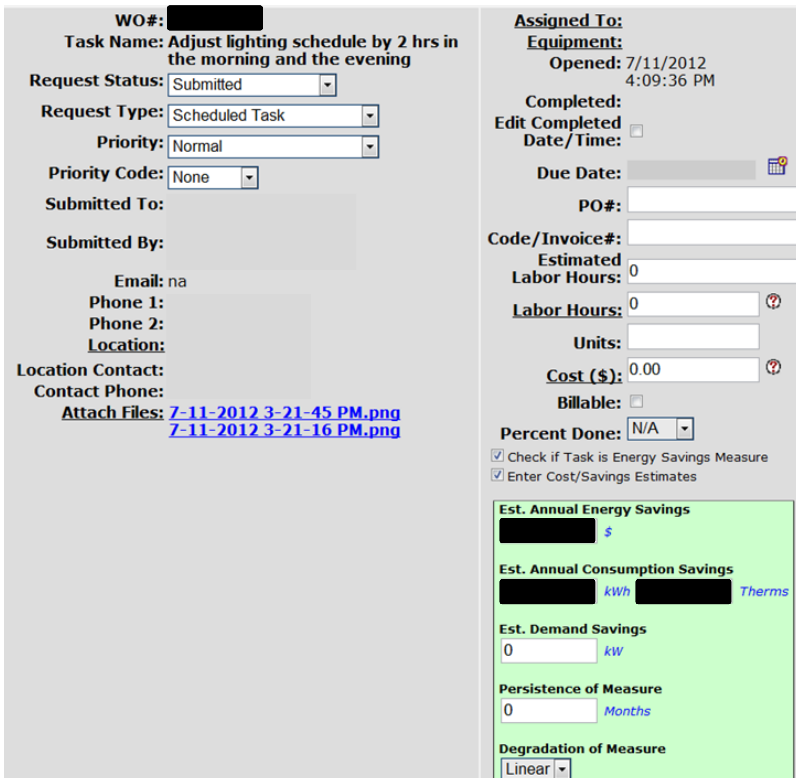
of 2012, and any new Energy Trust participants will be trained to use that portal. Current participants have the option of moving to the new system; however, because the new system has a different way of tracking energy saving measures, such a move would require more training.

4 Data uploaded more frequently would result in an increase in the vendor's cellular fees.

Use of the Task Screen

To promote continuous improvement at each facility, EIS consulting staff members regularly submit recommendations of energy-saving tasks to users through the online portal, as shown in Figure 8. These tasks offer low-cost or no-cost changes for improving energy efficiency, such as adjusting lighting or HVAC schedules. The EIS records the task status (e.g., submitted, in process, completed), and it displays fields showing detailed information about each task, such as the date the task was assigned and estimated energy savings (usually in dollars, kWh, and therms). Relevant files can also be attached to each task.

Figure 8. EIS Online Portal Detailed Task Screen



The EIS building model estimates energy savings for each task, including interactive effects. In addition, the work order tracking screen captures communications between the participant and vendor regarding operating changes that were made or how measure implementation issues were resolved.

The task screen also has fields for demand savings, persistence in months, and measure degradation, although these features currently are not being used. Enabling demand savings estimates would require incorporation of additional utility information.

EIS Progress Reports

The evaluation team reviewed several October 2012 progress reports from the EIS vendor. Figure 9 is an excerpt (with specific values removed ensure participant confidentiality) from the one-page report, showing the following information:

- Implementation status for each stage of the improvement process
- Number of energy saving measures recommended and implemented
- Energy savings results

Figure 9. EIS Monthly Progress Report

Implementation Status:

Installation	Survey	Model Development	Baseline Development	Short-Term Monitoring	Generating ESM's	Implement ESMs	Continuous Improvement

Complete	In Progress (Looking Good)	In Progress (Some Difficulties)	In Process (Project Stalled)	Not Started

Energy Savings Measure Progress:

No-Cost ESMs Identified	Low-Cost ESMs Identified	Capital ESMs Identified	Number of ESM's Implemented
[redacted]			

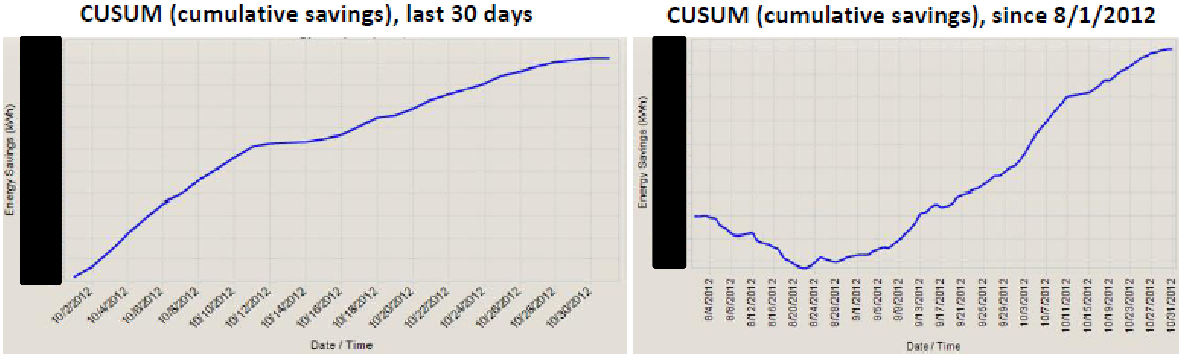
Savings Results:

Baseline period	kWh saved last 30 days	kWh saved post baseline	% saved	$ saved post baseline	Annualized kWh savings	$ saved, annualized
03/29/2012 — 07/01/2012	[redacted]					

Some progress reports also contain a graph showing the cumulative savings, as shown in Figure 10. At the bottom of the report is a section for comments from the vendor's implementation team. Specific values have been removed to ensure participant confidentiality.

Figure 10. EIS Monthly Progress Report—Savings Plots

CUSUM (cumulative savings), last 30 days | **CUSUM (cumulative savings), since 8/1/2012**



Implementation Team Comments:

One out of four of the [redacted] Energy Savings Measures (ESMs) has been completed . Two measures, the posting of energy savings tips and a blast email may have supported the [redacted] as well as [redacted] The completed measure, [redacted] was documented as finished at the end of the October and may not yet have shown up in the savings results. The other measures are awaiting completion of a

Early BPTaC Pilot Interview Findings

This section contains the feedback obtained by the evaluation team from interviews with participants, EIS and EMS vendors, and program staff.

First Round Feedback from Vendors

The evaluation team interviewed one EMS vendor and one EIS vendor.

Motivations to Participate

Both vendors expressed interest in participating in the Pilot for business development purposes.

EMS

The EMS vendor reported that program incentives helped in a difficult economy, a sentiment also expressed by Lockheed Martin regarding vendors' reasons for participating in the Pilot. Additionally, the EMS vendor was interested in the Pilot because the results would serve as a reference for its product. That is, the Pilot could validate EMS as an effective energy saving measure. As few utilities offered deemed savings for an energy-monitoring system, the EMS vendor hoped this Pilot could help develop a deemed value so that the system's performance would be better understood. Participants would then perceive such products as a less risky choice for achieving savings.

EIS

The EIS vendor had been offering its system to Lockheed Martin for several years before the BPTaC Pilot was implemented. When Lockheed Martin and Energy Trust became interested in researching operations-based savings, this vendor was ready to participate. Also, EIS had produced favorable results with a NYSERDA pilot program,[5] which differed from Energy Trust program in two key aspects:

- NYSERDA provided a 100% incentive, and
- The vendor teamed with a maker of web-based energy-monitoring solutions to conduct energy monitoring in real time.[6]

While recruiting participants for the NYSERDA pilot proved less challenging—due to the 100% incentive—the vendor said Energy Trust's approach ensured participants had a stake in the savings outcome.

Pilot Experience

Both vendors described Lockheed Martin as "responsive," although both also noted that some staff turnover occurred and the new staff members were overwhelmed, which resulted in some delays. One

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5 See: http://www.northwrite.com/propoganda/Case%20Studies/Project%20Brief%20-%20NYSERDA%20(16-040512).pdf

6 The vendor did not provide real-time data for the BPTaC installations as it added cost to the service.

vendor reported that a few opportunities were lost due to long turnaround times (sometimes a month or more) in the processing and approval of applications.

Vendors also said Pilot staff members have been supportive, but vendors wanted more marketing support. Although one vendor did not know all the ways in which Energy Trust and Lockheed promoted the Pilot, the vendor cited an experience with another utility program that arranged meetings between the vendor and customers each week, and this was a support service the vendor considered valuable.

Incentive Level

Although an energy-monitoring system can make operating a building easier for customers, the EMS vendor observed that when customers were risk-adverse or understaffed, the result was slow sales. Thus, the availability of an incentive proved important because closing a sale often required multiple calls at the corporate level.

Comparing incentive levels offered by Energy Trust (50% of installed cost) and PSE (70% of installed cost), the EMS vendor reported that while it was easier to close a sale at the 70% incentive level, a generous incentive still did not guarantee a customer would decide to install an energy-monitoring system. The EMS vendor reported that a chain restaurant had sites in both Energy Trust and PSE territories, yet neither site has moved forward.[7] The EMS vendor said that current Energy Trust incentive levels are likely appropriate, but reducing the incentive to 30% may not be sufficient to achieve uptake.

The EMS vendor is primarily a software company that works with its hardware supplier to stock the system's hardware. This supplier, having an incentive to move this product, offers lease financing, so the EMS vendor offers the lease financing option as a normal part of its proposals. Among EMS customers outside the BPTaC Pilot, 80% chose that option, as it structures the monthly savings to exceed lease payments. However, only one Energy Trust Pilot participant has opted to use the lease option. To obtain the lease financing, customers use an online application, and no formal credit check is required. The vendor finds this to be a simple, straightforward process for customers.

The EIS vendor thought the 50% incentive level appropriate because participants with "skin in the game" are more likely use the system and obtain savings. The vendor observed that BPTaC Pilot participants were more responsive than those in other Pilots, and the vendor attributed this to effective recruitment and to the fact that organizations in Energy Trust's region prioritize sustainability more than the organizations in other areas. This vendor noted it would be more difficult to have success in an area where organizations could not afford to pay for part of the system cost.

The EIS vendor thought improvements could be made to the incentive structure. This vendor worked with other pilots that paid incentives based on the amount of kWh saved, in contrast to Energy Trust's

7 Although this customer eventually decided to install the EMS (September 2012) at a location served by PSE, it took the customer a year to move ahead with the project.

upfront payment approach. The vendor thought paying for performance would prove less risky for Energy Trust and would allow the vendor to determine how to structure the payment arrangement with the customer.

Ideal Participant Characteristics

Both vendors said that customers who were not responsible for the utility bills would not be engaged in managing their energy; thus, they would be unlikely to install a monitoring system. The vendors said their ideal customer wants to interact with and depends upon the mechanisms each system uses to generate savings. Specifically, the EIS relies on customers to actively make improvements to their building operations, while the EMS is able to obtain active (customer-led) and passive (controls) savings.

Both vendors said a customer who is likely to succeed in generating active operations-based savings is one who is willing to address building maintenance issues. The vendors said that while customers initially expressed an interest in saving energy, if the customers were not disciplined on setpoints or were unwilling to make improvements or repairs[8], they would not obtain savings and so would blame the system. Their ideal customers are those who are engaged and willing to make operational changes, but lack the information needed to know how to proceed.

For passive savings opportunities resulting from the EMS' automatic controls algorithm, the vendor targets buildings that previously operated in a largely manual manner and that lack sophisticated tracking or automated control processes. The vendor also says they target building types with high energy intensity and dynamic loads, such as restaurants. However, because the EMS control algorithm is based on the assumption that the equipment is functioning normally, customers who do not maintain their buildings will not be able to reach the full potential for savings.

Approach to Energy Savings

This section describes specific approaches taken by each vendor to generate savings.

EMS

It is the EMS vendor's opinion that approaches that rely on behavioral changes are considered "soft savings," unlike controls, which provide more tangible savings. The EMS vendor found that participants could not be relied on to make behavioral changes that produced savings. In this vendor's experience with PSE, participants achieved 15% energy savings simply through controls optimization. The vendor stated, "The word of doom for these systems is behavioral savings. That is the objection of everyone who looks at web based thermostats or EMS systems."

According to the vendor, the persistence of savings is built-in by having properly maintained equipment. Using an EMS to control a whole building as a package prevents simultaneous heating and cooling.

[8] Paying for improvements seems a bigger barrier than paying extra energy costs over time.

EIS

In contrast, the EIS relies entirely on customers to implement and maintain changes. This approach can entail extensive labor on the part of the vendor to monitor customer actions and to understand why a customer does not move forward with recommendations. Often, a customer wishes to implement energy-saving measures, but as such measures may be low on the customer's priority list, implementing a measure may take months. Initially, customers implement a few energy saving measures but then lose momentum, so the vendor conducts follow-up meetings. The vendor follows the philosophy that the vendor is not there to fix their customers' buildings, but to help customers fix their building by telling them what they do well and what could be improved.

For each facility, the EIS vendor tries to obtain DDC system trend logs to run analytics on these and confirm that simultaneous heating and cooling is not occurring. However, the vendor has found that customers often do not know how to provide the information, nor do they have time to find the data. As such analysis is not required for service, it is considered a bonus. No straightforward way exists to automate obtaining this information because each DDC system operates differently, and placing sensors or other monitoring equipment would prove costly.

Helping Customers Make Changes

Regardless of the challenges, both vendors provide reports and recommendations to customers intended to prompt them to make changes to reduce energy consumption.

The EMS vendor provides semi-annual reports that summarize recommended actions and the costs associated with not making changes. They also provide recommendations during in-person visits and by email.

The EIS vendor regularly submits energy saving "tasks" through the online portal and encourages completion of these tasks. The recommended energy-saving measures are usually low cost or no cost, and they focus on avoiding wasteful energy use.

Upon request, both vendors advise customers on capital improvements and paybacks.

Post-Installation Feedback from Participants

The evaluation team interviewed seven participants, some of whom installed more than one system:

- Family entertainment center,
- Restaurant chain,
- Office park,
- Commercial property management company, and
- Facility departments at three city governments.

Most participants said they were aware of building monitoring systems before they enrolled in the Pilot, and all considered energy efficiency as either "very important" or "becoming more important" to their operations. Four participants learned about the Pilot through a vendor, and three learned of it through Energy Trust.

Three participants had the EMS and four had the EIS.

Motivation to Participate

All participants cited the Energy Trust incentive as influencing their decision to participate. They said the incentive helped reduce the payback period to an acceptable time frame, ranging from less than one year to three years.

