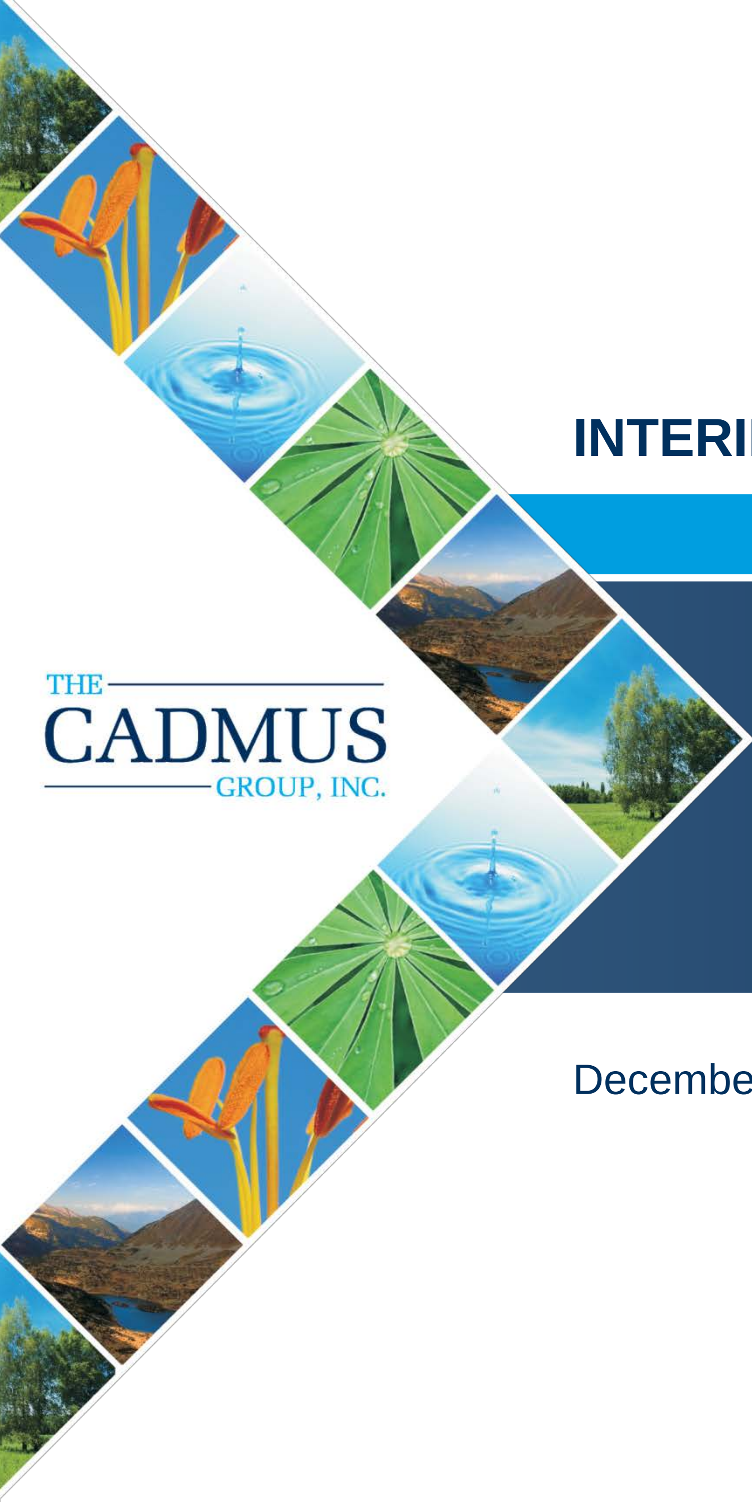

THE CADMUS GROUP, INC.

INTERIM REPORT

Process Evaluation of Building Performance Tracking and Control Systems Pilot

December 2012

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ACKNOWLEDGEMENTS

Cadmus would like to thank the staff of Energy Trust for their support over the last year during the BPTaC pilot evaluation. Phil Degens (the evaluation manager) and Spencer Moersfelder (the program manager) provided valuable insights about the pilot. Dustin Irwin (the pilot implementer) kept us informed of pilot progress and changes.

We also thank the BPTaC system vendors and participants for sharing their time and opinions.

EXECUTIVE SUMMARY

Energy Trust of Oregon's (Energy Trust) Building Performance Tracking and Control Systems (BPTaC) Pilot offers incentives for three building monitoring systems and a three-year subscription to their associated energy advice services:

1. Energy Management System (EMS)
2. Energy Information System (EIS)
3. Automated Optimization Software (AOS) for chiller systems

Lockheed Martin implements the pilot.[1] Working with system vendors, they began recruiting participants in June 2011. Over a year later, the pilot continues to recruit participants; Table 1 summarizes its progress toward participation goals through August 2012.

Table 1. Pilot Participation Goals and Progress as of August 2012

System	Goal	Systems Installed	Installation In Progress	Prospects
EMS	15	5	0	7
EIS	10	6	1	5
AOS	2	0	1	1

Overall, the BPTaC evaluation will provide Energy Trust with information on: monitoring system and service elements resulting in savings, the persistence of savings; and whether the systems track sufficient data for Energy Trust analysis and evaluation purposes. To achieve this goal, the evaluator: collected and reviewed pilot and project documentation, including reports generated by system vendors for customers; conducted interviews with program staff, vendors, and pilot participants; and reviewed information displayed through online project dashboards.

This preliminary report describes the evaluation progress, results, and insights from September 2011 to August 2012. A final report, planned for late fall 2013, will combine this report's findings with additional customer and vendor research.

Program Theory, Background, and Delivery

Program staff and considerable literature support the belief that substantial energy savings can be achieved through improved operation and maintenance in commercial buildings. The BPTaC pilot offers incentives to install monitoring systems to provide participants with "real-time" feedback and active consulting support about their buildings' energy use and performance. This combined approach intends to foster sustained changes in building operations that result in energy savings.

The systems allow building energy information to be accessed through a Web-based dashboard that displays energy use and trends as well as alerts that notify participants of manual overrides and mechanical failures so operators can make instant course-corrections. The consulting

[1] ICF will be the new implementer of the pilot, starting in 2013.

services provide continuous support and periodic reports that summarize various performance metrics and work performed at each building as well as recommendations for improving performance. The EMS and AOS systems also include built-in automated optimization capabilities that reduce the need for human interventions. The EIS is installed in buildings that already have control systems.

The three systems target different building types:

- EMS is offered to small buildings between 50,000 and 100,000 square feet.
- EIS is targeted to buildings over 100,000 square feet with direct digital controls.
- AOS serves chiller plants with a capacity greater than 600 tons.

Once the vendor identifies an interested participant, the participant submits an application to Energy Trust and the vendor develops a project scope. Lockheed Martin then verifies the customer's and project's eligibility, processes the application, and gives authorization to proceed with the project, provided it meets cost-effectiveness criteria. The participant engages the vendor to install the system, and the vendor conducts training with the participant at the end of the installation period, reviewing features and information displayed by the system.

Prior to paying the incentive, Lockheed Martin conducts a post-installation walk-through inspection of the system, and, for all pilot projects, asks the customer for feedback. After the incentive payment, Lockheed Martin and the vendors continue to monitor participants' energy-savings progress. Vendors also produce recommendations for energy-saving measures; after Energy Trust reviews the recommendations, vendors present them to participants. Vendors also provide regular, written reports to customers and are available to answer questions and provide support.

Summary of Findings

- The BPTaC pilot has required greater time to reach its participation goals than anticipated. Pilot staff and vendors attribute the slow uptake to: the economy; prospective participants' perception of the systems as risky and unproven; and prospective participants' unfamiliarity with the pilot vendors. Some project bids also had to be resubmitted due to Lockheed Martin needing to recalibrate the cost-effectiveness formula, adding time to the approval process. Only the EMS and EIS systems were operating at the time of this evaluation; one AOS system is being installed.
- The EMS and EIS dashboards have attributes in common but also differ in some important ways. They both provide information about energy usage and savings, compared to the baseline period. Both can be set up to alert customers if demand exceeds a certain threshold, prompting customers to investigate the cause. However, the EMS provides energy consumption in real time, while the EIS can take from one hour to a day to communicate updates. The EMS also provides information about different pieces of equipment monitored or controlled by the system while the EIS accepts information related to occupancy and settings, but does not actively monitor operating parameters.
- The EIS dashboard, unlike the EMS dashboard, includes a work order list that the vendor developed for customers to complete. These work orders have been designed to save

energy, and each order includes: an estimate of energy (electric and gas) and cost savings; documentation explaining the needed changes; and associated costs for completing the work. Customers can fill an order, and indicate when it was completed or if it remains in progress. Customers at five out of six buildings with EIS have implemented at least one recommended work order change.