- Two participants provided the evaluation team with a copy of their payback analyses, which showed that the system cost—net of incentives—had a simple payback of less than one year for a participant who installed an EMS and slightly more than one year for a participant who installed an EIS, assuming 10% energy savings in both cases.
- An EMS owner originally thought the system would have a payback of three years, which was an acceptable period; however, after several months of using the system, this owner discovered that the payback period was shorter than expected (17 months). He planned to invest the savings into a new revenue-generating project.
- Another EMS owner reported looking for a one- to two-year payback, so this owner said the three-year payback period made the system relatively expensive.

Only one EMS participant chose the lease financing option to pay for the cost that remained after the incentive was applied. The participant considered this as the best way to take on the risk in case the system did not result in savings.

Participants cited multiple other reasons for installing the monitoring systems. Two EMS owners said the scheduling capabilities help them avoid waste. As an example, one EMS owner said that to avoid incurring charges from demand spikes—before installing the system—equipment was turned on manually and gradually, one circuit at a time; however, now the new system automates this process. This participant also said he liked pilots because of the extra attention he would receive from the vendor. The vendor developed a special alert for this facility that sounded when a refrigerated cabinet that holds $800 worth of product was left open.

Another participant wanted to have an EIS in order to collect data needed to build a case to upper management for tearing down an existing building, as it lacked the infrastructure to operate efficiently and is too small for her department. She said that energy consumption in the building was so unpredictable, her organization did not bother calculating the return on investment or the payback. Poorly constructed in 1986, the building used a compressed cardboard duct system that leaked into unconditioned spaces and could not be cleaned (as moisture would ruin the cardboard). Fixing the building, according to the participant, would cost $11 million; however, a new building that was both bigger and energy efficient would cost $18 million, and the expected energy savings would recoup incremental costs.

This participant, who works in a political environment, reported that upper management is biased against its internal staff. She said outside experts and hard data may be necessary to convince management how best to prioritize capital investments, especially when management struggles with budgetary issues and pressure from taxpayers.

Another local government participant reported having the opposite experience—upper management has continually supported energy efficiency, and the city takes pride in participating in innovative pilot programs. This city recently experienced a positive outcome with a solar pilot, so joining the BPTaC Pilot appealed to upper management. Before signing up for the Pilot, this participant reported trying to understand why one of the city's buildings used so much energy, so the Pilot's timing proved fortuitous.

Finally, one EIS participant reported closing the deal for the energy-monitoring system because the product's contract guaranteed that the energy-cost savings would equal the portion of the project cost not covered by the BPTaC incentive. This participant had negotiated away all financial risk—if the vendor could not provide documentation proving the promised savings had been achieved, then the vendor would reimburse the participant for the system cost. Normally, the vendor does not make this guarantee, but the vendor wanted to close the sale and there was little risk that the building would not perform, given that the building's monthly energy costs were approximately $33,000, while the participant's net cost for the EIS was less than one month's energy costs.

Pilot Application

Participant responses regarding the application varied considerably.

- Two participants found Energy Trust applications confusing and difficult to complete. One said this was generally true of Energy Trust applications, while the other attributed difficulties to the program being a pilot.
- Another participant said the application process took three months until Lockheed Martin finally walked the participant through the form step-by-step. This participant said the application contained a large amount of legal language, and would have appreciated having assistance earlier.
- In contrast, two participants who had experience with Energy Trust projects thought the application clear.
- Another participant who thought the application process straightforward noted that the vendor handled the paperwork and made the process easy.
- One participant expressed confusion at the numerous Pilot stakeholders (vendors, consultants, administrator, implementer) and would have appreciated a clear summary of everyone's roles.

BPTaC System and Service

Most participants expressed satisfaction with both the vendor support and the energy-monitoring system. The participants reported that the vendors were responsive and, when dealing with unresponsive participants, were persistent. In addition, participants found the training user-friendly and of adequate length, although users of both systems said they benefited from a follow-up session in which their questions were answered and they received encouragement to maintain their momentum towards making efficient operational changes.

One EIS participant reported a time delay in the dashboard and wanted real-time information. The EIS vendor told this participant that it would be costly to provide instantaneous consumption information.

The EMS semiannual reports were not available at the time of the evaluation team's first round of participant interviews. In contrast, the evaluation team was able to observe participant activity level on the EIS web portal, including participants' comments on the task list. While we noticed that users had not yet updated any task status, we found that most tasks appeared to have been reviewed and considered, and many were in progress.

Operational Changes and Energy Savings

The three EMS participants saw some savings after installation, and they looked forward to discovering what savings could be achieved over a longer time. All of the EMS participants made changes to their building operations, such as scheduling and controlling HVAC and lighting use. Examples include:

- Using the "building open" button, which automatically starts the air conditioning and sequences how the equipment turns on. (Previously, equipment was turned on manually.)
- Establishing a target temperature setpoint for a space occupied by customers.

One participant considered placing monitoring and controls on more building loads to avoid waste. This participant had already worked with the EMS vendor to develop a temperature monitoring application for a refrigerated cabinet, as previously mentioned. The participant reported that the vendor worked hard to make everything run perfectly, and when the system did not perform satisfactorily, the vendor made the needed changes.

The four EIS participants also made low-cost or no-cost changes to their operations, based on the vendor's recommendations. The changes typically included these actions:

- Reducing HVAC system run times;
- Calibrating control sensors;
- Adjusting setpoints;
- Doing air balancing;
- Using air compressor timers; and
- Sending reminder e-mails to tenants.

At the time of the interviews, three of the EIS participants said it was too soon to tell whether any energy savings had been achieved; however, two offered examples related to system performance.

- One participant saw energy use go up because of a broken pump controller, which was resolved with the help of the EIS. This facility also had a broken controller and, instead of replacing the controller with a basic model, the participant installed a model that controlled multiple zones, using the EIS to improve the scheduling ability.

- Another participant reported that, although excited about the results, they did not yet have time to analyze savings. This individual thought savings were likely achieved since the HVAC run times in the building had been reduced by 14 hours over six units.

The EIS participant who reported savings said this was the result of adjusting the HVAC run times, adding that the change did not have a negative impact on the comfort level within the building.

Other BPTaC Systems Benefits

Most participants used the systems to monitor both energy spikes and the operating condition of their equipment, and to diagnose maintenance problems that could lead to unnecessary energy consumption. In one case, an EIS participant had used Excel to track bills for the past four years. With their prior approach, the participant's analysis was delayed by a month. Having information provided more quickly and in shorter intervals through the EIS proved helpful for collaborating with facilities staff to make operational changes and to improve response times to equipment malfunctions. This participant expects their ability to analyze the EIS's 15-minute interval data to improve and anticipates using practices learned from the BPTaC Pilot at other city buildings, if the program works out favorably.

Another EMS participant reported being pleased with the ability to maintain control of the facility, even while out of town, as users can log on to the system and change settings remotely. This participant also uses diagnostic reports to monitor the performance of the HVAC service companies employed by the facility.

Participants who had tenants also used the monitoring systems to manage their tenant relationships. One allowed tenants to look at the EMS dashboard so tenants could monitor the building's current conditions. Another used the EIS to transparently determine how much rent to charge a tenant who wanted longer hours of operation.

Barriers to Implementing Energy Saving Measures

Participants reported that their monitoring systems provided information enabling them to reduce energy use without sacrificing performance. Ultimately, however, the participants understand they are responsible for taking the actions needed to obtain or maximize energy savings. Both EIS and EMS users they reported these barriers to implementing energy saving recommendations:

- **Building occupant tolerance**. One EIS participant tried changing the setpoint, but experienced too many staff complaints and had to revert to the prior settings.
- **Resource constraints**, which fall under two categories:
  - ***Capital constraints*** prevented participants from moving forward with high-cost recommendations. For example, because no incentive was available to offset the cost of replacing a duct system, this measure would have to be in the next year's capital budget, and it is subject to approval from the building owner. Another participant reported difficulty

in obtaining upper management's approval for energy-efficiency projects. This participant said that upper management does not perceive energy-efficiency projects as highly "glamorous" and does not consider internal staff experts, so an outside expert and data may be necessary to make energy efficiency a priority.

- ***Staffing constraints*** prevented participants from spending time addressing operational changes. One facility manager reported always being in the field to address other problems and said she needed somebody else to work on the recommendations. As many local governments cannot add full-time employees at this time, she thinks the solution may be to team with other cities in hiring a consultant to complete energy-efficiency projects on a contract basis.

Project Performance Over Time

Typical Energy Savings Measures Installed

The Cadmus evaluation team sought to determine both the types of improvements participants typically make as a result of having installed a BPTaC system and whether the savings persist over time. Table 4 contains a representative list of the energy-saving measures implemented by participants (although actual implementation varies by facility).

Table 4. List of Implemented Energy Saving Measures by System Type

EIS	EMS
Post energy saving tips in facility	Optimize/repair economizer
Send email blast with energy saving tips	Retrofit lighting
Reduce system hours of use (HVAC and lighting)	Reduce system hours of use (HVAC and lighting)
Optimize/repair economizer	Adjust light levels
Complete air balancing	Maintain rooftop units
Optimize equipment start/stop time	Turn on equipment in stages to avoid demand spike
Install occupancy sensors	
Calibrate temperature sensors and adjust setpoints	
Retrofit lighting	

Savings Persistence

To answer the question about persistence of savings, we plotted the percentage savings for the EMS and EIS sites for which we had monthly performance data from the vendor. Both vendors calculated the energy savings relative to the pre-installation baseline and no adjustments are made to isolate impacts from energy-saving capital improvements installed after the BPTaC system. However, the vendors were able to quantify the impact of the capital improvements in separate reports to their customers.

Figure 11 shows the electric and gas savings[9] from the vendor for two EMS installations.[10] (Note that the savings are not adjusted for tenant occupancy or guest counts.) In general, these results show that savings for the EMS persist over time; however, there are fluctuations that may be caused by changing business conditions (such as occupancy).

The vendor noted that the two EMS participants were very different in their use of the system. The manager on Site 1 logged into the system multiple times per week and was highly engaged with the

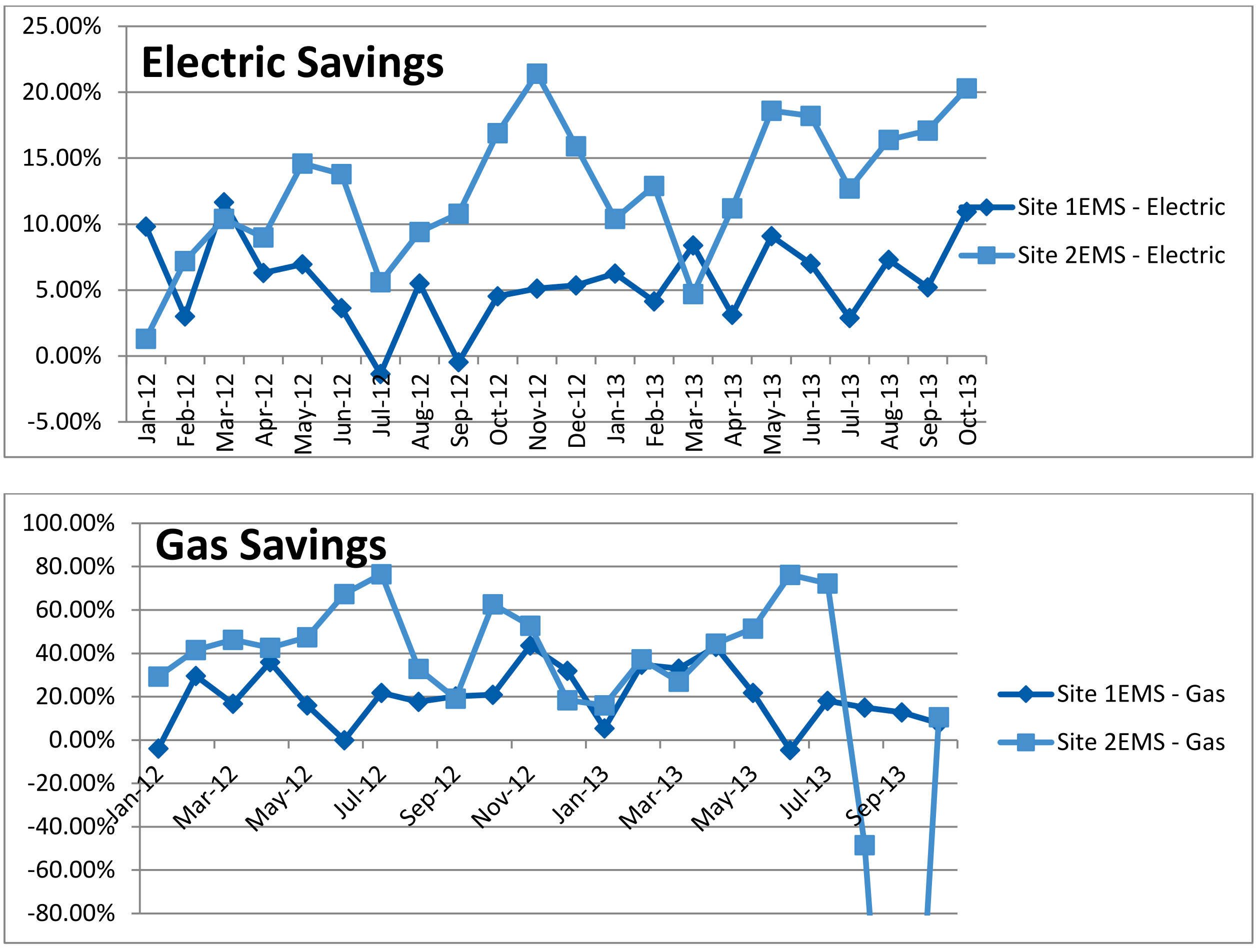
9 Savings for each month are relative to the consumption during the same month in the baseline period, adjusted for weather. The baseline is static.

10 We were unable to obtain this same type of data for one of the restaurant chains because of their different reporting practices; however we note that the participant says they did not observe any energy savings, which they attribute to the fact that they are open 24 hours a day, without much opportunity for scheduling.

vendor. In contrast, the facility manager for Site 2 was not engaged with the vendor and did not appear to log into the system very often. Still, both were successful in saving energy.

It appears that Site 2 has greater savings despite the lack of attention from management. The vendor attributes the large savings to the fact that this facility is an office building, which has greater saving opportunities for schedule optimization, repairing economizers, and pre-cooling the buildings with outside air during the early mornings. Buildings that operate with longer hours may have fewer opportunities to save energy.

Figure 11. EMS Savings Persistence*

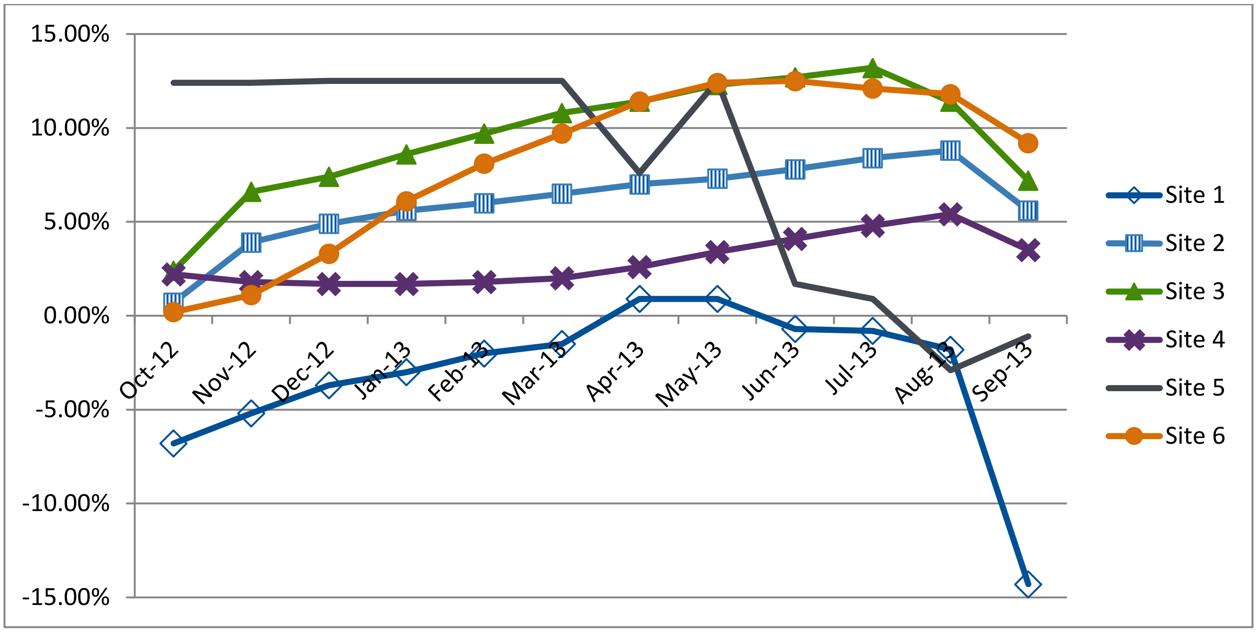


The exact reason for the sharp decrease in gas savings in September 2013 is unknown. The base period of September 2011 had very little gas usage, so the percentage change looks large. The vendor speculates this drop is due to weather or occupancy effects.

Figure 12 shows the results for the EIS participants. This figure, provided by the vendor, shows that many sites experience savings each month; however, at a few sites, the savings appear to be tapering off. The vendor attributed the savings decline in savings for Site 3 and Site 4 to the customer's impending move to a new facility. Customers who are focused on moving are less motivated to pay attention to energy use at the old facility.

Another site of note is Site 1, which was not successful at saving energy for much of the year. We believe that this was the facility that the customer wanted to tear down because it was poorly constructed and, hence, difficult to operate properly. This participant did not respond to the evaluation team's follow-up questions.

Figure 12. EIS Electric Savings Persistence



Participant Engagement Levels and Savings

Table 5 shows the project savings against indicators of how engaged the participant was in using the EIS over the Pilot period. The evaluation team determined this level of activity from the number of dashboard logins and vendor observations about a customer's level of involvement and ability to make operational changes.

Table 5. EIS Savings vs. Customer Activity

Site #	Post Baseline kWh Savings	Annualized kWh savings	Post Baseline Therm Savings	Annualized Therm Savings	Logins to platform (1/1/2012 – 10/31/2013)	Customer involvement	Customer ability to take action
1	-1.6%	-5,796	8.1%	408	34	Low	Low
2	5.6%	61,145	Pending bills	Pending bills	34	High	Medium
3	7.2%	83,401	49.9%	10,087	379	Medium	Medium
4	3.5%	51,010	10.7%	1,784	379	Medium	Low
5	-1.2%	-13,942	12.4%	3,285	30	Intermittent	Medium
6	9.2%	386,489	19.3%	85,92	491	High	High

The two sites (Site 3 and Site 6) that achieved the highest savings have the highest number of logins and are fairly involved from the vendor's perspective. The poorest performing site (Site 1) has the lowest activity, based on all our indicators. However, we also note that nearly all of the sites completed all of the energy-saving measures recommended by the vendor, although two sites failed to complete one or two tasks.

Second-Year BPTaC Pilot Interview Findings

This section contains the feedback from participants; EIS, AOS, and EMS vendors; and program staff obtained by Cadmus' evaluation team in 2013.

AOS Vendor Feedback

Due to staffing turnover with the AOS vendor, the evaluation team interviewed multiple AOS representatives. These respondents said Energy Trust paid for the vendor to conduct site assessments at two Portland-area hospitals to determine the viability of the AOS system.[11]

Energy Trust and Lockheed Martin helped facilitate the meetings with the hospitals and provided information about the BPTaC incentives. The vendor says the hospitals appeared interested in the projects presented, but ultimately the clients' internal decision-making process dictated the amount of time required to approve projects. Based on their past experience, the vendor says projects usually are executed within two years. However, they added that if the projected financial performance is not sufficiently attractive, customers may delay decisions even further. The evaluation team believes the vendor's measurement of project progress in years reflects the substantial upfront cost of these systems, even after incentives.

At the time of our interview (in April 2013), these hospitals were reviewing how they would pay for the AOS system. The vendor said that the interface between Energy Trust and Lockheed Martin and the hospitals was helpful and that this experience had given the vendor a better understanding of the information Energy Trust expected from vendors. During a follow-up communication in February 2014, the vendor noted that one of the hospitals was installing an AOS system through Energy Trust's Custom Incentive Program.

Value of AOS System and Vendor Services

The vendor says the value of the AOS system is that it optimizes an already functional chiller plant, provides visibility into how a customer's whole chiller facility is performing, and alerts customers when an issue is detected. To reap the full benefits of the system, the customer has to be willing to upgrade their facility so that it can be compatible with the AOS and then must address the issues identified by the AOS system and vendor support services.

With an AOS integrated into the controls and running the entire plant, operators can see their entire facility with one program, in addition to being able look at individual components. The vendor says without such a system as AOS, many plant operators will tune up their plant every few years, but will not know how well the maintenance persists over time, because older systems are not integrated, and the equipment is operated piecemeal. In addition, without any centralized control system, operators must look at a series of gauges daily.

[11] Energy Trust program staff confirmed that these assessments have been paid.

With the AOS, the operator can continuously track the facility's performance and make instant course corrections, based on the vendor's analysis of parameters such as refrigerant levels or air flow. Being able to diagnose problems early also helps operators justify needed preventative maintenance calls.

Second-Round Feedback from EMS and EIS Vendors

In 2013, the evaluation team conducted follow-up interviews with both the EMS and EIS vendors.

EMS Vendor

The EMS vendor said the Pilot in 2013 was challenging due to the Pilot's uncertain status and a hold on recruitment from January 2013 to April 2013. When the vendor learned in in April that customers could be enrolled again, they also learned that enrollments had to be completed by May 31. Thus, the vendor had to identify six projects in this time frame so as to get at least two done, and "It was hectic." The vendor said that having a permanent, standardized program would make it easier to work with Energy Trust.

Getting Savings

The EMS vendor said they are a controls vendor who helps customers maintain and tune their facility operations. The customer handles the setpoints and schedules, and the vendor ensures the building systems respond appropriately. Operational tuning is an ongoing process, but the vendor pays special attention during season changes when different types of equipment come online (such as boilers in the winter).

The EMS vendor said they are not surprised if the customer is not achieving their full savings potential during the first six months or even a year after system implementation. Typically, the first six months are spent tuning the controls algorithm and educating customers in caring for their buildings. The vendor tries to educate the customer to avoid making "penny wise, pound foolish" decisions, such as going with their HVAC contractor's recommendation for a cheap unit that ultimately requires frequent maintenance. Many occupants of small buildings tend to skip preventative maintenance because they can't quantify the costs of not doing the maintenance, so the vendor shows them with the cost implications of failing to maintain equipment.

Convincing Customers to Take Action

The vendor says customers who get the most out of their energy-monitoring systems and vendor subscription services are those who are willing to correct deficiencies in their buildings. They say the main barriers that prevent customers from acting on recommendations are a lack of management support and split incentives. For example, in one building with an EMS, the property manager refused to install an economizer recommended by the vendor since the tenant, a data center, was paying the energy bills. The energy use of the other tenants was paid by the owner.

Because of the challenges with motivating some customers to address their building issues, the EMS vendor has decided to be more selective in the types of projects pursued so that the projects will be

more successful. This vendor now asks potential customers about their current maintenance practices, such as whether they do air balancing or seasonal cleaning.

Tracking Energy Saving Measures

The EMS vendor typically offers recommendations via e-mail or verbally during discussions with the customer regarding the latest performance report. The vendor acknowledged that this process needs to be improved and formalized, and plans to work on this issue.

Feedback on Performance Based Incentive Structure

The EMS vendor says that delays in incentive payments or uncertainties over the amount of the incentive make it more difficult to sell energy-monitoring systems to customers. However, they thought there could be a way to provide incentives for customers to respond to recommendations. They mentioned some utilities in Southern California structure their EMS program incentive such that a percentage of the incentive is paid immediately after installation, with the remainder of the incentive paid after verification of performance.

Industry Trends

According to the EMS vendor, the “low hanging fruit” has been picked in the Pacific Northwest region, and energy conservation is becoming more complex. As a result, the EMS vendor is partnering with several energy related companies in the Pacific Northwest to create a “comprehensive, one stop solution that will make it easier for customers to realize true savings” and sustain them over the long term. Services that should be combined are: customer education, LEED certification, NEC compliance, field diagnostics, controls optimization, DCV, asset management, customer support, energy reporting, and sustained commissioning. The vendor believes the success of the EMS industry will depend on its ability to simplify the process of getting savings while maintaining affordability and attractive ROI.

EIS Vendor

Due to staff turnover, the EIS vendor representative we interviewed was not the same as the one we spoke to at the beginning of the pilot.

Getting Savings

The EIS services are provided in two rounds, and each round begins with a weeklong monitoring study during which the vendor installs a sensor package to gather temperature, relative humidity, carbon dioxide, and lux (light output). These sensors take a reading every two minutes. The vendor also gathers other information needed for energy modeling, such as space use, HVAC equipment types, schedules, and lamp types. Then, the vendor’s building analysts review the model and develop a list of energy-saving measures for the customer. The first round occurs during the first year after installation.

The second year through the end of the pilot period is considered the second round. During the second year, the vendor does a walk-through audit of any poor performing buildings.

In addition to the building analysis conducted at the beginning of each round, the vendor has analysts looking at each building's performance on a monthly basis. Each quarter, a vendor staff member visits customers whose facilities are not performing well.

Convincing Customers to Take Action

The level of EIS customer engagement varied, and the vendor says the facility that was most successful at saving energy was also the most demanding. This customer was strongly driven to obtain as much savings as possible and was always "hungry for measures." The EIS vendor responded to special requests made by this customer, from providing the customer with an analysis isolating savings from a capital improvement to assisting with ENERGY STAR rating.

At the other end of the spectrum, the EIS vendor struggled to get customers to respond to their recommendations and meeting requests. Budget limitations prevented some building managers from implementing recommendations, while other managers have simply become less responsive over time. The vendor also noticed that some customers do not maintain equipment setpoints due to occupant pushback, and that causes savings to decay. In these cases, the vendor reports that face time and repetition works best to get customers' attention.

Tracking Energy Saving Measures

Although the EIS has a formal energy-saving measures tracking feature in the online portal, the vendor says participants do not regularly update the status of completed measures. The vendor found it more effective to enter information for the participants during meetings via telephone or in person.

Feedback on Performance Based Incentive Structure

The EIS vendor says that since some customers became less responsive over time, it may be useful to implement an incentive structure where part of the incentive is paid based on performance or responsiveness to recommendations.

Industry Trends

The EIS vendor sees the EIS market continuing to evolve in the coming years. Their approach is to move increasingly towards "combining EIS software with other services, such as continuous commissioning." They see this as a high growth market as more utilities provide incentives for EIS measures and the market becomes more aware of operations based savings, as opposed to capital improvement based measure.

Second-Round Feedback from EIS and EMS Participants

The evaluation team conducted one-year follow-up interviews with these six BPTaC participants, some of whom installed more than one system. Their company type is listed below:

- Family entertainment center,
- Restaurant chain,
- Office park,

- Commercial property management company, and
- Two city governments.

Of the six participants interviewed, three had an EMS and three had an EIS.

EMS Participants

Participants' Use of EMS Dashboard and Vendor Support Services

Participants reported that they or their colleagues monitor energy use through the dashboard on a daily or weekly basis. The dashboard facilitated monitoring of equipment performance and enabled participants to confirm that equipment was operating according to the intended schedule.

The rights to control equipment are reserved for participating management or maintenance personnel, although management allows tenants to see and adjust temperature settings. Participants also rely on the EMS's alert system to flag potential performance issues which they then discuss with the vendor to resolve. For example, one participant received an alert when the office building's temperature reached 80 degrees. The EMS vendor was able to diagnose the issue as a bad rooftop unit and direct the participant's HVAC contractor to fix the problem, saving time and money by avoiding needless diagnostic testing. Another participant provided their HVAC vendor with access to the dashboard so this service provider could be aware of alerts and directly diagnose mechanical malfunctions.

Overall, participants found the dashboard interface useful, but they also identified these difficulties:

- Alerts do not distinguish between an operational or equipment issue, so participants need to contact the EMS vendor to determine the cause. One participant says because the vendor has only one staff member responding to system alerts, the result is a longer response time than desired. On occasion, this has caused the participant to send for an HVAC vendor to diagnose the reason for the alert, rather than waiting for the EMS vendor. This participant also says there was an instance when the lights would not turn on in a portion of their building, and the response from the vendor took over an hour, which had a negative effect on business. The participant believes that response time should be less than 15 minutes for such emergency situations.
- Initially, one participant wanted the ability to download the data tracked by the energy-monitoring system but could only obtain monthly reports. This participant had engaged with a third-party energy management company and wanted to provide their contractor with the raw data to analyze and track the effect of making individual repairs. Since this interview, Cadmus has discovered that the vendor has provided this data to this participant. Another facility had issues with the dashboard not displaying information properly. Once the participant contacted the vendor, the vendor completed the dashboard recalibration within a few days. All participants were satisfied with and commended the vendor on response times to dashboard issues.

Implementation of Energy Saving Measures

Participants say that shortly after installation of the EMS, they completed most of the recommended energy-saving measures, starting with the low-cost energy saving measures first. Only one participant plans to make additional capital improvements (specifically, phasing in LED parking lot lighting) as funding allows. This participant is very pleased with the EMS and has convinced a sister property in another state to also install the EMS and replicate the energy-savings measures suggested by the vendor.