- The vendors provided reports to the evaluator detailing recommended work performed at each customer facility and cumulative and monthly kWh savings; these reports do not include demand savings. The EMS vendor included gas savings in its reports; the EIS vendor did not provide gas savings in documents to the evaluator. These reports were not available at the time the evaluator interviewed the participants so the evaluator was unable to obtain participant feedback on the reports.
- The EIS and EMS vendors work closely with customers, helping them troubleshoot equipment issues, and providing regular feedback.
- Vendors believe the following key traits make some customers better candidates to benefit from their systems and services: responsibility for energy bills; willingness to address building maintenance issues; and ability to maintain vendor-advised set-points.
- Participants moving forward with BPTaC projects reported the pilot incentive influenced their decisions to participate. All were interested in the two to three year payback. Other reasons to participate included: the ability to schedule when equipment turned on (EMS); the willingness of vendors to develop new applications (EMS); and the ability to obtain data they could present to upper management to justify capital improvements (EIS).
- Participants found the application form confusing and a participation barrier. Participants found the process easier when vendors completed application forms.
- The program has not operated long enough to determine whether savings have accrued or if savings will persist. Participants were satisfied with vendor support and monitoring systems immediately after installation, although most said they could not tell if they had saved energy. Participants reported benefits in addition to energy savings; for example, one EIS participant used the system to determine how much additional rent to charge a tenant seeking longer hours of operation.
- Barriers to implementing vendor recommended operational changes included: tolerance of building occupants to changes in set-points; capital constraints; and lack of staff to implement changes.

Conclusions and Recommendations

The conclusions and recommendations listed below are condensed from a more in-depth set presented in the last chapter of this report.

1. **Conclusion**: Pilot uptake has been lower than anticipated due to a variety of reasons, some that are outside program control (the poor economy), and some that the pilot may be able to affect, such as reducing uncertainty about savings and making the application process easier.

   Recommendation: Energy Trust should consult with its new commercial implementer, ICF, to brainstorm ideas to increase uptake and to fill the remaining pilot slots. Energy

Trust should also consider developing collateral materials (including successful case studies) for vendors, once more savings information is available. These materials should focus on quelling worries about savings, but also highlight other system benefits. Vendors should assume they will complete application forms for customers.

2. **Conclusion**: Participants may face barriers to implementing recommended changes, including lack of time or capital. Our research to date suggests the vendors can take steps to help mitigate some of these barriers.

   Recommendation: Vendors should continue to regularly monitor customers, documenting and encouraging energy saving changes through a variety of channels. If possible, in-person meetings should be arranged with customers to help ensure important operational changes are completed. When recommending improvements, estimates from vendors should include expected costs the business will incur for not making the improvements.

3. **Conclusion**: The pilot has not operated long enough to determine savings amounts and whether these persist over time, but sponsors, vendors, and customers want high caliber savings reports. This means that additional information from the customers' electric utilities will be required to calculate savings. In addition, EMS and EIS vendor-generated written reports also can be improved. Finally, though the systems can generate demand savings, fewer concerns about demand charges in the Pacific Northwest have resulted in these charges not being reported; demand savings will be important elsewhere.

   Recommendation: While waiting for the systems to influence changes to save energy, arrangements should be made with electric utilities for any needed additional information to reliably calculate savings. Based upon our review, the EMS report should organize utility information in chronological order and in a comprehensive table rather than separate boxes for each month and fuel type. The EIS report should include gas savings and note which recommendations were implemented. Vendors should also begin to plan and develop the design of demand savings reports in anticipate of a wider audience for their systems.

EnergyTrust of Oregon

MEMO

Date: January 30, 2013
To: Board of Directors
From: Philipp Degens, Evaluation Manager
Spencer Moersfelder , Existing Buildings Project Manager
Subject: Staff Response to the Process Evaluation of Building Performance Tracking and Control Systems Pilot report

The Pilot is providing great insights into the market for energy management systems that are bundled with O&M expert systems. The Pilot is providing Energy Trust with a baseline on costs of these systems and services as well as the source and a preliminary understanding of energy savings that result from their implementation. Longer monitoring periods on more systems are required before reliable cost-benefit analysis based on verifiable energy savings can be performed.

The report indicates that the Pilot's satisfied customers are taking actions that result in energy savings. It also indicates that the vendors are active in marketing, selling and improving their services as well as working with the customer to achieve savings. A future report will continue to inform Energy Trust about the progress of this Pilot.

1. INTRODUCTION AND EVALUATION APPROACH

Energy Trust of Oregon (Energy Trust) 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 several new technologies. It 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).
- The Automated Optimization Software (AOS), applicable to buildings with chillers

This interim process evaluation report describes BPTaC's progress, and insights developed through interviews with pilot stakeholders through August 2012. The BPTaC process evaluation sought to provide information to help Energy Trust determine: how the pilot can be improved; and if offerings should be incorporated into the overall program. Specific process evaluation research questions included:

1. What motivated participation in the pilot?
2. What features proved critical to participants using the systems?
3. Do the systems lead to additional investments/actions towards energy efficiency? What types of improvements do participants pursue?
4. What benefits do the systems provide?
5. What participant characteristics influence savings and persistence of savings?
6. How do the systems track and maintain savings? Are these tracking procedures sufficient for Energy Trust analysis and evaluation purposes?

Summary of Evaluation Approach and Efforts to Date

To answer the researchable issues described above, the evaluation plan called for the Cadmus evaluation team (evaluation team) to:

- Review monitoring system tracking reports; and
- Conduct interviews with pilot stakeholders and participants at two targeted times: a month after installation of a monitoring system; and a follow-up interview approximately one year later.

Pilot stakeholders include: three monitoring system vendors,[2] and staff from Energy Trust and Lockheed Martin, the pilot's implementer.[3] In addition, partly because the program's uptake

[2] During this report's development, the program added a fourth vendor, with an EIS type system. The following report will include information gained from interviews with this vendor.

[3] ICF will take over as the implementer in 2013.

stretched over a number of months, the evaluation team maintained regular communications with Energy Trust and Lockheed Martin to remain aware of pilot developments. Lockheed Martin provided a monthly pilot participation update report to the evaluation team, allowing the team to schedule participant and vendor interviews upon projects' completion.

To date, the evaluation team completed the following activities:

- Attended a kick-off meeting with Energy Trust and Lockheed Martin staff.
- Attended a product overview meeting with three vendors.
- Collected and reviewed program documentation, including pilot design documents and monthly project tracking updates.
- Reviewed online project dashboards of projects completed to date, seeking to understand data tracked.
- Developed interview guides, and conducted first-round interviews (in-person and by telephone) with vendors, participants, Lockheed Martin, and Energy Trust, as summarized in Table 2.

Participant interviews addressed: how they became aware of the pilot; why they participated; satisfaction with the vendor and product; changes in building operations; benefits attained; and recommendations for improvements.

Interviews with Lockheed Martin and Energy Trust focused on the pilot's development and progress, and on lessons learned.

Vendor interview topics addressed: motivations for participation; explanations of how their products would lead to customer savings; challenges; and lessons learned.[4]

Table 2. Interviews Conducted Through August 2012

Organization	Type	System	Interview 1 Date
Energy Trust of Oregon	Administrator	All	7/25/2012
Lockheed Martin	Implementer	All	12/15/2011
EMS Vendor	Vendor	EMS	12/14/2011
EIS Vendor	Vendor	EIS	8/8/2012
Family Fun Center	Participant	EMS	11/21/2011
Chain Restaurant (3 installations)	Participant	EMS	3/15/2012
Municipality (2 installations)	Participant	EIS	7/19/2012
Property Development Group	Participant	EIS	7/19/2012
Office Park	Participant	EMS	7/20/2012
Municipality (2 installations)	Participant	EIS	8/1/2012
Municipality	Participant	EIS	8/1/2012

4 This report could not include an interview with the AOS vendor as no AOS systems had been installed in any facilities as of August 2012.

This report synthesizes findings from all these activities. The final report will contain additional findings, combined with the results from this interim report.

Evaluation Next Steps

The final report is planned for delivery in the late fall of 2013. The evaluation team anticipates producing an interim findings memo in March 2013, addressing information from the following research:

- An interview with the AOS vendor whether an AOS project has been completely installed
- An interview with the newly added EIS vendor; and
- One-year follow-up interviews with applicable participants.

2. BPTAC PILOT BACKGROUND AND DELIVERY

Pilot Program Logic

Energy Trust and Lockheed Martin staff, along with the results of many studies, support the belief that many commercial buildings are not operated optimally, and offer significant opportunities to obtain energy savings through improved building operations. Energy Trust is piloting two approaches to operations-based savings: the BPTaC pilot, a technology enabled approach; and the strategic energy management pilot, which targets building operators at large real estate management firms.

The BPTaC pilot offers incentives to commercial customers to install monitoring systems that provide "real-time" feedback about their buildings' energy use and system performance and to receive active consulting support from system vendors. This combined approach intends to supply participants with the information, guidance, and support they need to make and sustain changes in building operations that lead to energy savings.

The monitoring systems allow building energy information to be accessed through a Web-based dashboard, which displays energy use and trends as well as alerts notifying participants of manual overrides and mechanical failures; so operators can make instant course-corrections. The consulting services provide continuous support and periodic reports summarizing various performance metrics and work performed at each building as well as recommendations for improving performance. Some systems include built-in automated optimization capabilities to reduce the need for behavioral interventions.