All participants said they would be interested in making additional improvements if the recommendations had an attractive return on investment (ROI). This is important information for facility managers seeking to obtain upper management support for implementing measures. Currently, energy saving measure recommendations from the vendor are not usually presented with ROI or cost savings estimates.

Overall, the energy-savings measures implemented tended to persist over time. However, one participant said that local store managers reversed one of the operational changes because the water flow rate of the dipper wells was too low to keep the restaurant's food-handling equipment clean.

Feedback on Energy Savings Analysis

All participants received a report containing an analysis of their energy savings, and all said they primarily looked at the percentage and dollar savings, which they noted stayed fairly consistent over time.

The participants would appreciate more follow-up from the vendor and an explanation as to what causes the savings (or lack of savings). Specifically, participants reported being unclear about why changes in occupancy are not reflected in a new baseline and what causes consumption spikes in the data, as well as what can be done to address these spikes. A third participant reported not seeing meaningful energy savings despite investing thousands of dollars in implementing the vendor-recommended energy-savings measures. This participant attributes some of the poor savings performance to the facility's 24-hour-per-day operations and to faulty lighting controls.

Benefits of EMS and Consulting Services

Two of the three EMS participants realized significant savings in both electric and gas costs. In addition, the participants reported a variety of non-energy benefits. One participant says the EMS has improved tenant satisfaction and has resulted in a decrease (ranging from 40% to 50%) in the number of calls from tenants reporting system malfunctions and lack of comfort. This reduction in call volume has resulted in a significant reduction in building management costs.

All participants also appreciated the ability to view, diagnose, and quickly solve issues brought to their attention through the EMS alerts. The EMS and vendor consulting services have helped participants determine if their HVAC system needs to be serviced, thus allowing participants to avoid incurring costs from unnecessary service calls. What participants liked most about the EMS was it gave them more

control over the systems in their facility, with two participants saying they considered the energy cost savings to be a secondary benefit.

Summary of Recommendations from Participants

Participants made the following suggestions for EMS product and support improvement:

- Enable participants to download raw data from the dashboard
- Create a smartphone app
- Include a dashboard function that indicates the reasons for performance issues
- Make the dashboard more intuitive for HVAC vendors
- Increase staffing for support calls regarding alerts and aim to respond to critical system malfunctions within 15 minutes
- Continue in-person meetings to review building performance, energy savings, and additional energy saving measure
- Allow the vendor to obtain a copy of the utility bills without the customer having to send it to the vendor
- Have the vendor identify causes for spikes in consumption
- Simplify or remove the LCD monitor

EIS Participants

Participants' Use of EIS and Vendor Support Services

The participants' usage of the EIS varied:

- One reported using the online portal on a regular basis (from daily to weekly) to monitor the energy consumption and look for unexplained usage spikes, which may indicate faulty equipment. At this organization, building technicians receive daily reports by e-mail. When the report shows unexpectedly high usage, the technician will access the online portal to diagnose the issue by closely examining the energy usage throughout the day.
- Another participant relies on system alerts to indicate an equipment malfunction. In one case, a participant discovered that an alert was caused by a fan operating incorrectly.
- The third participant did not access the online portal often, preferring to use the monthly reports from the vendor.

Participants had few issues with the online portal, and said the vendor quickly resolved issues if they arose. While participants found the legacy online portal interface useful, they also offered the following suggestions:

- Using buttons instead of links would make the website more user-friendly and attractive
- Make the Tools section more intuitive
- Keep ENERGY STAR ratings, which are important to some participants, up-to-date and accurate

- Two participants said they would prefer having real-time performance data, which would allow them to see the effect of operational changes more quickly and encourage them to make additional changes

Participants said they communicated frequently with the vendor during setup and initial operation. During the following year, communication slowed to once every one to two months. Participants reported they usually communicated with the vendor about high usage on a certain day, while vendors tended to communicate with them about the status of energy-saving measures or encouraging them to implement measures. As an example of this, one participant said the vendor sent an e-mail to remind the building manager to change the HVAC start/stop time for the season change. Another participant was seeking ENERGY STAR certification for his facility, which required additional vendor support due to issues with data reporting and interfacing with the ENERGY STAR Portfolio Manager tool.

Implementation of Energy Saving Measures

Participants completed most of the recommended energy-saving measures shortly after installation of the EIS. For the energy-saving measures that they did not implement, participants usually said cost was the main barrier. In one case, a participant felt that posting energy efficiency tips or sending out awareness e-mails would not be effective and thus did not complete that energy-saving measure. In another case, a participant who was preparing to move into a new building said not all energy-saving measures were worth completing before the move.

Participants found vendor support very helpful during the implementation of energy-saving measures. However, all participants wanted another round of energy-saving measure recommendations. Shortly after obtaining the EIS, participants focused on implementing the energy saving recommendations, and they were happy to see savings on their monthly reports following the completion of energy-saving measures. The momentum has now slowed, and participants believe that having additional recommendations will reignite their interest in energy savings.

Participants said they generally maintain energy-saving operational practices. Only one participant changed the temperature setpoint back to the original setting in response to occupant complaints. Participants resolved to continue maintaining the energy-saving measures as long as they continue to save money.

Overall the participants find the energy-saving measure recommendations to be a very valuable component of the EIS system and have offered the following suggestions for improvements:

- The vendor should conduct additional audits to identify energy saving opportunities
- They would like to receive additional energy-saving measure recommendations
- The vendor should try to better understand the business activities that occur within the building to make more customized energy-saving measure suggestions
- Enable direct communication between facility technicians responsible for implementation and the vendor during measure development and implementation

- More frequent communication and reminders from the vendor would help to maintain their interest in energy efficiency.

Feedback on Monthly Reports and Energy Savings

For a time, participants received[12] monthly reports showing the status of energy-saving measures and graphs of their energy savings. Participants found that the reports provided useful information regarding the implementation status of their measures, and some used portions of the reports in the status updates they gave their management to show the facility's savings progress. Participants were satisfied with their savings levels, and one participant was very satisfied with how significant the energy savings were.

The participants offered these recommendations for increasing the usefulness of the monthly reports:

- Include month-to-month and year-to-year comparisons customized to the participant's fiscal year
- Scale graphs to make them more legible
- Remove graphs that are duplicative
- Update the building pictured on the report to the correct building
- Disaggregate the effect of renewables, such as solar, from the overall facility savings

Benefits of EIS and Consulting Services

All of the EIS participants realized significant electric savings, with one participant reporting savings ranging from 24% to 32%. The ability to see energy savings following the implementation of an energy-saving measure motivated participants to continue making energy-saving changes. One participant said that having the EIS allowed their company to finally move forward with a large capital improvement that had been planned for many years. Without the information from the EIS, the participant was unsure what level of return to expect, but having the EIS gave the participant the confidence to implement the project. Another participant has seen less wear on a chiller due to decreased operation, and this has resulted in reduced maintenance and repair costs and an extension of the expected life of the equipment.

Participants also said the EIS has been important to changing company culture because the information provided by EIS has led to more conversations about and an increased awareness in energy efficiency and conservation. The EIS has enabled building managers to quantify savings performance to decision makers. Also, one participant now includes other resource sustainability issues—such as water conservation—into budget discussions.

[12] The last monthly report Cadmus found in the project dashboard was for May 2013.

Conclusions and Recommendations

In this section we first discuss conclusions and recommendations for the Pilot overall. We then highlight similarities and differences between the EIS and EMS systems.

Program-Level Findings

Conclusion 1. The Pilot did not meet its installation goals for any of the eligible systems. The main reasons for these shortfalls are: (a) the long decision-making time frame that can be needed for these projects; (b) the slow economy; and (c) businesses' unfamiliarity with the pilot measures.

Recommendation 1. Pilots often take a long time, especially those testing products or practices that are not commonly found in the target market sector. Allow vendors ample time to recruit participants, especially for more costly projects. In particular, decision-making in large organizations typically requires time to obtain management approval and to earmark funds. Depending upon when a proposal comes forward in a budget cycle, decisions about such systems could take a year or more.

Conclusion 2. Vendors noted, and some participants concurred, that they lost momentum at various points in the program – for instance, after their systems were installed, their facilities inspected, or after they had taken some actions. Vendors suggested an incentive structure where the first portion of the incentive would be paid to the participant immediately after installation and inspection, and the second portion would be paid after certain level of recommended energy-saving changes were in place. This structure would provide an incentive for participants to remain responsive to the vendor's early energy saving advice.

Recommendation 2. If Energy Trust makes EMS and EIS measures a normal part of its portfolio, it should continue to offer incentives for both the system and consulting services. Energy Trust can then take determine if a two-part incentive (incentives provided after system installation and inspection, and incentives provided for implementing recommended energy-saving changes) is preferable to the existing incentive structure. Although a two-part incentive would require more administrative time, the structure could influence the vendor to follow through with energy-saving recommendations and the participant to follow through with implementing those recommendations. In addition, the vendors and Energy Trust should work together to develop a variety of methods to keep participants engaged, including offers targeted to or tailored for their facilities.

Similarities Between the Systems

Conclusion 3. The commissioning process (optimizing a building's performance to maximize energy savings) can take a year or more. Both vendors of these systems explained that the implementation process entails multiple phases during which the vendor and customer work together to address seasonal issues and to fine-tune the operation.

Recommendation 3. Measure the performance of these systems and the consulting services over an extended period (at least one year, ideally two) to obtain meaningful results about the effectiveness of these systems.

Conclusion 4. Participants are busy and, hence, resistant to completing the documentation required to receive the incentives and to track system performance. Cadmus found that participants avoid filling out application forms on their own and that EIS participants often do not update the status of energy-saving measures in the online dashboard.

Recommendation 4. To prevent delays in the participation process, require vendors or implementers to help participants complete application forms from the start of a pilot program. Also, have vendors track or continue to track implementation of energy-saving measures for participants as part of their consulting services.

Conclusion 5. The participants said that the non-energy benefits of these systems were of great importance, and they specified the following advantages: providing data to better manage tenants, providing more control over building system scheduling, raising awareness of the importance of conservation, and providing information to justify investments for maintaining or improving building systems.

Recommendation 5. Have vendors highlight the non-energy benefits of these systems when promoting their capabilities to prospective customers. In addition, if these systems become part of a regular program offering, Energy Trust marketing can also emphasize these messages.

Conclusion 6. Some customers are more receptive and responsive than others regarding energy-saving measure recommendations. During the initial sales process, vendors can gauge the level and type of involvement that a potential participant is likely to have by asking questions about current maintenance practices and policies.

Recommendation 6. Rather than provide the same level of energy-saving recommendations to all customers, vendors should identify customers who are receptive to ideas and then provide them with more aggressive and frequent recommendations, including suggesting measures that require capital investments. Vendors should work with Energy Trust to determine what incentives are available to support these improvements. The program should create an incentive structure that rewards both vendors and customers for maximizing and maintaining savings.

Differences Between the Systems

Conclusion 7. With the EIS, the savings appear to be more sensitive to participants' willingness to implement energy-saving measures. With the EMS, the most significant savings likely result from effective scheduling, which does not require a high level of attention from participants.

Recommendation 7. Screen participants for characteristics that are likely to lead to significant savings based on the type of system for which they qualify. Thus, for an EIS, target customers who are engaged and willing to implement multiple recommendations, and for an EMS, target customers whose facilities are not already optimally scheduled (and carefully consider the savings potential for those with 24/7 operations).

Conclusion 8. The reporting capabilities of the EIS and EMS have different strengths and weaknesses for supporting evaluation. The (legacy) EIS dashboard tracks, in a systematic and transparent way, the recommended energy-saving measures and the implementation outcomes. In contrast, the EMS does not have a formal way of tracking energy-saving measures, although the EMS vendor is researching ways to add this feature. The EMS vendor's energy savings spreadsheet presents calculations in a transparent, easy-to-follow manner, unlike the EIS reports and portal, which do not explicitly show how the savings are calculated. Both vendors could improve their savings reporting practices by offering additional interpretation of what is driving changes in consumption.

Recommendation 8. Energy-saving measures need to be tracked for all facilities and systems, and the associated energy savings calculations should be made transparent. Results reporting should be organized logically (e.g. in chronological order) and accompanied with explanations of what is causing changes.

To inform participants' decision making, vendors should regularly provide customers with (written) project payback or cost saving estimates for each of their energy saving measure recommendations (at the project or measure level).

Building Performance Tracking and Controls Pilot: Energy Savings Review

September 12, 2014

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Executive Summary

Energy Trust of Oregon launched its Building Performance Tracking and Control Systems (BPTaC) Pilot program in June 2011. This pilot tests the feasibility and persistence of obtaining energy savings from businesses that operate buildings and facilities when they used two different monitoring technologies.[1] The BPTaC Pilot offers participants significant incentives for the following commercial building monitoring systems and their associated consulting services:

- Energy Management System (EMS), intended for smaller buildings.
- Energy Information System (EIS), targeting large buildings with direct digital controls (DDCs).

In this report, Cadmus presents the methods used and the results from its independent review of the energy savings that can be expected from future installations of BPTaC systems. Cadmus performed the following analyses:

- Ascertained if the vendors' reported savings are consistent with Cadmus' analysis of billing data
- Analyzed, given the variability across sites, how well pilot savings are likely to be representative of future BPTaC projects.

Cadmus analyzed the energy savings of five (of seven) EMS and four (of nine) EIS installations. We included only those sites that had at least one year of performance data and where customers participated in process evaluation interviews. More details on the program and its performance are available in the *BPTaC Process Evaluation Report*, May 2014.

Overall Results

Based on Cadmus' utility billing analysis, Table 1 summarizes the performance of both technologies.

Table 1. Summary of Savings and Distribution From Utility Billing Analysis

Technology Approach	Number of Sites	Number of Buildings	Savings from Baseline			
			Mean Year 1	Range Year 1	Mean Year 2 (Partial Year)	Range Year 2
Electric						
EIS	4	4	9%	0% to 17%	17%	6% to 30%
EMS	5	8	9%	1% to 26%	11%	1% to 38%
Gas						
EIS	4	4	8%	-10% to 34%	14%	-30% to 42%
EMS	5	8	16%	-8% to 59%	24%	-18% to 66%

[1] BPTaC also offered incentives to install Automated Optimization Software (AOS), applicable to buildings with chiller plants. However, no customers installed AOS and thus these systems are not included in this analysis.

The Year 1 data includes a full year of operation while Year 2 data is does not include a full year of operation. The percentage of savings for Year 2 is based on the year-to-date comparison of utility billing data to the normalized baseline for the same months.

The program's planning target for annual gross savings was 5% for the EIS. The results of the utility billing analysis show that the average savings for the EIS exceeded the target for both electric and gas savings, with greater savings in the second year.

The target for annual savings for EMS was 15%. While the billing analysis shows the average savings for the EMS did not quite meet the target for electric savings, EMS did meet the target for gas savings. As with EIS, savings increased in the second year.