Pilot Offerings

Engineers at Lockheed Martin designed the pilot program to:

- Verify savings each system achieves;
- Verify savings' persistence over the pilot's course; and
- Identify product specifications necessary to maintain a cost-effective program, should Energy Trust determine the pilot should be integrated into the existing buildings portfolio.

Energy Trust screened each system for cost-effectiveness using: vendor savings claims; past case studies: and data from Energy Trust's Existing Buildings program. After the measures could be determined cost-effective for pilot's purposes in June 2011, Lockheed Martin began to work with Energy Trust and the vendors to recruit and qualify participants. Generally, the pilot seeks participants with a dedicated end-user willing to:

- Complete training to use the system;
- Implement any additional equipment installations, operations and maintenance actions, or behavioral changes recommended by the vendor's consultancy; and
- Cooperate with evaluation, measurement, and verification activities.

The EMS also requires buildings have: an adequate shell (not porous); adequate ductwork; and reasonably up-to-date and properly sized HVAC equipment.

Table 3 shows the three different types of building monitoring systems offered through BPTaC. The pilot incentive covers 50% of the BPTaC system's purchase and installation costs, and up to 50% of the three-year subscription fee.[5]

Table 3 also contains detailed information about each of the systems, including: the targeted building type, features, estimated savings, and costs. The EMS and AOS include automated controls optimization, while EIS is installed in buildings that already have automated controls. The EIS does not alter existing DDC. To minimize variability in the technologies offered and in vendor management, the pilot only supports systems offered by a limited number of vendors.

Table 3. BPTaC Pilot Offerings

Technology Approach	EMS	EIS	AOS
Product Name	Unity	Energy Expert	OptimumLOOP
Building Type	Between 50,000 and 100,000 sq. ft. (e.g. Small Office, Retail)	Greater than 100,000 sq. ft. with DDC Controls (e.g. Hotels)	Variable air volume systems and chiller plants 600 tons+ (e.g. Hospital)
Real Time Energy and Performance Monitoring	X	X	X
Automated Control Optimization	X	No**	X
Estimated Energy Savings	15% of total baseline	5% of total baseline	22% of HVAC baseline
Original Estimated Cost	$14,537	$27,687	$200,000
kWh Levelized Cost	$0.05	$0.04	$0.03
Measure Life*	3	3	3

*The measure life reflects the pilot's requirements that participants subscribe to vendors' consultancy services for three years. The systems have a much longer expected lifetime. Energy Trust will allow up to 5 years to enable more projects to pass the pilot's cost-effectiveness screen.

**Controls are part of another system in the building.

The EIS and AOS systems primarily offer software and/or Web-based solutions. EMS includes a site controller (Figure 1), sensors, and wireless controls. Section 3 of this report presents: screenshots from each system's online portal; and a description of each system's tracking and reporting capabilities.

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

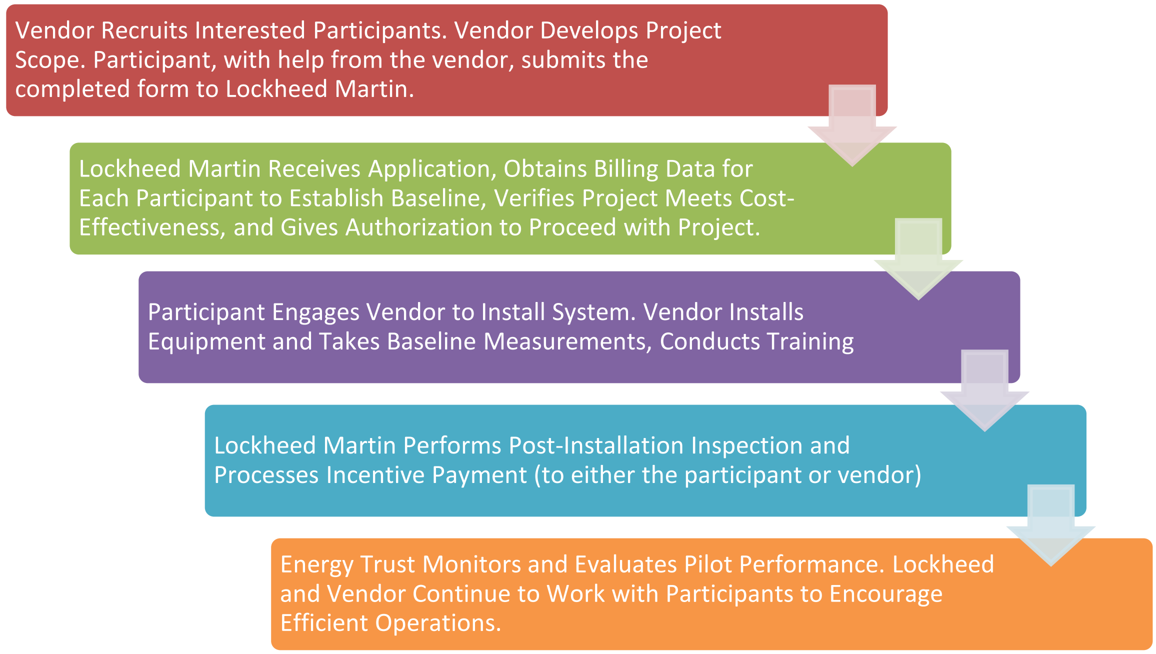
Figure 1. Unity Site Controller

Pilot Participation Process

Figure 2 summarizes the participation process. After an interested participant has been identified, the vendor pre-screens each site, and develops a project scope and bid. The vendor also provides the application form to the participant. Once Lockheed Martin receives the application and bid, it obtains three years of billing data to establish the participant's baseline energy usage, and checks if the project passes the Combined Societal cost-effectiveness test, with a benefit-cost ratio of 0.08 or higher. If it does not pass, Lockheed Martin asks the vendor to submit a lower bid. If the second bid also fails to pass the cost-effectiveness screen, the project is abandoned. If it passes, Lockheed Martin approves the project's installation. The participant then engages the vendor to install the system and conduct training.

After Lockheed Martin receives an invoice from the vendor, and, before paying the incentive, conducts a post-install, walk-through inspection and asks for feedback on the systems. Upon installation completion, Lockheed and the vendor continue their coordination to encourage each participant to maintain and achieve operational savings. Vendors submit recommended energy-saving measures (ESMs) to Energy Trust for approval prior to presenting them to participants. The vendor also provides Lockheed Martin with a dashboard login for each pilot project.

Figure 2. BPTaC Pilot Participation Process



Pilot Goals and Progress

Originally, the pilot's sought to recruit: 20 organizations to install the EMS; 10 organizations to install the EIS; and five organizations to install the AOS by the winter of 2011. In addition, as BPTaC systems currently are custom measures, Lockheed Martin sought to use the pilot to develop a deemed savings value for these systems so measure savings could be standardized.

In its July 24, 2012 interim report, Lockheed Martin staff revised EMS target down to reflect lower uptake expectations. It also revised down the number of AOS installations to two, as project costs generally ran twice as high per system as originally thought (as shown in Table 4), and concerns emerged that the pilot budget would not cover more than two AOS incentives.

Table 4. Average Completed Project Costs through August 2012

	Unity (EMS)	Energy Expert (EIS)	OptimumLOOP (AOS)
Original Estimated Cost	$14,537	$27,687	$200,000
Average Cost of Projects Installed or Completed through 8/2012	$29,167	$23,901	$423,182*

*One project in progress.

Table 5 shows: updated pilot goals; and progress as of August 2012.

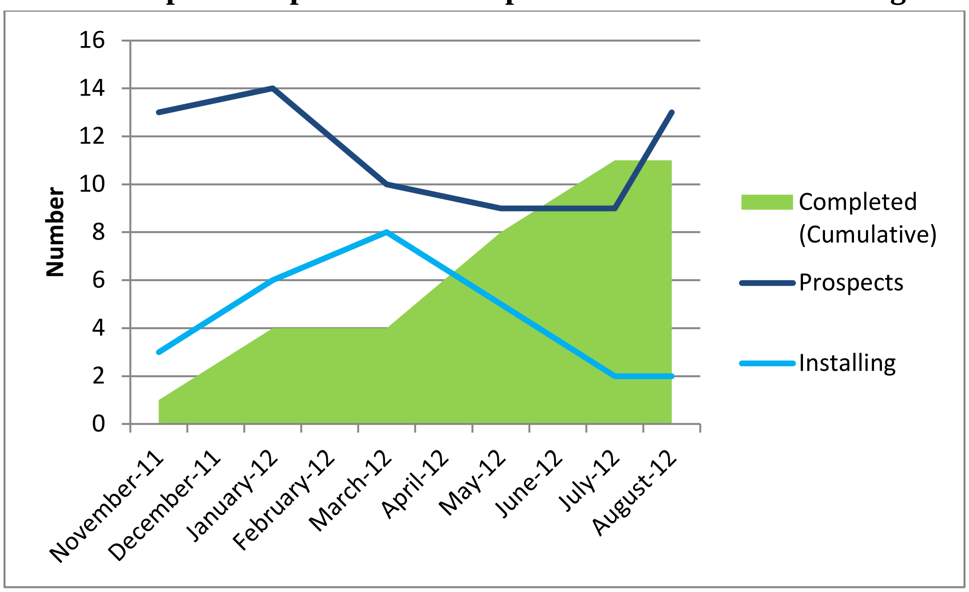
Table 5. Updated Pilot Goals and Current Progress in August 2012

System	Goal	Systems Installed	Installation In Progress	Prospects		Post-Installation Interviews*	One Year Interviews**
EMS	15	5	0	7		3	0
EIS	10	6	1	5		4	0
AOS	2	0	0	2***		0	0

*Some participants interviewed had installed more than one system.
**No participants achieved the one-year mark.
*** Two AOS projects are past the study phase and awaiting customer commitment. These projects are not expected to move forward until late 2013 or early 2014.