For both technologies, the results show significant variability in the savings on a site-by-site basis, which will affect the reliable use of deemed savings in savings estimates.

Comparison of Utility Billing Analysis to Vendor Reported Savings

Cadmus performed a utility billing analysis using monthly billing data and compared the results to the vendors' reported savings. Savings are summarized in Figure 1 (electric) and Figure 2 (gas, EMS only). The electric savings reported by the EMS system vendor were similar to the savings documented through the utility billing analysis. However, the gas savings reported by the EMS vendor had a larger deviation from the utility billing analysis savings. The electric savings reported by the EIS vendor did not match the savings documented through the utility billing analysis. To provide an indication of the order for magnitude for the savings difference for the EIS sites, the electric savings are summarized in Table 2. Cadmus could not compare gas savings because the EIS vendor did not report them in their monthly reports or dashboard.

Figure 1. Comparison of Electric Savings - Vendor Reported and Utility Billing Analysis[2]

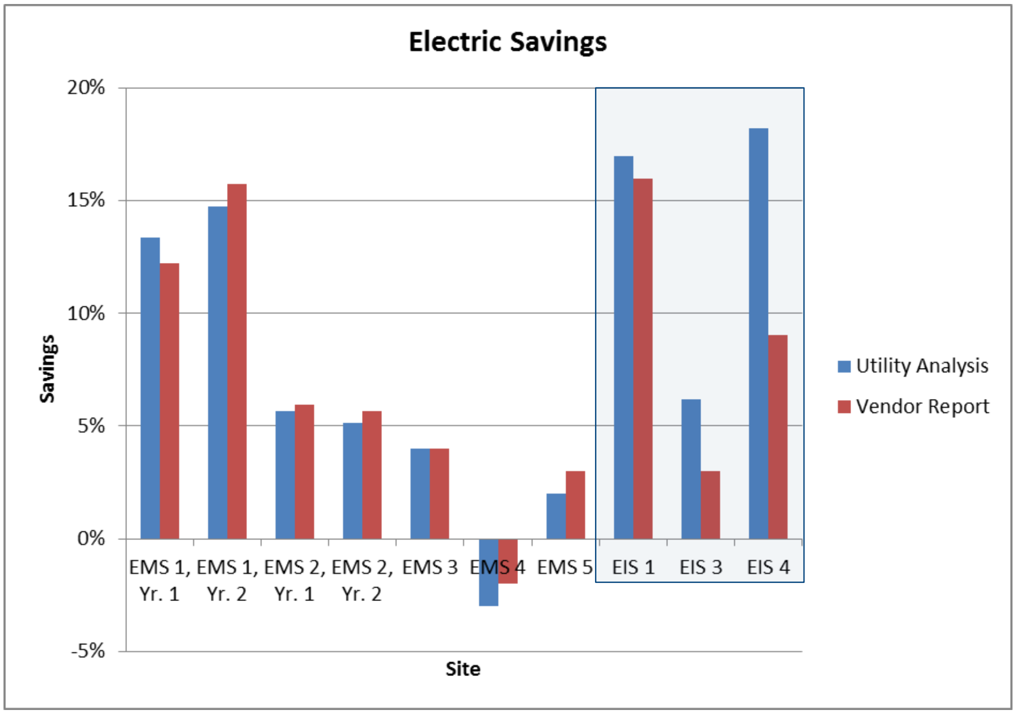
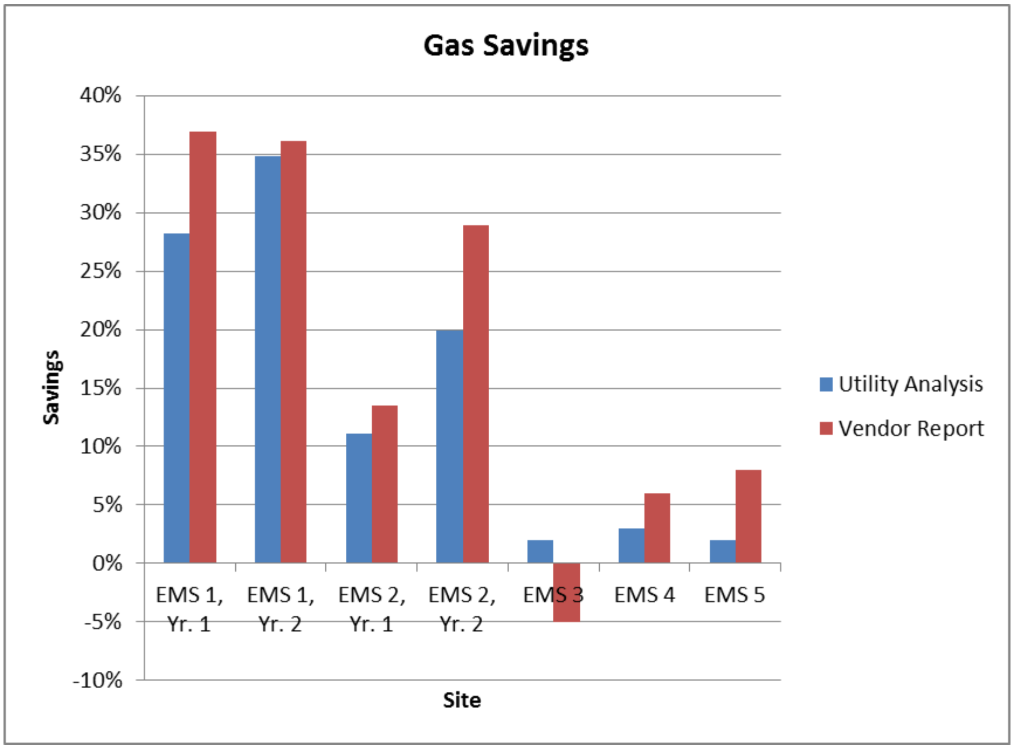


Table 2. EIS Electric Savings

Type	Vendor Reported Electric Savings (kWh)	Utility Analysis Electric Savings (kWh)
EIS Site 1	536,000	344,800
EIS Site 3	43,900	92,090
EIS Site 4	224,780	110,500

[2] Site 2 was omitted in this analysis due to concerns about validity of vendor results.

Figure 2. Comparison of Gas Savings - Vendor Reported and Utility Billing Analysis (EMS only)



Conclusion and Recommendations

Comparison of Utility Billing Analysis to Vendor Reported Savings

Conclusion 1

The lack of a standardized savings report format interfered with the pilot's ability to track system performance and to compare results across system types and facilities.

Recommendation 1

Energy Trust should develop a standard report format for these and similar technologies that will allow a more reliable assessment of both electric and gas savings. The report should include: baseline period used for the energy-savings calculations, the amount of energy savings generated in the report period, the amount of savings that are being attributed to the system, and an indication of whether the reported savings were weather normalized. If the savings are weather normalized, savings compared to the baseline period for the same month should also be provided. Energy Trust could also stipulate the specific periods for the reports, possibly to coincide with the monthly billing periods.

Conclusion 2

The EMS vendor reported electric savings were close to the savings calculated by Cadmus using the utility bill analysis, but there was a larger difference between the two in the gas savings. This is attributable to the different methods of weather normalization used. Gas savings are more weather dependent than electric savings; therefore, Cadmus' gas results show a bigger difference from vendor reports than our electric results.

Recommendation 2

Energy Trust should require that vendors use an analysis method with weather normalization that is customized for each building, not one based on an assumed linear correlation between outside air temperature changes and weather dependent energy consumption and assumed weather dependent loads. Using such assumptions will not match the specific building performance characteristics of each building and will result in inaccurate weather normalized savings.

Conclusion 3

The electric savings reported by the EIS vendor did not match the savings documented through the utility billing analysis. The weather normalization routine that the EIS vendor used is included in the EIS software and is customized for each building. While the method is described, the monthly calculations are not transparent, preventing a direct comparison of the normalization methods to determine if the normalization method had an impact on difference in calculated savings. The utility billing analysis showed that gas savings occurred at three of the EIS sites, but Cadmus could not compare gas savings because the EIS vendor did not report them.

Recommendation 3

Energy Trust should require that vendors document the methodology for weather normalization and report all savings from the installations.

Conclusion 4

For validating energy savings technologies that focus on whole building improvement, weather normalization and regression analysis can be improved with an increase in the available data points. Monthly billing data provides 12 data points from which to develop baseline load shapes. Where possible, using interval data from the utility meters and hourly weather data from a local weather station is recommended. These details may help improve the determination of weather-dependent characteristics and can also provide insight into time-of-day operating characteristics that are not observable from monthly data.

Recommendation 4

We recommend that Energy Trust work with the local utilities to get interval data when available.

Savings Variability and Prediction of Performance

Conclusion 5

The level of variability in savings that Cadmus observed in the pilot study applies to both electric and gas savings. Such variability is normal due to site-specific factors. We would expect variability to continue as new sites are added, making a deemed savings approach unreliable for these technologies.

Recommendation 5

Although the systems do not lend themselves to a deemed savings approach, expected savings targets are useful for setting participant expectations and for use in cost-effectiveness screening. Individual sites did have substantial variability in savings produced, but the average savings do provide revised levels of expectations. We recommend that Energy Trust revise the target savings from 5% savings for EIS systems and 15% savings for EMS systems to those shown in Table 3.

Table 3. Recommended Revised Target Savings

Type	Target Electric Savings (kWh)	Target Gas Savings (therms)
EIS (5% original target)	9%	8%
EMS (15% original target)	9%	16%

Introduction

Energy Trust of Oregon launched its Building Performance Tracking and Control Systems (BPTaC) Pilot program in June 2011. This pilot tests the feasibility and persistence of obtaining energy savings from businesses that operate buildings and facilities when they used two different monitoring technologies.[3] Energy Trust offered participants significant incentives for the following commercial building monitoring systems and their associated consulting services:

- Energy Management System (EMS), intended for smaller buildings.
- Energy Information System (EIS), targeting large buildings with direct digital controls (DDCs).

A more thorough description of the pilot and each of these systems, and an analysis of its performance, can be found in a companion report: *BPTaC Process Evaluation Report*, May 2014. Energy Trust is no longer enrolling customers into the pilot and is assessing whether these types of services should be considered for its incentive programs.

This report describes the results from Cadmus' analysis of energy savings generated from nine BPTaC projects (five EMS and four EIS).

Analysis Goals and Researchable Issues

Energy Trust asked Cadmus to independently quantify energy savings from pilot projects and characterize the amount of energy savings that can be expected from installing EIS and EMS measures at future sites. The analysis:

- Ascertained if the vendors' reported savings are consistent with Cadmus' analysis of billing data
- Analyzed, given the variability across sites, how well pilot savings are likely to be representative of future BPTaC projects.

Summary of Analysis Methods

The Cadmus evaluation team conducted these key activities:

- Identifying which sites should be included in our analysis.
- Collecting and reviewing program documentation for selected sites, including EMS and EIS vendor reports.
- Reviewing online project dashboards.

[3] BPTaC also offered incentives to install Automated Optimization Software (AOS), applicable to buildings with chiller plants. However, no customers installed AOS and thus these systems are not included in this analysis. In addition, since the pilot began Energy Trust has decided to serve future AOS projects as custom projects.

- Reviewing utility billing data and weather data to establish baseline building performance and BPTaC post-installation building performance.
- Analyzing BPTaC system savings by comparing utility bill data and savings variability across sites.

Site Selection for Analysis

Cadmus selected participating sites for this analysis if they met two criteria:

1. The BPTaC system was installed for at least one year, allowing a full year of performance data to be analyzed.
2. The customer contact at the site was responsive to interview requests during the process evaluation.

Table 4 shows the five EMS sites and four EIS sites we selected.

Table 4. Sites Selected for Analysis

Project Number	Type	Install Date	Target* Savings Percent	Target* Electric Savings (kWh)	Target* Gas Savings (therms)	Include in Cadmus Savings Review?
BE15297	EIS	12/1/2011	5%	230,887	2,483	Yes
BE13943	EIS	1/24/2012	5%	71,087	1,017	Yes
BE15137	EIS	5/1/2012	5%	79,117	825	Yes
BE15135	EIS	5/1/2012	5%	58,830	530	Yes
BE15429	EMS	5/1/2012	15%	105,406	1,137	Yes
BE13901	EMS	10/1/2011	15%	138,420	1,860	Yes
BE13965	EMS	11/1/2011	15%	41,691	3,867	Yes
BE13966	EMS	11/1/2011	15%	49,500	4,557	Yes
BE13967	EMS	11/1/2011	15%	51,960	3,458	Yes
BE13968	EIS	pre-2013	5%	54,929	170	No, participant unresponsive
BE15467	EIS	pre-2013	5%	54,085	775	No, participant unresponsive
ETEBPS1527195849	EMS	5/31/2013	15%	68,820	4,888	No, less than one year of data
ETEBPS1527218674	EMS	5/31/2013	15%	230,980	1,839	No, less than one year of data
ETEBPS1527027370	EIS	5/31/2013	5%	2,398	2,398	No, less than one year of data

Project Number	Type	Install Date	Target* Savings Percent	Target* Electric Savings (kWh)	Target* Gas Savings (therms)	Include in Cadmus Savings Review?
ETEBPS1527027497	EIS	5/31/2013	5%	1,979	1,979	No, less than one year of data
ETEBPS1527324043	EIS	8/30/2013	5%	40,437	1,303	No, less than one year of data

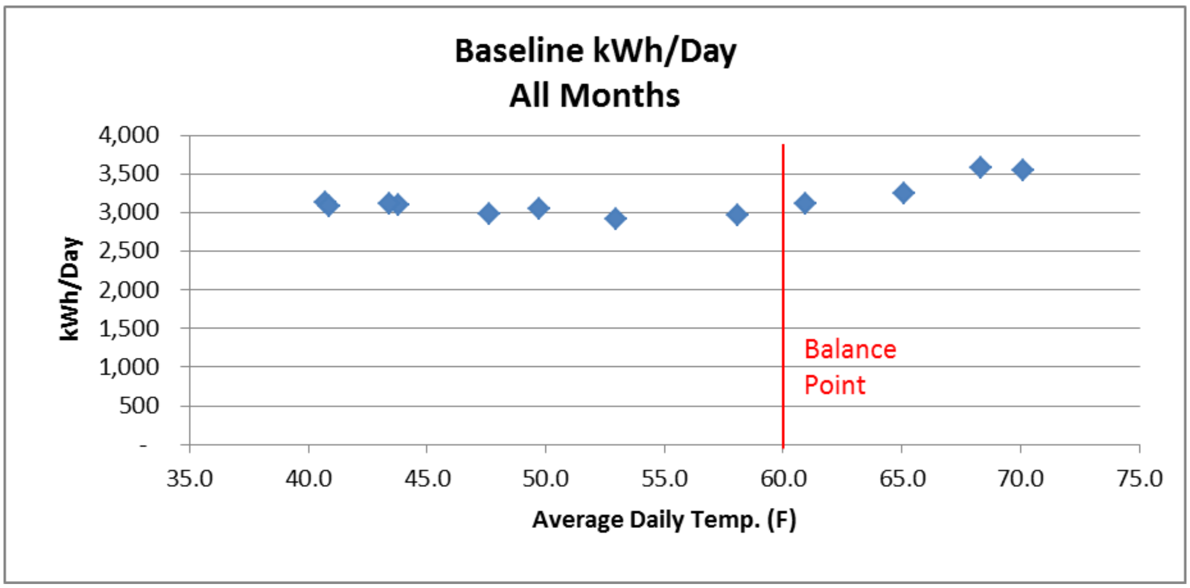
* These targets are project planning assumptions. The EIS savings target is based on 5% savings from the average consumption in the three years prior to installation. The EMS savings target is based on 15% savings from the average consumption in the three years prior to installation.

Cadmus Energy-Savings Analysis

Cadmus conducted an independent analysis of utility billing data to determine energy savings for the selected sites. To establish a baseline for performance measurement, we used energy consumption and weather data for the 12 months preceding implementation. Data from project number BE15135 is used below to illustrate the process we completed for all nine projects.

To determine a baseline load profile that could be used for normalization, we analyzed average daily energy consumption against outside air temperatures for each billing period. Figure 3 shows the average energy consumption per day plotted against the average daily temperature for each monthly billing period in the baseline.

Figure 3. Baseline Period Daily Average kWh vs. Average Daily Temperature (Project BE15135)

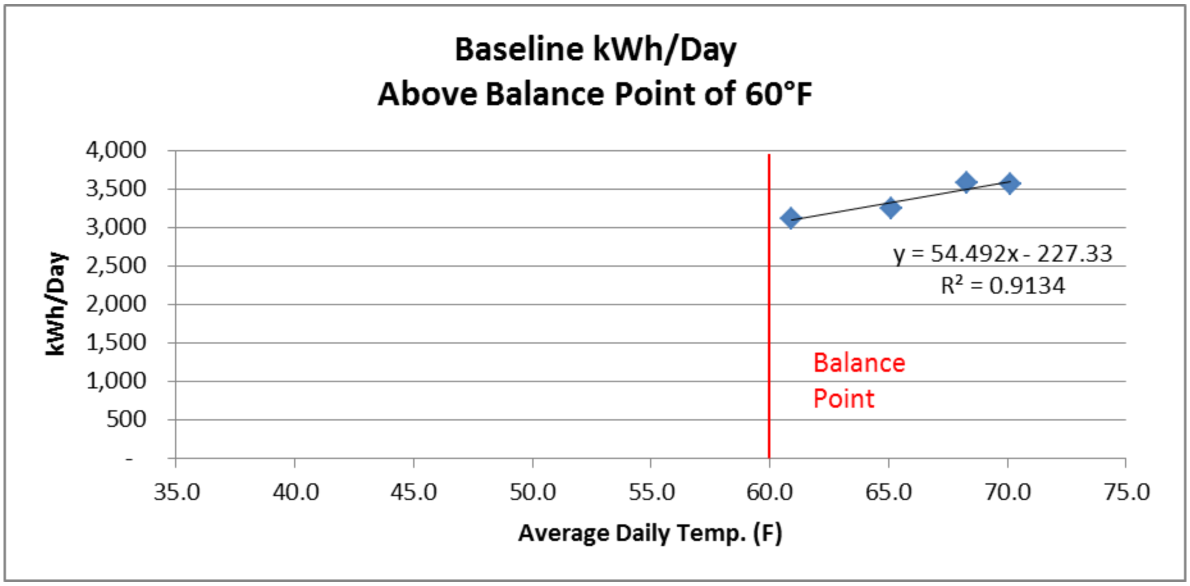


Using this baseline load profile, we determined the outside air temperature balance point for each building. The balance point represents the outside temperature when the building systems change from heating to cooling mode. For a building with electrically powered cooling equipment, the cooling balance point is observed when average daily energy consumption increases from being relatively flat as the outside temperature increases. Depending on the system types, building layout, and control variables, it is possible for a building to have separate heating and cooling balance points.

Once we identified the cooling balance point, we conducted a regression analysis for the weather dependent periods. If the data did not present a specific balance point, Cadmus used the full set of data for the regression analysis. Cadmus analyzed gas and electricity consumption separately. For the building in this example, the data show a relatively constant daily energy consumption load until the average temperature reaches 60°F, at which point the load starts to increase as the temperature increases. Based on this data, Cadmus determined that this facility has a cooling balance point of 60°F.

Figure 4 shows the data points above the balance point and the results of the regression analysis for these points. During the baseline period, which is below the cooling balance point, the facility consumes an average of 3,047 kWh per day.

Figure 4. Baseline Period With Temperature Above Cooling Balance Point



Cadmus performed a similar analysis of this facility's gas consumption. Figure 5 shows the gas consumption for the baseline period. Based on this data, we determined that the facility has a heating balance point of 61°F.

Figure 5. Baseline Period Daily Average Therms vs. Average Daily Temperature (Project BE15135)

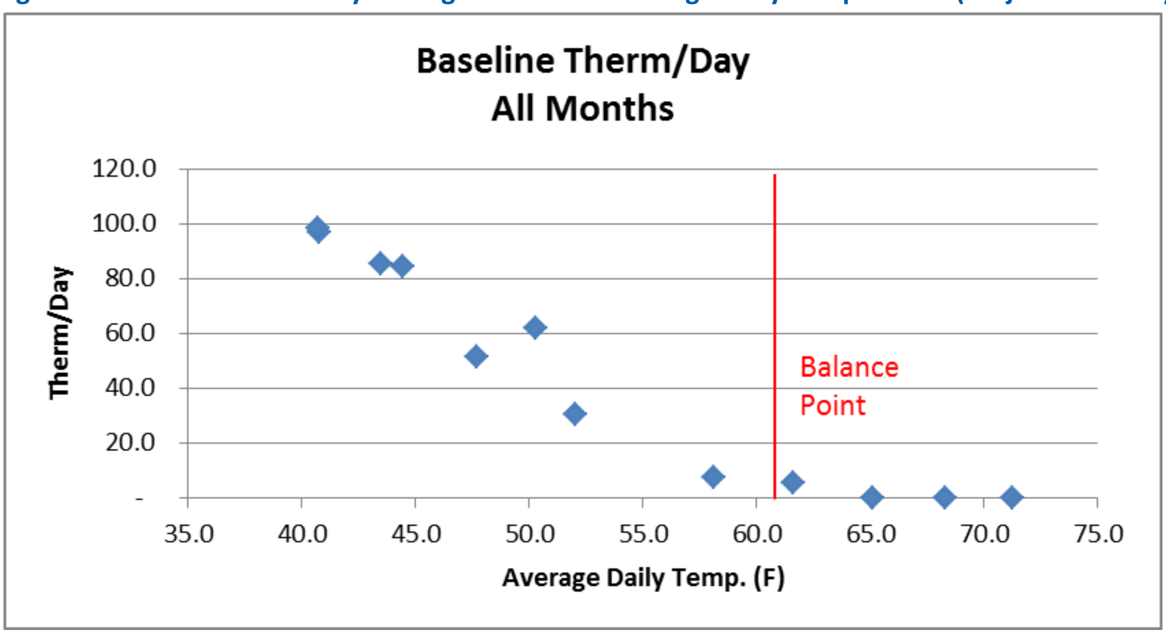
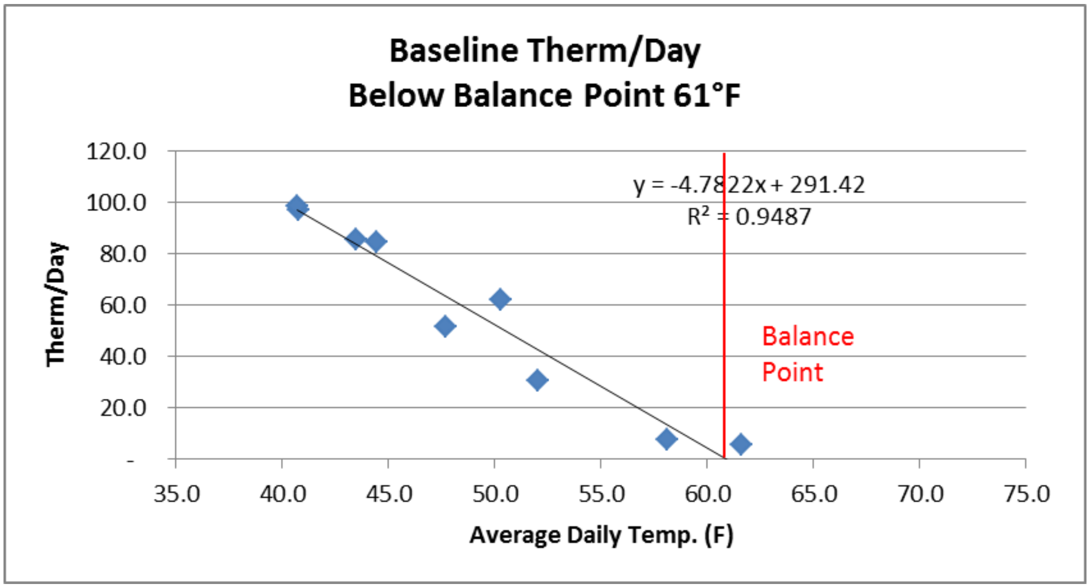


Figure 6 shows the data below the heating balance point and the resulting regression equation.

Figure 6. Baseline Period With Temperature Below Heating Balance Point



Cadmus used the resulting regression curves to calculate the baseline performance in the post-implementation period using the actual weather data for the period, which yielded a weather-normalized energy baseline. For the electric energy consumption, we used the daily average energy consumption for temperatures below the balance point for the baseline calculations.

Cadmus compared the calculated baseline performance data against actual utility billing data, then calculated savings as the difference between the two:

Normalized Baseline Energy Consumption = Calculated Baseline Consumption (applying post-implementation period weather data to regression curves)

Post-Implementation Energy Consumption = Utility Billing Data for Period

Savings = Normalized Baseline Energy Consumption– Post-Implementation Energy Consumption

The post-implementation utility data that was available for analysis ranged from 17 months for one project to 23 months for another. With enough months of data available, the Year 2 savings analysis can be used as an indication of system performance. However, if only six months of data is available, and it does not include the heating season, the data does not present an accurate indication of the percentage of gas savings at the site.

A summary of the savings from Cadmus' analysis is included in Table 5 and Table 6. Site BE15429 is comprised of four individual buildings; Cadmus performed an analysis of each individual building and combined the results for the whole site.

Table 5. Summary of Cadmus Electric Savings Analysis

Project Number	Type	Planning Target Savings	Year 1 Electric Savings*	Year 2 (Partial) Electric Savings*	Months of Year 2 Data*
BE15297	EIS	5%	17%	31%	Dec.-Aug. (9 months)
BE13943	EIS	5%	7%	6%	Feb.-Sep. (8 months)
BE15137	EIS	5%	0%	10%	Apr.-Sep. (6 months)
BE15135	EIS	5%	10%	22%	Apr.-Sep. (6 months)
BE15429	EMS	15%	13%	15%	Apr.-Aug. (5 months)
BE13901	EMS	15%	6%	5%	Oct.-Aug. (11 months)
BE13965	EMS	15%	6%	9%	Dec.-Sep. (10 months)
BE13966	EMS	15%	5%	3%	Dec.-Sep. (10 months)
BE13967	EMS	15%	1%	3%	Nov.-Aug. (10 months)

* Year 1 is defined as the first 12 months after installation. Year 2 is defined as the second 12 months after installation; however, Cadmus only analyzed partial data for Year 2 (based on the available data).

Table 6. Summary of Cadmus Gas Savings Analysis

Project Number	Type	Target Savings	Year 1 Gas Savings*	Year 2 (Partial) Gas Savings*	Months of Year 2 Data*
BE15297	EIS	5%	1%	23%	Dec.-Sep. (10 months)
BE13943	EIS	5%	-10%	-30%	Jan.-Oct. (10 months)
BE15137	EIS	5%	5%	42%	Apr.-Oct. (7 months)
BE15135	EIS	5%	34%	19%	Apr.-Oct. (7 months)
BE15429	EMS	15%	28%	35%	Apr.-Sep. (6 months)
BE13901	EMS	15%	11%	20%	Oct.-Sep. (12 months)
BE13965	EMS	15%	3%	-1%	Dec.-Oct. (11 months)
BE13966	EMS	15%	-1%	2%	Nov.-Aug. (10 months)
BE13967	EMS	15%	5%	15%	Nov.-Sep. (11 months)

* Year 1 is defined as the first 12 months after installation. Year 2 is defined as the second 12 months after installation; however, Cadmus only analyzed partial data for Year 2 (based on the available data).

Variability Across Sites for Cadmus Utility Billing Analysis

Based on Cadmus' utility billing analysis, Table 7 summarizes the performance of both technologies. For the EMS installations, site BE15429 included four individual buildings, each of which had separate utility meters. Cadmus analyzed each of the four individual buildings on the site. Having additional building-level data is helpful for the variability analysis.

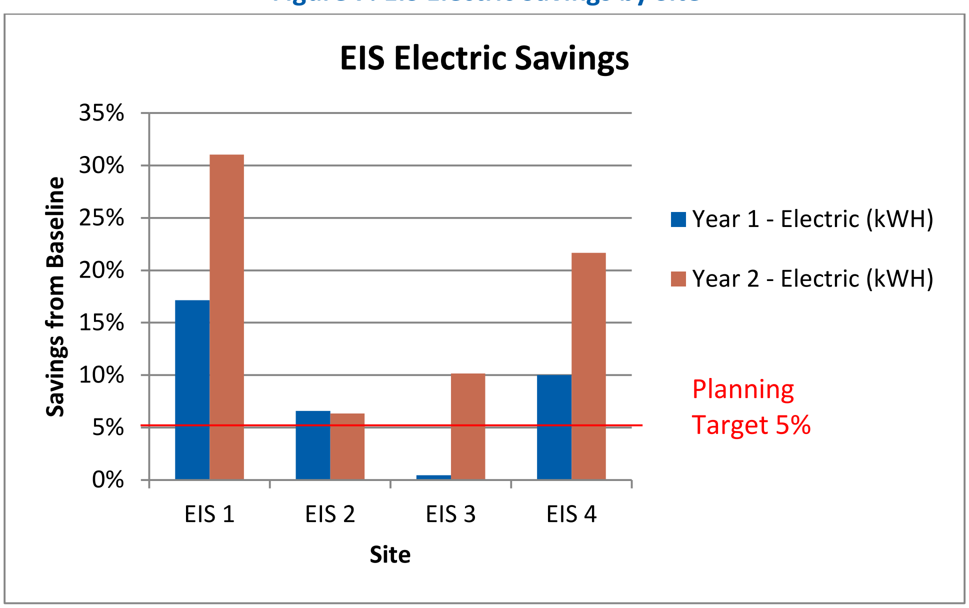
As discussed in the previous section and shown in Table 5 and Table 6 above, the Year 2 data does not include a full year of operation. Cadmus based the percentage of savings for Year 2 on a year-to-date comparison of utility billing data to the normalized baseline for the same months.