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, the program had not achieved full subscription, and no AOS systems had been installed. Figure 7 shows: the number of completed projects; pilot prospects; and projects installed each month, through August 2012. Pilot prospects include projects in the preliminary evaluation stage or awaiting a bid from the vendor; over time, projects abandoned or moved to another participation process phase were removed from the prospect category.

Figure 3. Pilot Participation Pipeline and Completes November 2011 through August 2012



Only seven unique participants completed installing their systems, and a few participants installed more than one system through the pilot. The evaluation team interviewed all seven participants shortly after Lockheed Martin conducted its post-installation inspection.

Pilot staff believed the slow uptake resulted from the difficult economy and from participants asked to take a chance on systems not yet proven. They also reported vendors not well known to the organizations, presenting recruitment challenges. In addition, prospects may have been concerned about installing a system and locking into a subscription service. Finally, the EIS bids often did not meet cost-effectiveness criteria, and had to be resubmitted, adding more time to the process. Lockheed Martin and Energy Trust pilot staff cited the main lesson learned as: pilot programs can take more time than expected to recruit participants, and the main goal remains to learn from the experience. The EMS vendor noted one customer took a year to proceed with an installation outside of Energy Trust's territory.

Participants also reported having to procure management buy-in, which takes time. One reported the application process was drawn out due to insufficient time to process all paperwork and the application only got completed when the vendor stepped forward to help them.

The pilot experienced a minor setback during its beginning due to an error in the cost-effectiveness calculation, with the calculation used for the initial pilot proposal based on 42 months of estimated savings, not 36 (three years) as intended. For many projects considered at the time, the change meant they would not meet the cost-effectiveness criteria, and would not qualify. Energy Trust allowed an extension of the measure life to five years as physical limitations did not require three years.

3. SYSTEM TRACKING AND REPORTING CAPABILITIES

Lockheed Martin provided the evaluation team with dashboard logins for projects completed through August 2012. Figure 4 shows screenshots from a sample EMS project, and Figure 5 shows screenshots for an EIS project. AOS information will be added to the final report.

EMS Overview

The Unity (EMS) dashboard contains a meter in the upper right corner of the screen, showing instantaneous kW demand. It also shows kWh used throughout the day, and current and historical usage.

The main part of the screen shows a map of the building's equipment as it relates to the actual building layout. Unity uses open-source software, and communicates wirelessly to a variety of sensors and controllers installed at the facilities. A shadow meter, placed on the mains with a current transducer around the wires, detects the current draw. The system logs the peak and tracks usage. Data are later reconciled with the customer's utility bill.

The system does not measure therms directly, nor logs behavior changes or measure installations. The vendor logs known system changes in its reports, and attempts to isolate savings from the EMS and installed measures.

The dashboard relays parameters for: temperature; lighting levels; and status for various pieces of equipment. Separate screens allow scheduling, adjusting set-points, and parameter values over the past 24 hours. A reporting screen provides average parameters for all control points over a user-specified time period. Alerts notify users of maintenance issues. The system can also track savings, as summarized in semiannual reports. Other system features include automatic peak demand control and equipment demand response.

Figure 4. Unity Overview Screen

EMS Reports

The evaluation team reviewed three types of reports provided to participants as part of the EMS service. The first, an example of an initial HVAC/Field Diagnostic report, was meant as a startup guide to help the building operator identify fixes to improve operations. Separate from the online portal, it summarizes: 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 a list of maintenance recommendations (as shown in Figure 5).

Figure 5. 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
A/C 3 K1	6/29/12	ALERT: Recover charge.	1	82	89	$370

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

The recommendations include a calculation (shown in Figure 6) of free cooling cost savings, which could be translated into kWh or therm savings using the provided information.

Figure 6. 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
D2-F					3.2	224	4.6	0.9568	$0.08	$17.15		
D2-1	0%	35.9	57.3	72	1.6	111.9	11	2.288	$0.18	$20.48	22.10	$4.05
D2-2	0%	35.9	57.3	72	1.3	91	11	2.288	$0.18	$16.66		
									$0.44	$54.28		$4.05

The evaluation team also reviewed a semiannual report for an example project completed prior to the pilot's start. This report contains a six-month utility summary of:

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

The semiannual report's utility summary divides into sections for electricity and gas, with each month summarized in a box, as shown in Figure 7. The report displays kWh and dollar savings for individual months and for the entire six-month period. Though it does not include peak kW savings, these could be included if the building's electric utility provides additional information. Savings have been normalized, based on the number of days in the billing period and relative to historical energy usage. The report does not indicate if weather effects have been factored into savings estimates, although other sources suggest it includes these. It does not always order boxes chronologically, which can make understanding the report challenging. Alternatively, gas and electric information could be presented in a table, with a column for each month.

Figure 7. Excerpt from Semi-Annual Report (EMS)

Period		
From 3-Mar-11	Through 1-Apr-11	
Number of days this period	29	
Same period last year	29	
kWh consumptin this year	100963	
Same period last year	100866	
Average kWh per day this year	3481.48	
Same period last year	3478.13	
Percentage savings per day	-0.10%	
Average kWh cost this period	$232.91	Per day
Total Amount billing	$7,255.62	
Estimated daily savings	-$0.22	
Estimated Monthly Savings	-$6.73	
Estimated 6 mo Savings	-$80.76	

Period		
From 30-Nov-10	Through 3-Jan-11	
Number of days this period	34	
Same period last year	34	
kWh consumptin this year	116300	
Same period last year	124600	
Average kWh per day this year	3420.58	
Same period last year	3664.7	
Percentage savings per day	6.66%	
Average kWh cost this period	$229.14	Per day
Total Amount billing	$7,306.15	
Estimated daily savings	$15.26	
Estimated Monthly Savings	$457.92	
Estimated 6 mo Savings	$5,495.01	

Six month total	$43,672.72
Six months electrical savings	$2,504.58
	5.73%

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

The evaluation team also reviewed an energy-savings report presented as an Excel spreadsheet. Customers typically receive these as a PDF; the spreadsheet version is provided to Lockheed Martin and the evaluator. This report aggregates monthly billing data for all electric and gas meters on the premises, including costs and usage for the current and previous year. It then analyzes aggregated monthly utility consumption information to produce the kWh and therm savings as well as total cost savings. Figure 8 shows savings reported, as presented on a summary sheet.

Figure 8. Energy Savings Report

Energy Savings Summary							
Electricity							
Usage Period	**Jan-12**	**Feb-12**	**Mar-12**	**Apr-12**	**May-12**	**Jun-12**	**Average**
Avg kWh/Day Change	-24.1	-133.0	-198.5	-168.6	-257.3	-292.2	
Total kWh Change	-723	-3,991	-6,154	-5,057	-7,718	-9,351	
Pecentage Change	-1.3%	-7.2%	-10.4%	-9.0%	-12.9%	-13.8%	-9.1%
Gross Cost per kWh	$0.1032	$0.1036	$0.1029	$0.1029	$0.1023	$0.0998	
Impact of kWh Change	-$75	-$414	-$633	-$521	-$790	-$933	-$561
Natural Gas							
Usage Period	**Jan-12**	**Feb-12**	**Mar-12**	**Apr-12**	**May-12**	**Jun-12**	
Avg Therms/Day Change	-10.8	-23.0	-13.8	-10.5	-4.6	-4.1	
Total Therms Change	-315	-668	-443	-304	-142	-131	
Pecentage Change	-27.1%	-48.5%	-42.4%	-53.4%	-51.3%	-67.4%	
Weather-adjusted Therms Change	-340	-573	-484	-243	-132	-131	
Weather-adjusted % Change	-29.3%	-41.6%	-46.3%	-42.6%	-47.5%	-67.4%	-45.8%
Gross Cost per Therm	$1.0745	$0.9858	$0.8947	$1.1885	$1.0400	$1.0400	
Impact of Therms Change	-$338	-$659	-$396	-$362	-$148	-$136	
Weather-adjusted Impact of Change	-$366	-$565	-$433	-$288	-$137	-$136	-$321
Total Energy Cost Impact	**-$440**	**-$978**	**-$1,066**	**-$809**	**-$927**	**-$1,069**	**-$882**
Avg. Daily Temp % Change	-2.4%	7.3%	-4.3%	12.5%	5.5%	0.0%	

A note in the spreadsheet indicated impacts do not account for tenant occupancy changes. Weather adjustments rely on www.wunderground.com readings.

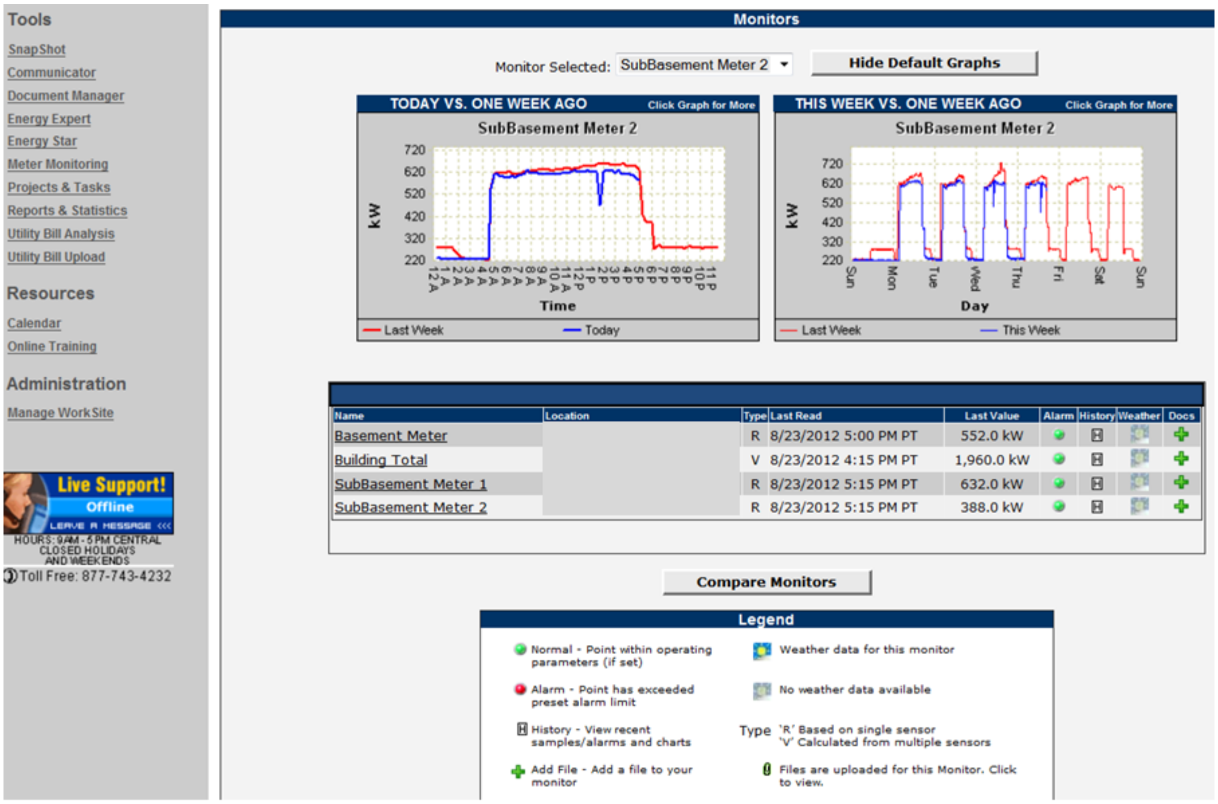
EIS Overview

Energy Expert (EIS) dashboard shown in Figure 9 contains multiple screens, displaying different types of information. The meter monitoring screen shows the current and past week's consumption patterns, allowing the user to detect irregularities. If consumption falls outside the bounds of preset limits, an alarm notifies the user. A monthly view of each day's consumption over time can also be produced, and weather data, occupancy, and operational parameters can be incorporated into the system.

During installation, the EIS vendor's support team takes a two-week sample of building operation parameters using CO_2/Temperature/Light sensor packages placed in the building. For facilities served by Portland General Electric (PGE), the building's usage is uploaded to the system once a day at midnight. For Pacific Power customers, the system uses a cellular data logging device, which uploads the data every one-half hour.[6] Both approaches provide data in 15-minute intervals.

6 Data uploaded more frequently would increase the vendor's cellular fees.

Figure 9. Energy Expert Meter Monitoring Screen*

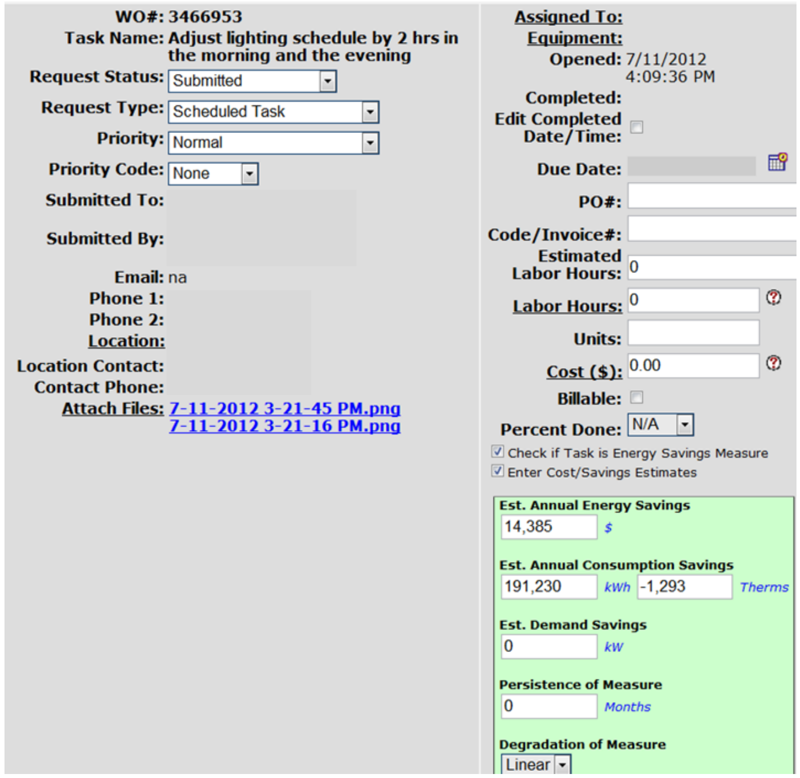


* This building uses the cellular data logging service.

To promote a continuous improvement process at each facility, EIS consulting staff members regularly submit tasks to users through the EIS online portal, as shown in Figure 10. These tasks offer low or no cost changes to improve energy efficiency, such as adjusting lighting or HVAC schedules. The EIS records the task status (e.g., submitted, in process, completed), and contains fields with detailed information about each task, including the estimated cost, labor hours, units, and estimated energy savings (usually in dollars, kWh, and therms). The EIS building modeling algorithm calculates energy savings, including interactive effects.

The task screen includes slots 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. Upon task completion, actual savings can be quantified with the system. The EIS records cumulative energy savings over time. The system can also adjust the baseline to ensure savings from other energy-savings measures do not count as operational savings, and can adjust the baseline based on occupancy or weather effects.

Figure 10. EIS Online Portal Detailed Task Screen



EIS Progress Reports

The evaluation team reviewed several October progress reports from NorthWrite. Figure 11 shows information from the report's beginning, including: a photo of the building where the system has been installed (located in the upper right corner of the page): site contact information; and customer status for each stage of the process. It also summarizes ESM progress, including the number of no-cost, low-cost, and capital improvement ESMs identified as well as a count of ESMs implemented. The report does not summarize ESMs implemented or completion dates, nor does it clearly define the criteria for each status. Note that Figure 11 shows the implementation of ESMs is "looking good," however the table below it shows the number of ESMs implemented is zero.

Figure 11. NorthWrite Monthly Progress Report—Top of Page

NorthWrite

MBCx Monthly Progress Report

Site Information:

Site	Contact	Site Contact	Project Manager	Lead Analyst

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:

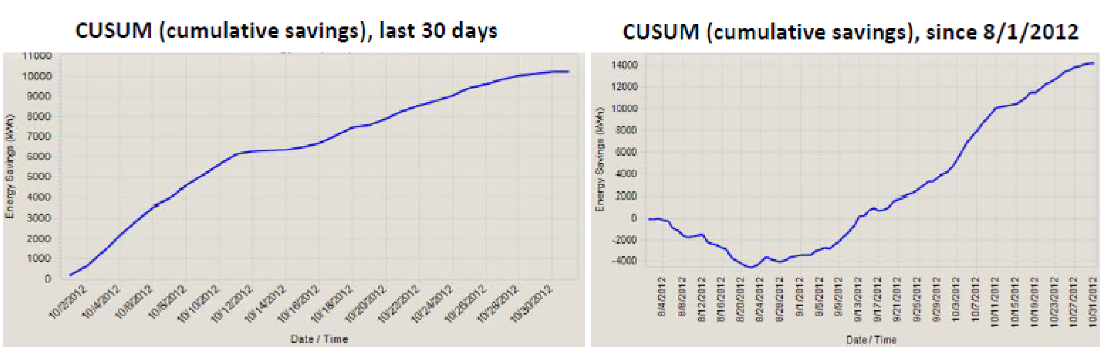
No-Cost ESMs Identified	Low-Cost ESMs Identified	Capital ESMs Identified	Number of ESM's Implemented
8	0	0	0

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	34,715	2,112	0.2%	$169	9,635	$800

Some reports also contain a graph showing the cumulative savings, as shown in Figure 12. The end of the report includes a space for comments from the implementation team.