Table 7. Summary of Savings and Distribution

Technology Approach	Number of Sites	Number of Buildings	Savings from Baseline			
			Mean Year 1	Range Year 1	Mean Year 2 (Partial)	Range Year 2
Electric						
EIS	4	4	9%	0% to 17%	17%	6% to 30%
EMS	5	8	9%	1% to 26%	11%	1% to 38%
Gas						
EIS	4	4	8%	-10% to 34%	14%	-30% to 42%
EMS	5	8	16%	-8% to 59%	24%	-18% to 66%

A comparison of the electric and gas savings on a site-by-site basis for the two technologies are shown in Figure 7, Figure 8, Figure 9, and Figure 10.

Figure 7. EIS Electric Savings by Site

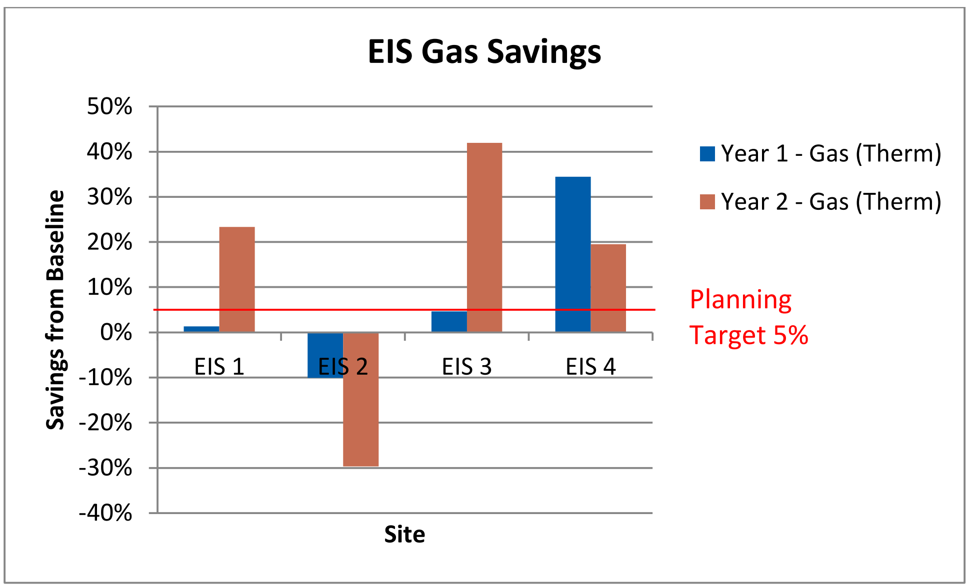


The EIS targeted savings for the pilot program was 5% for electricity. As shown in Figure 7, three sites exceeded the target in Year 1 and all sites are on pace to surpass the target in Year 2. The range of electric savings in Year 1 was 0% to 17%. Year 2 results for three of the sites showed an increase is savings performance, with one of those three sites holding relatively steady at approximately 6%. The fact that three sites have a Year 2 increase in savings indicates that year-over-year savings is possible, but without a full year of data it is premature to draw that conclusion.

The average Year 1 savings for the sites was 9%; however, the variability in the savings data does not lend itself to using a fixed deemed savings value for an EIS installation. EIS systems can help identify performance issues at a facility, and the opportunities for improvement are based on a number of factors that can be very site specific. This could include the types of systems installed, the level of maintenance performed on the systems, and the operating characteristics of the facility. Therefore, the level of variability in this study is expected and applies to both electric and gas savings.

The EIS gas savings by site for Year 1 and Year 2 are shown in Figure 8.

Figure 8. EIS Gas Savings by Site



The EIS targeted gas savings for the pilot program was 5%. As shown in Figure 8, in Year 1, one site met the target, one site exceeded the target, and two sites did not meet the target. One site had an increase in gas consumption relative to the weather-normalized baseline. The range of gas savings in Year 1 was -10% to 34%. The average savings for the Year 1 sites was 8%; however, the variability in the savings data does not lend itself to using a fixed deemed savings value for EIS installations.

Year 2 data does not include the heating season for Sites 3 and 4. Year 2 partial year results did not show a consistent trend, with savings being -30% for Site 2 and 22% for Site 1. However, as noted, the performance period does not include heating season data. Without a full year of data, it is premature to draw a conclusion about annual savings.

Figure 9 and Figure 10 show Cadmus' results for the EMS systems at the building level.

Figure 9. EMS Electric Savings by Building

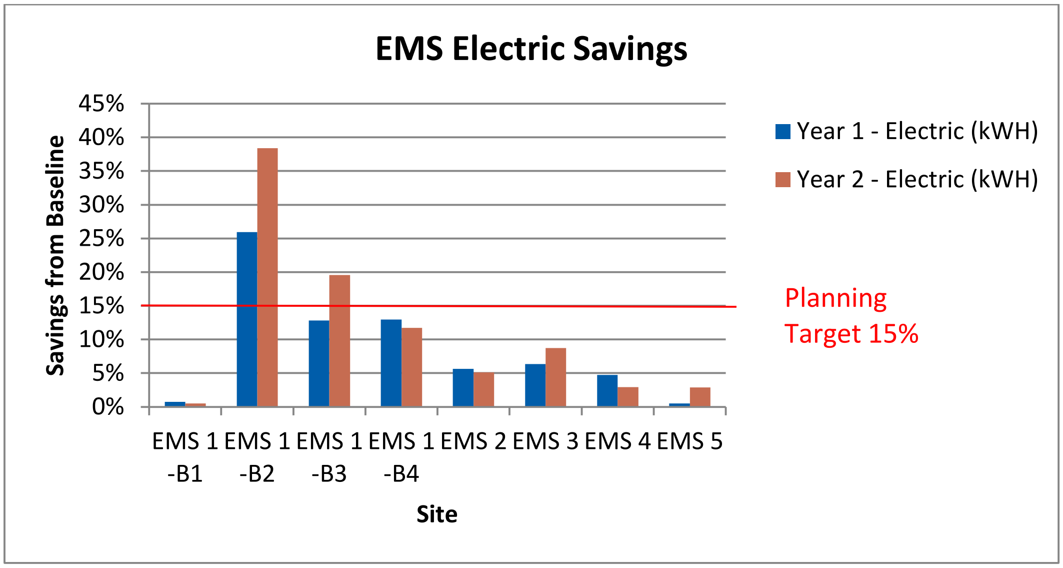
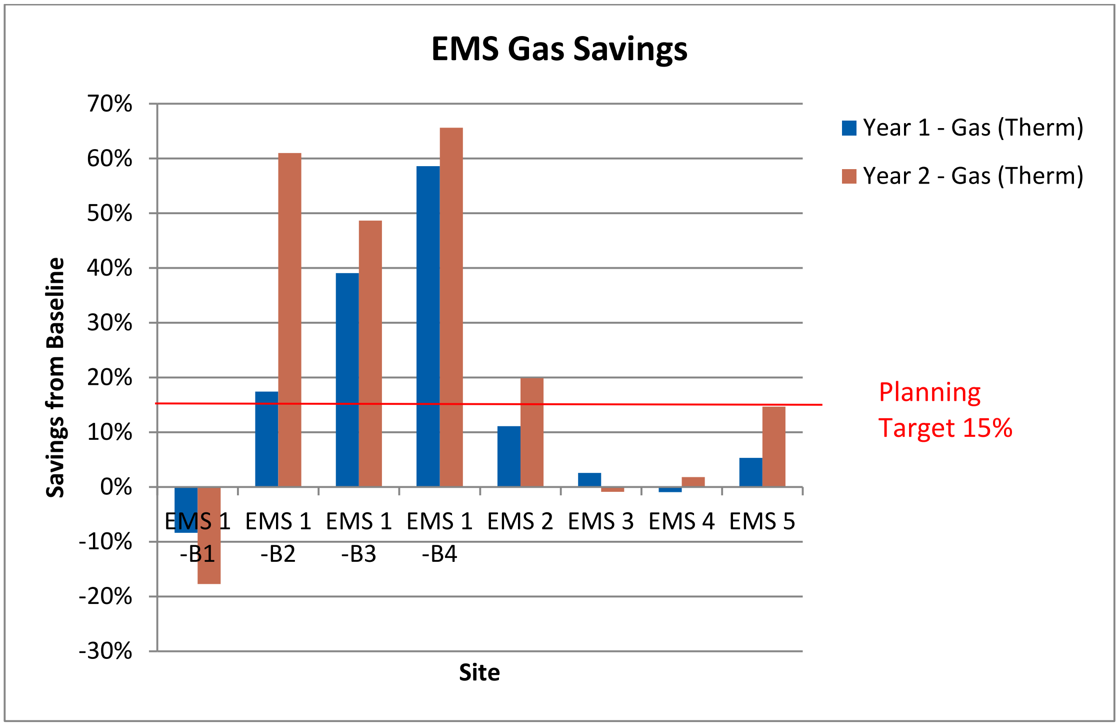


Figure 9 (above) and Figure 10 (below) are based on the number of buildings, because one site we analyzed included four different buildings. The EMS targeted savings for the pilot program was 15% for electricity. As shown in Figure 9, only one building exceeded the target in Year 1 and two sites are on pace to surpass the target in Year 2. The range of electric savings in Year 1 was 1% to 26%. Year 2 partial year results for 50% of the sites showed an increase in savings performance, but without a full year of data it is premature to draw performance impact conclusions.

The average savings for the Year 1 sites was 9%, but the variability in the savings data is high due to the small sample size and differences in the commercial building types. EMS systems can help improve performance at a facility; however, the opportunities for improvement are based on a number of factors that can be very site specific. This could include the types of systems installed, the level of maintenance performed on the systems, and the operating characteristics of the facility. Therefore, the level of variability in this study is expected and applies to both electric and gas savings.

Figure 10. EMS Gas Savings by Site



The EMS targeted gas savings for the pilot program was 15%. As shown in Figure 10, three buildings exceeded the target in Year 1 and five buildings are on pace to meet or surpass the target in Year 2. The range of gas savings in Year 1 was -8% to 59%. Year 2 partial year results for five of the buildings showed an increase in savings performance, but without a full year of data it is premature to draw performance impact conclusions on an annual basis. The average savings for the Year 1 sites was 16%, but the variance of these savings is quite high.

Comparison to Vendor Reported Savings

The EIS and EMS services included customized recommendations from vendors on ways to improve energy performance. The vendors provided an estimate of energy savings from implementing their recommendations. The vendors calculated the actual energy savings achieved based on the meter data collected by the system.

Energy Trust did not require BPTaC vendors to submit a standardized savings report. Vendors provided savings by site in several formats, including spreadsheets with monthly energy consumption and savings calculations, monthly summary reports, and data accessed through the online dashboards. The baseline for savings and the amount of monthly data that was available varied based on the style of the vendor savings report, so Cadmus varied our methods for comparing the utility billing analysis to vendor reported savings to match the savings report format provided.

Table 8 shows a summary of the vendor report formats the vendors used at each site.

Table 8. Summary of Vendor Report Formats by Site

Project Number	Type	Install Date	Savings Report Type
BE15297	EIS	12/1/2011	Monthly Monitoring Report
BE13943	EIS	1/24/2012	Monthly Monitoring Report
BE15137	EIS	5/1/2012	Monthly Monitoring Report
BE15135	EIS	5/1/2012	Monthly Monitoring Report
BE15429	EMS	5/1/2012	Annual Savings Spreadsheet
BE13901	EMS	10/1/2011	Annual Savings Spreadsheet
BE13965	EMS	11/1/2011	Portfolio Spreadsheet
BE13966	EMS	11/1/2011	Portfolio Spreadsheet
BE13967	EMS	11/1/2011	Portfolio Spreadsheet

EIS Sites

The EIS vendor provided a Monthly Monitoring Report that lists the baseline period, the electrical energy savings generated in the period covered by the report (which is typically the last 30 days), and the cumulative electrical energy savings from the end of the baseline period. The savings are weather-normalized. The vendor reports used in the analysis cover the months of October 2012 to September 2013, and the baseline period varies by installation date. The EIS vendor reports do not include gas savings. Table 9 summarizes the results for the three sites analyzed.[4]

[4] Site BE13943 savings did not appear to be valid, so Cadmus left that site out of our analysis. The monthly reports noted that a solar photovoltaic system was being installed at the site, but listed a constant savings number through most of the post-installation period.

Table 9. Annual Savings From Baseline Period, EIS Monthly Monitoring Report Sites

Site	Baseline Period	Utility Bill Analysis - Electric (kWh)	Vendor Analysis - Electric (kWh)
BE15297	April 2012 to July 2012	17%	16%
BE15137	June 2011 to May 2012	6%	3%
BE15135	June 2011 to May 2012	18%	9%

Cadmus determined a different amount of variability in electrical savings than was reflected in the EIS vendor reports. We had similar results at one site for both estimates, and had a 50% difference at the other two sites, yielding double the vendor's savings percentage with our utility billing analysis. Based on the utility billing analysis, the site savings met or surpassed the targeted savings of 5% initially set for the EIS systems in the BPTaC Pilot program. Cadmus also calculated gas savings which were not tracked or reported by the EIS vendor.

EMS Sites

For two of the five EMS sites, the vendor provided an Annual Savings report in Microsoft Excel® spreadsheet format. This report included the monthly energy usage for a particular period, the average temperatures per month, and the weather-normalized energy consumption. The vendor calculated savings by comparing data for a monthly period against the weather-normalized consumption from the baseline period. The vendor method for determining the electrical consumption was to:

1. Assume that a percentage of the electrical consumption was weather dependent, then
2. Adjust the baseline energy consumption by applying the change in average temperature in the billing period to the portion of weather-dependent energy consumption.

For the electrical energy, the Annual Savings Spreadsheets used an assumption of 30% for cooling in the months of May through September, and was therefore weather dependent. For the gas consumption, Annual Savings Spreadsheets assumed a non-weather-dependent amount of gas and the weather-normalization equation was applied to all remaining gas usage.

Two key variables impact this method of weather normalization: (1) the assumed percentage of energy that is weather dependent, and (2) the calculation used to adjust for a change in temperature. The calculation methodology in the Annual Savings Spreadsheets used a direct proportional relationship between energy consumption and outside air temperature for the weather-dependent portion of the building energy consumption. The normalized savings were reported as compared to a baseline period.