Figure 12. NorthWrite Monthly Progress Report—Savings Plots



Implementation Team Comments:

One out of four of the library-specific Energy Savings Measures (ESMs) has been completed . Two measures, the posting of energy savings tips and a blast email may have supported the library as well as City Hall. The completed measure, Reduce Lighting Hours, 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

Table 6 summarizes ESMs and annualized savings across all pilot buildings, as indicated in the October progress reports. Most participants implemented at least one ESM, though the building without ESMs implemented had the highest number of ESMs identified and an estimated 9,635 kWh in annual savings. One building had negative energy savings, indicating the building used using more energy than during the baseline period. The implementation team noted only one ESM had been implemented at this site. Annualized kWh savings varied widely, and no gas savings were reported.

Table 6. Summary of Monthly Reports

Building	No Cost ESMs	Low Cost ESMs	Capital ESMs	Number ESMs Implemented	Annualized kWh Savings
A	8	0	0	0	9,635
B	6	0	0	2	29,042
C	5	0	0	1	126,751
D	4	0	0	1	-24,760*
E	7	0	0	2	6,437
F	6	0	0	3	2,0379

*The report indicates this site used more electricity than in the baseline period, and only recently began showing energy savings.

Evaluator's Observations for Each System

Table 7 assesses various EMS and EIS system aspects, based on evaluator observations and input from participant interviews, in terms of capabilities and reporting. Though similar in many ways, the systems vary in terms of: timing of data delivery; frequency and type of report; presentation of recommendations; and (perhaps) in visual appeal and intuitiveness to customers. Shaded rows indicate key difference in the attributes.

Table 7. Summary of BPTaC System Properties

	Unity (EMS)	Energy Expert (EIS)	OptimumLOOP (AOS)
Aesthetics	Visually appealing "Cool looking"*	Basic	System not assessed
Intuitiveness of Dashboard	High**	Medium***	System not assessed
Data Timing	Real Time	½ hour (PacifiCorp) or 1 day (PGE) delay	System not assessed
Alerts when Parameters Exceed Preset Limits	Yes	Yes	System not assessed
Benchmarking	Yes	Yes	System not assessed
Communication of Recommendations for Operational Changes	Via semiannual reports	Via online portal (Vendor checks monthly to see if actions are needed)	System not assessed
Recommended Changes Include Estimated Energy Savings	Yes, in dollars	Yes in both dollars and kWh/therms	System not assessed
Recommended Changes Include Estimated Energy Savings	No	No	System not assessed
Tracks Work Performed	Semiannual Report	Online Portal	System not assessed

	Unity (EMS)	Energy Expert (EIS)	OptimumLOOP (AOS)
Reports Energy Savings Attained	Yes	Yes	System not assessed
Weather Adjusted?	Yes	Yes	System not assessed
Interactive Effects	Unknown	Yes	System not assessed
Reports Demand Savings	No, but appears possible given more information	No, but appears possible given more information	System not assessed
Carbon/Emissions	Yes	Yes	System not assessed

* Participant quote.

** A participant liked the dashboard's use of color to show heating and cooling, and found was easy to tell when a fan was on because the icon spins.

***Based on participant feedback and evaluator opinion. One participant said it seemed user friendly, while another said it was not intuitive.

4. BPTAC PILOT EVALUATION FINDINGS

This section contains insights and feedback drawn from participants, EIS and EMS vendors, and program staff, from July 2011 to August 2012. As previously noted, the evaluation team did not conduct participant or vendor interviews for AOS projects as none of these had been completed as of August 2012.

First Round Feedback from Vendors

The two vendors interviewed included representatives from the EMS and EIS vendors. The EMS vendor has worked with utilities, such as Puget Sound Energy (PSE), for a decade, winning praise for its efforts. The EIS vendor developed its building modeling algorithm in cooperation with Pacific Northwest National Laboratory, and has won a number of industry awards.

Motivations to Participate and Pilot Experience

Vendors expressed interest in participating in the pilot for business development purposes. The EMS vendor reported program incentives helped in a difficult economy, a sentiment also expressed by Lockheed Martin regarding vendors' reasons for participating. Additionally, the EMS vendor cited interest in the pilot serving as a reference for its product, validating the EMS as a real savings measure: one that can save more energy than other maintenance programs, such as coolant top-off or changing air filters. Few utilities offered deemed savings for an EMS system, and the EMS vendor's hoped this pilot could help develop a deemed value so its performance would be better understood. Participants would then perceive the EMS as a less risky choice for achieving savings.

The EIS vendor had been offering its system to Lockheed Martin for several years prior to the BPTaC pilot. When Lockheed Martin and Energy Trust became interested in operations-based savings, this vendor could readily begin participation. It also produced favorable results with a NYSERDA pilot program,[7] which differed from Energy Trust program primarily in that 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.[8] Recruitment for the NYSERDA pilot proved less challenging due to the 100% incentive, but the vendor said Energy Trust's approach ensured participants had a stake in the outcome, which they thought could be a significant factor in the final savings outcome.

The EMS vendor reported the pilot did not accept many of its prospective projects, adding they did not fully understand the requirements needed to attain project approvals. They believed many of their prospects may have been rejected due to buildings being considered "too efficient." However, they view the best candidates for capital improvements not necessarily the best for operational savings as operational measures use low or no-cost adjustments equipment. Thus, the EMS vendor did not consider a building with a low ENERGY STAR score ideal as most savings opportunities would likely be capital based. In contrast, a building with capital improvements may benefit the most from the EIS.

7 See: http://www.northwrite.com/propoganda/Case%20Studies/Project%20Brief%20-%20NYSERDA%20(16-040512).pdf A report on the results of the NYSERDA pilot will become available at the end of 2012.

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

Both vendors reported Lockheed Martin as responsive, although both also noted some staff turnover and overwhelmed new staff. One vendor reported a few opportunities lost due to long application turnaround times, sometimes taking a month or more.

Vendors also said pilot staff have been supportive, but they wanted more marketing support. Although one vendor did not know all the ways Energy Trust and Lockheed promoted the pilot, the vendor cited an experience with another utility program, which provided a smaller incentive to vendors as part of its normal program offerings. This utility set up several meetings for the vendor to meet with customers each week, a support service the vendor considered valuable.

Incentive Level

Though the EMS can make operating a building easier, the EMS vendor observed risk-adverse and understaffed customers resulted in slow sales. Incentive availability proved important as closing a sale may require 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 it easier to close a sale at the 70% incentive level, but a generous incentive still did not guarantee a customer would install the EMS. The EMS vendor reported a chain restaurant had sites in both Energy Trust and PSE territories, and neither site has agreed to move forward, despite differences in incentives.[9] The EMS vendor considered current Energy Trust incentive levels likely appropriate, but reducing it to 30% may not be significant enough to achieve uptake.

The EMS vendor, primarily a software company, works with its hardware supplier to stock the hardware. This supplier has an incentive to move this product, thus offers lease financing. The EMS vendor offers the lease financing option as a normal part of its proposals, and 80% of its customers outside the BPTaC pilot opted for that route, as it structures monthly savings to exceed lease payments. Customers use an online application; there is no need to undergo a formal credit check. The hardware supplier qualifies an application based on information provided by customer. Thus, the vendor finds this a simple, straightforward process for customers. However, only one Energy Trust pilot participant has opted to use the lease option, with the others opting to use cash.

The EIS vendor thought the 50% incentive level appropriate as participants with “skin in the game” will more likely use the system and obtain savings. The vendor observed BPTaC pilot participants are more responsive than those the vendor has worked with in other pilots, which they attributed to: effective recruitment and that organizations in Energy Trust region prioritize sustainability more than those in other areas. This vendor noted it would be more difficult to have success in an area where organizations could not afford to have “skin in the game.”

The EIS vendors noted improvements could be made to the incentive structure. In contrast to Energy Trust’s upfront payment approach, this vendor worked with other pilots that paid incentives based on the amount of kWh saved. The vendor thought paying for performance

[9] Though this customer eventually decided to install the EMS in September 2012 at a location served by PSE, it took a year for the customer to move ahead with the project.

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

Vendors remarked that participants not responsible for the bills would not be engaged in managing their use, and would be unlikely to install a monitoring system. They said the ideal participant wants to interact with and depend upon the mechanisms each system uses to generate savings: the EIS relies on customers to actively make improvements to their building operations, while the EMS includes active and passive savings sources.

For passive savings resulting from the automatic controls optimization algorithm, the EMS vendor targets buildings previously operated in a largely manual manner, without sophisticated tracking or automated control processes. They also target buildings types with high energy intensity and dynamic loads, such as restaurants.

Both vendors explained a customer likely to succeed in generating active operations-based savings would be willing to address building maintenance issues and "stick with it." Initially, they said customers want to save energy, but, if not disciplined on set-points or unwilling to make improvements or repairs[10], would not obtain saving and blame the system. Ideal customers are engaged and willing to make operational changes, but lack the information needed to make targeted changes.

Participants not maintaining their buildings also will not be able to reach the full potential for operations-based savings as the monitoring and feedback systems require normally functioning equipment. With the EMS, the control algorithm assumes equipment functions normally, and self-adapts, based on the temperature of the space heated or cooled. As previously noted, EIS can also help to optimize operations in buildings where capital improvements have already been made. One vendor found buildings analogous to automobiles: "like a car, you have to take care of it in order for it to continue running well."

Approach to Energy Savings

To continue with the car analogy, one vendor explained the value of building monitoring systems by saying: "You don't need a speedometer to drive a car, but when you have one you can drive better." By "driving better," building operators can gain operations-based savings. This section describes specific approaches taken by each vendor to generate savings.

The EMS vendor found it difficult to rely on customers to make behavioral changes producing savings. In their experience with PSE, they obtained 15% energy savings without equipment changes, just using control optimization (also called passive savings). 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." Approaches relying on behavioral changes are considered "soft savings"; in contrast, automated savings provide firm, proven savings. According to the vendor, persistence is built-in by properly maintained equipment. Using EMS to control a whole building as a package prevents simultaneous heating and cooling.

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

In contrast, the EIS system relies entirely on customers to implement and maintain changes. This can take much vendor labor to monitor customer actions, and understand why they do not move forward with recommendations. Often, customers wish to implement ESMs, but, as ESMs are considered low on their priority lists, they can take months to implement. Initially, customers do a few ESMs and then lose momentum; so the vendor conducts follow-up presentations to maintain customer actions. The vendor operates using a philosophy that they are not there to fix buildings, but to help customers fix them 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, making sure simultaneous heating and cooling does not occur. However, they have found customers often do not know how to provide the information, or do not have time to find the data. As such analysis is not a required for service, it is considered a bonus. No straightforward way exists to automate obtaining this information as DDC systems operate uniquely, and placing sensors or other monitoring equipment would prove costly.

Regardless of the challenges, both vendors offered similar approaches to help customers make changes. They provide reports to customers intended to prompt them to make changes to reduce energy consumption. The EMS vendor provides semi-annual reports that summarize costs associated with not making changes and recommended actions. The EIS, along with its consultants, regularly submit energy saving “tasks” through the online portal, and encourage their completion. ESMs usually are low or no cost, and focus on avoiding wasteful energy use. Upon request, both vendors advise customers on capital improvements and paybacks.

Both solutions also alert customers if detecting high demand. The EMS system sends alerts to customers upon waste detection, such as a refrigerator door left open. The EIS also has been used to detect faulty equipment; in one facility, the vendor found energy use higher than in the past, and notified the customer, who discovered a pump switch had malfunctioned and was stuck in the on position. The customer immediately fixed the pump, so it no longer ran nonstop, and the vendor could see usage drop back into the expected range.

Post-Installation Feedback from Participants

The evaluation team interviewed seven unique participants, some of whom installed more than one system. These participants included: a family entertainment center, a restaurant chain, office park, three city governments, and a commercial property management company. Three participants had experience with EMS, while four installed the EIS.

Most participants said they were aware of the concept of building monitoring systems prior to enrolling in the pilot. All considered energy efficiency 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. One participant had not yet started using the system, and could not comment on some of topics addressed. The evaluation team relayed this information to the vendor, which followed up with this participant a few days later to ensure they were able to access the system.

Motivation to Participate

All participants cited the incentive as influencing their decision to participate. They said the incentive helped to bring the payback down to an acceptable time frame, ranging from less than one year to two to three years. Two participants sent the evaluation team a copy of their payback analyses, which showed the system cost, net of incentives, had a simple payback of less than one year in one case, and slightly over one year for the EIS, assuming 10% energy savings in both cases.

Another EIS owner reported a two to three-year payback as a goal. One EMS owners originally thought the system would pay back in three years, an acceptable period, but, after owning the system for a few months, found it would pay back more quickly than expected (17 months). Another EMS owner reported typically looking for a one to two-year payback; so they considered their three-year payback for the EMS relatively expensive.

Only one EMS participant chose the lease financing option to pay for the remainder of costs after the incentive as this was a better way to take on risk, in case the system did not result in savings.

Aside from the payback expectations, participants cited multiple other reasons for installing the monitoring systems. Two EMS owners mentioned the scheduling capabilities help them avoid waste; one owner said that, prior to installing the system, they manually turned on their equipment over a period of time to avoid PGE's demand spike charges; now, he said, they have the system automate this process.

However, participants considered scheduling just a bonus. They particularly valued the high support levels they received, and the ability to develop new individualized capabilities, such as monitoring temperatures of an ice cream cabinet. The EMS vendor developed this function for one owner: an alert sounds any time the cabinet, which holds $800 worth of product, is left open.

Another participant planned to use the EIS to build a case to upper management for completely tearing down an existing building as it lacks the infrastructure to operate efficiently, and is too small for their department. She explained the building can be so unpredictable that they did not even bother calculating the return on investment or payback.

She went on to describe the building's (constructed in 1986) very poor construction. For example, the building used a compressed cardboard duct system, which leaked into unconditioned spaces, and could not be cleaned, as cardboard cannot get wet; so ducts remained dirty. To fix the building, the participant reported, would cost $11 million. A new building, bigger and energy efficient, would cost $18 million, and energy savings would recoup incremental costs.

This participant works in a political environment, and reports upper management does not consider its internal people as experts; rather, outside experts and hard data may be necessary to convince them how to prioritize capital investments, especially when upper management struggles with budgetary issues and pressure from taxpayers.

Another local government participant reported an opposite experience: upper management has continually supported energy efficiency, and the city takes pride in participating in innovative pilot programs. This city recently experiences a positive outcome with a solar pilot, so joining this pilot appealed to upper management.

In addition, the city signed up for the U.S. Department of Energy's (DOE) Better Building Challenge, and plans to use energy data from the monitoring service to feed the Environmental Protection Agency's Portfolio Manager Tool, used for reporting progress to DOE. Better Buildings Challenge partners target a 20% reduction in energy use by 2020, and must showcase a project and implementation model. This participant reported they will use the EIS as their model, and hopes to develop a case study transferrable to other cities. Prior to signing up for the pilot, this participant reported trying to understand why one of their buildings used so much energy; so the pilot's timing proved fortuitous.

Finally, one EIS participant reported that they closed the deal when their contract guaranteed energy-cost savings would equal the portion of the project cost not covered by the BPTaC Incentive. The participant had negotiated away all financial risk: if the vendor could not provide documentation proving they had achieved savings, the vendor would reimburse the participant for their costs. The vendor typically did not make this guarantee in its contracts, but it wanted to close the sale, and thought the risk low that the building would not perform, given the building had energy costs around $33,000 a month, while the participant's net EIS costs were $32,000.

Pilot Application

Two pilot participants found Energy Trust applications confusing and difficult to complete. One reported this generally true for Energy Trust applications, while another attributed the difficulties to the program being a pilot. One participant said their application took three months until Lockheed Martin finally walked them through the form step-by-step. They found the application contains a good deal of legal language; so the best way to move through the process would be having someone assigned to help them fill it out.

In contrast, two participants who also had experience with Energy Trust projects thought the application clear. Another participant who thought the application process straightforward noted the vendor handled the paperwork and made the process easy. One participant expressed confusion by all the pilot stakeholders (e.g., vendors, consultants, administrator, implementer), and would have appreciated a clear summary of everyone's roles.

BPTaC System and Service

Most participants expressed satisfaction with the vendor support and monitoring system, though one could not comment as they had not started using the system. Vendors proved responsive to participants and were persistent in reaching participants who were unresponsive. Participants found the training user friendly and of adequate length, although users of both systems noted advantages from a follow-up session to answer questions and to maintain momentum towards efficient operational changes.

One EIS participant reported a lag in energy information displayed, and wanted real-time information. This participant thought it would be helpful if the diagnostics package with building sensors could also be left in place, instead of only during the two-week baseline measurement. The EIS vendor indicated it would be costly to provide instantaneous consumption information. The vendor representative also said they were developing their own diagnostics kit with a supplier, and thought it would be possible, at a future date, to let customers rent them for checkups or buy them.

As noted, at the time of interviews, the EMS semiannual reports were not available for comment. The evaluation team noticed some participant activity level on the EIS Web portal, including participants' comments on the task list describing tasks attempted, determined not to be cost-effective, or in progress. However, users did not update the task status or % completion fields. Most tasks appeared to have been reviewed and considered; many were in progress.