The Spreadsheets used utility billing data, so Cadmus performed a direct comparison of the vendors saving results to our results (Table 10).

Table 10. Annual Savings Spreadsheet Report Sites, Savings From Baseline Year

Site	Year 1 - Electric (kWh)		Year 2* - Electric (kWh)		Year 1 - Gas (Therm)		Year 2* - Gas (Therm)	
	Utility Billing Analysis	Vendor Report	Utility Billing Analysis	Vendor Report	Utility Billing Analysis	Vendor Report	Utility Billing Analysis	Vendor Report
BE15429**	13%	12%	15%	16%	28%	37%	35%	36%
BE13901***	6%	6%	5%	6%	11%	14%	20%	29%

* Year 2 is a partial year; there were five months of data for BE15429 that did not include the heating season, and there were 10 months of data for BE13901.

** The baseline year for BE15429 is April 2011 to March 2012.

*** The baseline year for BE13901 is October 2010 to September 2011.

The electrical savings from the vendor Annual Savings Spreadsheets and Cadmus' utility billing analysis were similar for each site. There was a larger difference in gas savings between the vendor spreadsheet and utility billing analysis. Gas savings tended to be a higher percentage of savings than electrical savings, and gas savings were mostly above the targeted savings of 15% initially set for the EMS systems in the BPTaC Pilot program.

The remaining three EMS sites in the pilot program were owned by one client, a restaurant chain. This client had additional sites using the EMS that were not included in the pilot program. The vendor did not provide site-specific savings reports, but sent an overall Portfolio Spreadsheet of the full client portfolio. The spreadsheet is interactive and allows for selecting reports of individual facilities.

Charts of weather-normalized savings are provided in the spreadsheet, but the method used for normalization was not transparent. The normalized savings were reported by comparing the current month to that month in the previous year, not a specific baseline period. These reports were also based on calendar months, not utility billing periods, so it was not possible for Cadmus to make a direct comparison.

Cadmus did compare the vendor Portfolio Spreadsheet reported savings to our utility billing analysis (Table 11).

Table 11. Portfolio Spreadsheet Report Sites, Savings From Previous Year*

Site	Utility Bill Analysis - Electric (kWh)	Vendor Report - Electric (kWh)	Utility Bill Analysis- Gas (Therm)	Vendor Report - Gas (Therm)
BE13965	4%	4%	2%	-5%
BE13966	-3%	-2%	3%	6%
BE13967	2%	3%	2%	8%

* The period of analysis was October 2012 to September 2013. Cadmus based our utility bill analysis on billing data time intervals, while vendor reports are based on calendar months. Vendor calculated savings based on the previous year, not on a pre-EMS installation baseline.

The electrical savings from the vendor Portfolio Spreadsheets and Cadmus' utility billing analysis were similar for each site. As shown in the table, BE13966 showed an increase in electrical energy consumption from year to year in both the vendor and Cadmus' analyses. There was a larger difference in gas savings between the vendor spreadsheet and utility billing analysis. The savings in both years were all well below the targeted savings of 15% initially set for the EMS systems in the BPTaC Pilot program.

Figure 11 shows a summary of all the electric savings data, with the vendor reported savings and utility billing analysis for each site. As noted previously, the Year 2 savings did not account for a full year of data.

Figure 11. Comparison of Electric Savings - Vendor Reported and Utility Billing Analysis (EIS and EMS)

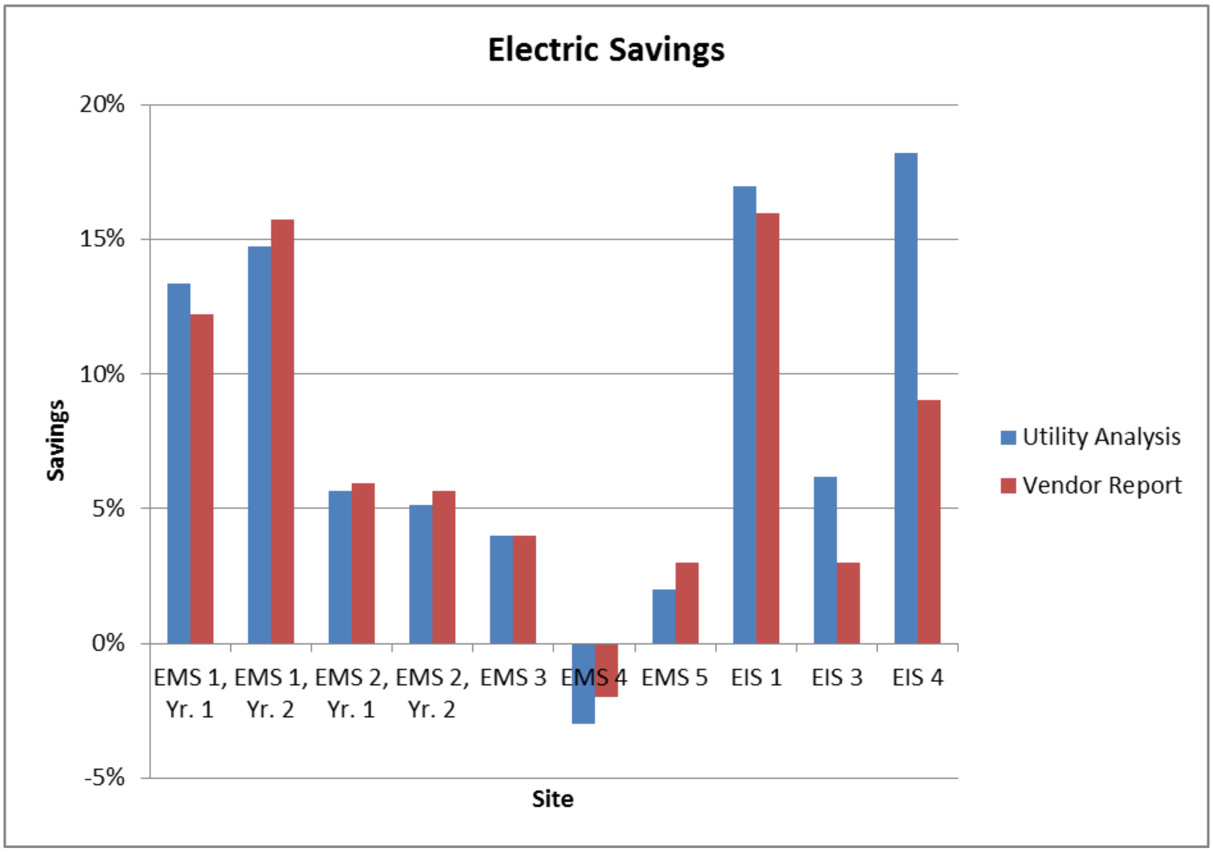
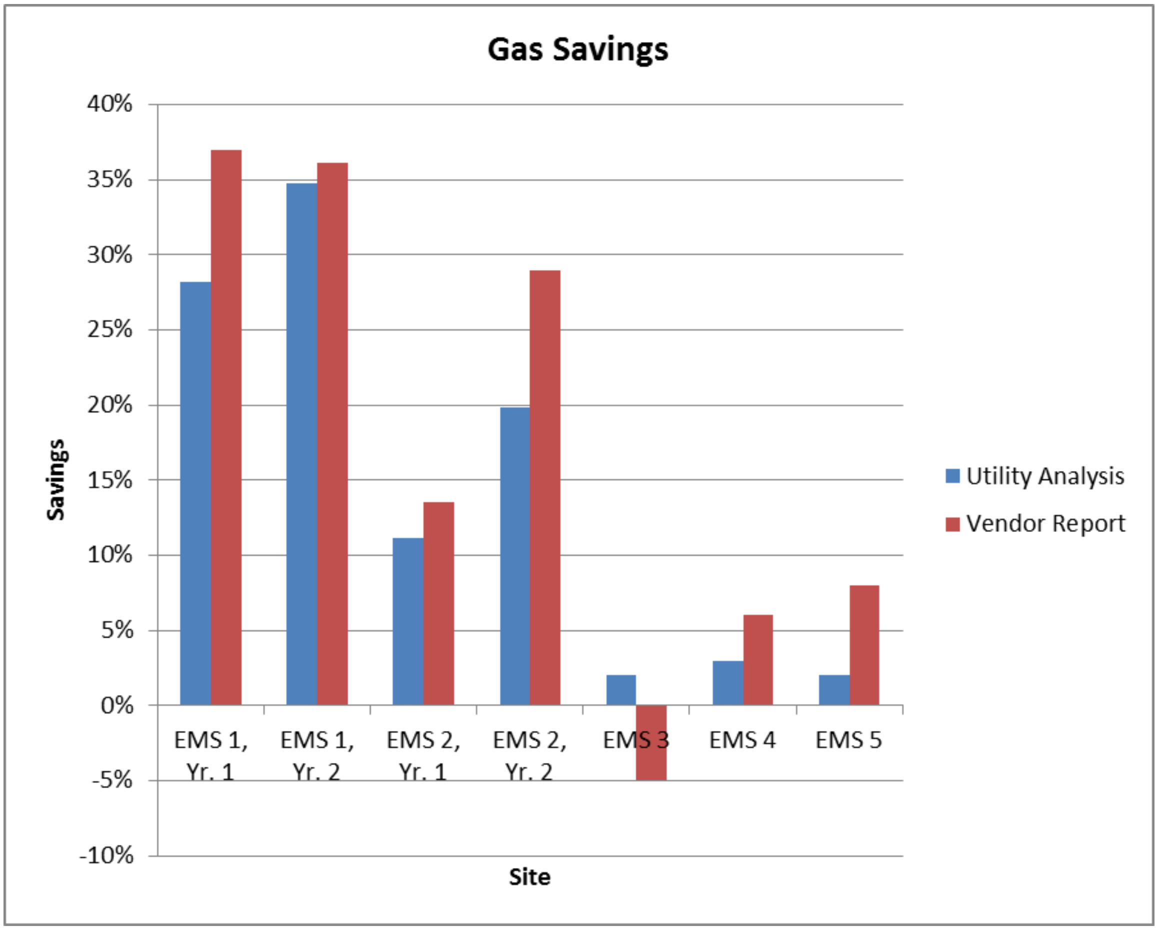


Figure 12 shows a summary of all the gas savings data, with the vendor reported savings and utility billing analysis for each site. All of the sites are EMS installations; the vendor reports for the EIS installations did not include gas savings. As noted previously, the Year 2 gas savings did not account for a full year of data.

Figure 12. Comparison of Gas Savings - Vendor Reported and Utility Billing Analysis (EMS only)



The EMS reports showed both direct monthly utility savings and weather normalized monthly savings. In general, there was alignment between the vendor and Cadmus savings calculations when making direct utility data comparisons, but there was a larger variation between vendor-reported weather-normalized savings and the method Cadmus used for the utility billing analysis. The EMS differences can be attributed to the vendor assumptions about the portion of weather-dependent energy use and about there being a direct proportional relationship between temperature change and energy consumption. For our weather-normalization, Cadmus used the pre-installation energy performance to determine a baseline performance equation, effectively customizing the relationship between energy consumption and outside air temperature for each building. This included both the portion of energy consumption that is weather dependent and the relationship between energy consumption and outside air temperature. Cadmus' method is more accurate than the EMS vendor method for normalizing weather data.

The EIS reports showed weather normalized monthly savings. The EIS system uses a bin-based normalization routine based on outdoor temperature bins that cover 10°F increments. The EIS reported savings were generally less than the savings determined by Cadmus.

Conclusions and Recommendations

Utility Billing Analysis Comparison to Vendor Reported Savings

Conclusion 1

The BPTaC Pilot program did not have a standard savings report format, so vendors provided savings reports in several formats including spreadsheets with monthly energy consumption and savings, savings summary reports, and data accessed through the online system. Baselines for savings and the amount of monthly data varied based on the style of the vendor savings report. The lack of a standardized savings report format interfered with better tracking of system performance and comparison of results across system types and facilities.

Recommendation 1

Energy Trust should develop a standard report format for all pilot programs that includes documentation for both electric and gas savings. The report should include: baseline period used for the energy-savings calculations, the amount of energy savings generated in the report period, the amount of savings that are being attributed to the system, and an indication of whether the reported savings were weather normalized. If the savings are weather normalized, savings compared to the baseline period for the same month should also be provided. Energy Trust could also stipulate the specific periods for the reports, possibly to coincide with the monthly billing periods.

Conclusion 2

The EMS vendor reported electric savings were close to the savings calculated by Cadmus using the utility bill analysis, but there was a larger difference between the two in the gas savings. This is attributed to the different methods of weather normalization used. Gas savings are more weather dependent than electric savings; therefore, Cadmus' gas results show a bigger difference from vendor reports than our electric results.

Recommendation 2

Energy Trust should require that vendors use an analysis method with weather normalization that is customized for each building, not one based on an assumed linear correlation between outside air temperature changes and weather dependent energy consumption and assumed weather dependent loads. These assumptions will not match the specific building performance characteristics of each building and will result in inaccurate weather normalized savings.

Conclusion 3

The electric savings reported by the EIS vendor did not match the savings documented through the utility billing analysis. The weather normalization routine used by the EIS vendor is included in the EIS software and is customized for each building. The method is described in the vendor documentation, but the monthly calculations are not transparent, preventing a direct comparison of the normalization methods to determine if the normalization method had an impact on difference in calculated savings.

The utility billing analysis showed that gas savings occurred at three of the EIS sites, but Cadmus could not compare gas savings because the EIS vendor did not report them.

Recommendation 3

Energy Trust should require that vendors document the methodology for weather normalization and report all savings from the installations.

Conclusion 4

For validating energy savings technologies that focus on whole building improvement, weather normalization and regression analysis can be improved with an increase in the available data points. Monthly billing data provides 12 data points from which to develop baseline load shapes. Where possible, using interval data from the utility meters and hourly weather data from a local weather station is recommended. These details may help improve the determination of weather-dependent characteristics and can also provide insight into time-of-day operating characteristics that are not observable from monthly data.

Recommendation 4

We recommend Energy Trust work with the local utilities to get interval data when available.

Savings Variability and Prediction of Performance

Conclusion 5

The level of variability in savings that Cadmus observed in the pilot study is to be expected and applies to both electric and gas savings. We expect savings to continue to vary due to site-specific factors in the future, making a deemed savings approach unreliable for these technologies.

Recommendation 5

Although the systems do not lend themselves to a deemed savings approach, expected savings targets are useful for setting participant expectations and for use in cost-effectiveness screening. Individual sites did have substantial variability in savings produced, but the average savings do provide revised levels of expectations from the original targets of 5% savings for EIS systems and 15% savings for EMS systems. We recommend that Energy Trust revise the target savings to those shown in Table 12.

Table 12. Recommended Revised Target Savings

Type	Target Electric Savings (kWh)	Target Gas Savings (therms)
EIS (5% original target)	9%	8%
EMS (15% original target)	9%	16%