Operational Changes and Energy Savings

All three EMS participants made operational changes to their buildings, such as scheduling and controlling HVAC and lighting use. Examples include:

- Using the "building open" button, which automatically starts up the AC, and sequences how equipment turns on (previously, equipment had been turned on manually).
- Establishing a target temperature set-point for a space occupied by customers,

One participant considered additional work to place 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 their ice cream cabinet. The participant reported one benefit from participating in the pilot was vendors worked hard to make everything run perfectly; if they found their system did not perform satisfactorily, they made changes. Although EMS participants saw some savings after installation, they wanted to wait and see what savings could be achieved over a longer period of time.

EIS participants also made low or no-cost changes to their operations, based on the vendor's recommendations. These typically include actions such as:

- Reducing HVAC system run times;
- Calibrating control sensors;
- Adjusting set-points;
- Lockout of individual zone control units;
- Air balancing;
- Air compressor timers; and
- Reminder e-mails to tenants.

Three out of four EIS participants considered it too soon to tell whether any energy savings had been achieved at the time of the evaluation team interviews. One saw energy use go up due to a broken pump controller, which was resolved with the help of the EIS. This facility also had a broken controller, and, as it had EIS, instead of replacing the controller with a basic model, they installed one controlling multiple zones to improve their scheduling ability. Another reported that, although excited about quantifying results, they did not have time to analyze savings. Still, they thought there savings would be achieved since they reduced their HVAC run times by

14 hours over six units. The fourth EIS participant said they saw savings from adjusting their HVAC run times, and did not notice a negative impact on the building's comfort level.

Other BPTaC Systems Benefits

Most participants used the systems to monitor energy spikes and equipment health, and to diagnose maintenance problems that could lead to unnecessary energy consumption. In one case, an EIS participant had tracked bills using Excel for the past four years. Their analysis experiences a one-month delay; so having information more immediately and in shorter intervals proved helpful for collaborating with the facilities department to make operational changes, and with their ability to respond more quickly to equipment malfunctions. This participant expects their ability to analyze 15-minute interval data to improve, and sought to expand practices learned from the BPTaC pilot to 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 the EMS allows users to log on and change settings remotely. This participant also uses diagnostic reports to better monitor performance of HVAC service companies they employ. Other participants indicated their facilities or HVAC engineers often served as system end users.

Participants with tenants also used monitoring to better manage their tenants. One allowed tenants to look at the EMS dashboard to improve transparency on the building's current conditions. Another used the EIS to transparently determine how much more rent to charge a tenant who wanted longer hours of operation.

The EMS participant who thought the system would have a quicker payback than expected planned to invest savings into a new revenue-generating project.

Barriers to Implementing ESMs

Participants reported monitoring systems provided participants with the knowledge to reduce energy use without sacrificing performance, a helpful attribute. Ultimately, however, they understand they are responsible for taking actions to obtain or maximize energy savings. Both EIS and EMS users say they have a list of recommendations, but barriers to implementing those recommendations included the following:

- **Building occupant tolerance**. One EIS participant tried changing the set-point, but experienced too many staff complaints.
- **Resource constraints**, which can fall under two categories:
  - Capital constraints prevent participants from moving forward with higher-cost recommendations. For example, one recommendation was to replace a duct system. As an incentive was not available for it, it would have to be in the next year's capital budget, and subject to approval from the building owner. Another pilot participant found difficult to obtain upper management approval for energy-efficiency projects. As upper management does not perceive energy-efficiency projects as highly "glamorous" and does not consider internal staff experts, an outside expert and data may be necessary to convince them to prioritize energy efficiency.

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

Lessons Learned

At the pilot's midpoint, some participants cannot yet determine what energy savings they have achieved. However, they hope to see positive changes in the future. One reported that now they could visualize their energy consumption, they have become more conscientious about their consumption. Another considered the program great, but did not have time to learn the system as well as she would have liked; so she advised other facilities managers to commit to the investment, and really learn how to use it. She understands the system will not run itself, and she vows to use it more after facility maintenance issues have been resolved.

5. CONCLUSIONS AND RECOMMENDATIONS

Participants and vendors generally expressed satisfaction with their pilot experience, and have been responsive to each other's requests and needs. Research questions about energy savings and persistence cannot yet be addressed. Participants must be willing to make changes to the ways they approach operations and maintain those changes over time. Ideally, these improved operations will eventually become ingrained habits for participants and standard practices for organizations. The next set of interviews with participants a year after installation will offer more insights into the long term experiences and outcomes from the pilot systems and services.

Participants' Motivation to Install a Building Monitoring System

Conclusion: Participants considered reducing energy costs without sacrificing performance the most important reason for installing a monitoring system, but this alone may not be sufficient to justify installing a system. A number of participants cited other important reasons likely contributing to their decisions. Most participants also looked for a three-year or shorter payback, which only Energy Trust incentive made possible. Some building owners or managers installed EMS or EIS products in multiple locations, indicating chains or multi-property decision makers only need be convinced once to try a building monitoring system.

Conclusion: Although the pilot has required a longer time than expected to enroll participants, it appears to be progressing towards full subscription and is recruiting participants who will likely use the systems and services. It can be challenging to find participants who: 1) see value in the systems and services, 2) have funds to pay for the project, 3) and manage a building that is maintained to a minimum standard. An AOS project, significantly more costly than the other systems, has yet to be completed, indicating larger projects take more time to complete.

Recommendation: Energy Trust should consult with ICF, the new commercial program implementer, regarding approaches for increasing uptake, and communicate filling the remaining slots quickly as a high priority. Energy Trust and ICF should continue to help vendors with recruitment by acting as a credible reference and by identifying high-quality leads. Vendors should work closely with prospects to understand their internal barriers, including helping them convince upper management to value energy efficiency, and emphasizing benefits other participants have obtained.

To increase uptake, the evaluation team understands the EMS vendor will be offering a performance guarantee payment plan to prospective EMS participants. This seems appropriate, considering some participants said they were concerned they would not obtain the estimated savings. The family entertainment center participant expressed willingness to participate in a case study, and this could offer another potential recruitment tool for the EMS.

Conclusion: Filling out application forms can be a barrier for some participants.

Recommendation: Vendors should fill out application forms for participants, as to prevent delays in the participation process.

Participants' Motivation to Improve Building Operations

Conclusion: Although participants expressed the greatest interest in cost savings, and felt the cost of the monitoring systems was a significant investment, a few reported not using the system as much as they thought they could have, or losing motivation.

Conclusion: After installing their systems, most participants made some changes to operations, based on vendors' low or no-cost recommendations. Participants found the system and vendor support valuable; they said they understood what can be done to achieve improvements and what to prioritize. Participants with information on energy spikes and trends report more responsively addressing maintenance issues than before. Participants say alerts prompt them to take immediate action to avoid waste.

Improvements requiring more capital, such as installing new controls or replacing a duct system, appeared to take longer to implement, if implemented at all. EMS participants found Unity's scheduling and control capabilities useful, but the extent that they used the controls varied between participants, with some using Unity to control more systems than others.

Recommendation: Participants often do not have time or resources to complete recommendations right away. ICF and vendors should continue to check in on customers regularly, documenting and encouraging energy-saving changes. Vendors should make it as easy as possible for participants to make beneficial changes to their operations. Some possible ideas, which may already be standard practice, include the following:

- Make an appointment for an in-person visit to accompany participants as they make recommended changes throughout their facilities, such as adjusting set-points or run times, or calibrating sensors. Use this opportunity to gather other needed information on the facility, such as trend logs.
- Set up follow-up meetings to walk participants through beneficial operation changes; so these become scheduled and completed.
- When making capital improvement recommendations, continue to note if Energy Trust incentives are available and expected costs of not taking action.

Conclusion: The pilot's incentive structure may need to be reconsidered if pilot systems become a part of the Existing Buildings offerings. Currently, Energy Trust incurs some risk that savings will not be achieved: the monitoring systems can only be as effective as participants' discipline to stick with them. In addition, having to pay for the system and consulting services upfront can present a barrier, requiring a sizable incentive to spur participation.

Recommendation: ICF and Energy Trust should consider if it proves more effective to pay incentives to vendors on a per-kWh saved basis instead of upfront as a percentage of costs, letting vendors determine how to structure payment arrangements with customers. This would require some vendor management and oversight to ensure consistent and accurate reporting.

Savings Tracking

Conclusion: The EIS and EMS can track energy usage, comparing it against historical and/or projected usage to obtain a savings value. Lockheed Martin currently is reviewing these savings and reports. The evaluation team did not see demand savings quantified, although it seems possible to quantify this, given additional information from the utilities.

Recommendation: Should the vendors wish to expand to regions where demand presents a greater concern, such as California or the East Coast, they may need to determine demand savings for program reporting.

Conclusion: The utility summary of the EMS semiannual report lists monthly results in boxes, and separates gas and electric savings into different sections, with boxes not always ordered chronologically.

Recommendation: The utility summary section of the EMS semiannual report could be better organized in a table rather than boxes, with a column for each month, and rows for electric and gas information. Information should be presented chronologically.

Conclusion: The EIS monthly progress report does not specify ESMs implemented and implementation times, nor does it quantify gas savings.

Recommendation: The EIS monthly progress report should list ESMs implemented and their implementation times, along with estimated gas savings.