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Evaluation of Energy Trust of Oregon's CORE Improvement Pilot

Year 1 Report

Prepared for:
Energy Trust of Oregon

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EnergyTrust of Oregon

MEMO

Date: October 27, 2014
To: Board of Directors
From: Kim Crossman, Sector Lead, Industry and Agriculture
Dan Rubado, Evaluation Project Manager
Subject: Staff Response to the Evaluation of the CORE Improvement Pilot

This is the first of two evaluation reports on the CORE Improvement Pilot which was developed and implemented by the Production Efficiency (PE) program beginning in 2012 to help medium-sized industrial customers adopt strategic energy management (SEM) practices. This first report covers findings from staff and participant interviews, as well as a technical review of the Monitoring, Tracking &Reporting (MT&R) tools used by customers, from the first CORE cohort. The second report, to be completed in 2015, will provide findings from the second CORE cohort, as well as verification and persistence of savings and assessment of follow through with capital projects from the first cohort.

The results of this first evaluation report demonstrate that medium-sized industrial customers are fully capable of success with Strategic Energy Management. CORE participants were able to achieve significant energy savings through the pilot. The demonstrated success of CORE and the relatively large market of potential participants caused the PE program to expand this offering to additional cohorts and to other regions of the state.

Many of the recommendations made in this evaluation report are to refine the delivery of SEM in areas that are working well or are related to energy tracking and the methods used to quantify savings. The PE program and SEM technical service contractors will use the findings from this report as a guide to help continue improving the CORE offering as it expands and evolves. In addition, the program will consider making changes to the MT&R models and savings estimation methodology where it make sense and the changes are feasible, based on the recommendations in the report.

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Table of Contents

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List of Tables

Tables:

Executive Summary

The CORE Improvement (CORE) pilot is an offering within Energy Trust of Oregon's (Energy Trust) Production Efficiency program that helps medium-sized industrial customers (i.e., those spending $50,000 to $500,000 annually on electricity and natural gas combined) implement strategic energy management (SEM) practices at their facilities. The CORE pilot is implemented by Triple Point Energy (Triple Point), an energy consulting firm specializing in delivering strategic energy management programs to the industrial market. The CORE pilot is modeled after the successful Industrial Energy Improvement (IEI) initiative also offered by Energy Trust and implemented by Triple Point. The goal of the IEI is to put into operation at each participant facility a process of continuous energy management improvements which enable energy savings and reductions in energy intensity. The CORE pilot is an experiment to see if the concepts of SEM can be successfully delivered to medium-sized industrial customers.

The initial CORE pilot consists of two cohorts; the first cohort began with 11 participants and concluded with nine. The first cohort conducted activities throughout a 15-month process to identify, implement, and evaluate SEM practices. This report discusses the activities conducted by the first cohort.

Evaluation Objectives

The purpose of the CORE Improvement pilot evaluation is to verify whether smaller industrial customers can embrace and adopt SEM practices and embed them in their corporate culture given the inherent time and resource constraints of smaller industrial sites. The evaluation will test and refine the delivery model, compile feedback and lessons learned and determine which types of companies are successful with SEM. In addition, the evaluation will verify the energy savings resulting from the pilot, assess the persistence of those savings, determine how many customers follow through with capital projects, and identify the best methods for evaluating the impacts of the CORE.

Evaluation Methodology

For this first year report, the Navigant team conducted an initial program evaluation and an initial review of the participants' Monitoring, Tracking, & Reporting (MT&R) tools and reports.

For the program evaluation, Navigant conducted in-depth interviews to assess whether the CORE pilot is operating effectively, delivering value to participants, and promoting the adoption of SEM practices among small industrial customers. Navigant interviewed the following parties:

- Energy Trust program management staff;
- Program Delivery Contractors (PDCs) serving the participants;
- Representatives from Triple Point;
- One participant who dropped out during the CORE pilot; and
- Each of the nine participants who completed the first year of the CORE pilot program.

For the initial review of the MT&R tools and reports used by the participants, Navigant:

- Reviewed all participants' MT&R models to evaluated the state of participants' energy tracking and reporting capabilities; and
- Reviewed a sample of MT&R models from a statistical standpoint in order to assess the level of statistical rigor and determine if there are methods that can be adopted to increase the MT&R's accuracy at predicting participant energy savings.

Key Findings and Recommendations of Program Evaluation

Findings

Program Management Findings:

- Thus far, the pilot program has shown that medium-sized industrial customers are just as capable of being successful at SEM as larger companies.
- Energy Trust found that recruiting was more difficult for the CORE program than for IEI.
- Although employee engagement of CORE in general was not as strong as in IEI, one major advantage of working with smaller companies is that Energy Trust found it easier to engage executive sponsors because they are more involved in the day-to-day business of the firm.
- Energy Trust was very impressed with Triple Point's work on the CORE pilot.
- Energy Trust noted that the program savings estimates were slightly higher than they expected, but they have had a difficult time substantiating the savings.
- Energy Trust supported expansion of the CORE initiative, noting that it is a good complement to IEI and that it allows them to reach a different market segment of smaller customers.

PDC Interview Findings:

- In general, PDCs believed that they are well-positioned to leverage their existing relationships with customers to identify candidates and effectively recruit for the pilot program.
- PDCs believed that the CORE pilot would increase their customers' awareness of and interest in energy efficiency when initiating capital projects, but some were concerned that participation in CORE may cause customers to divert resources away from capital projects already in progress.
- In terms of expanding the CORE program, PDCs thought that about a third of their active customers would be good candidates for CORE.

Triple Point Interview Findings:

- Triple Point spent more time and had more difficulty than they anticipated in training participants to use the MT&R and identifying production variables (some sites lacked detailed production data, requiring additional work to generate this MT&R input). However, they recognized the need to balance keeping the MT&R simple for participants and gathering enough data to quantify program savings. Triple Point observed that a pre-defined measurement period was not appropriate for smaller production facilities because of the variation in production schedules and increments of the energy and production data.
- PDCs have the potential to be a valuable resource, particularly in activities that can benefit from their expertise, such as on-site energy scans. PDCs can also assist in recruiting by drawing on their existing networks.

Participant Interview Findings (Including Drop-out):

- Most participants felt that they had received value from their participation in CORE, and most anticipated that they would continue with many of the energy-saving practices they had learned through CORE. Additionally, all of the participants who completed the pilot said that they would recommend CORE to other companies in the future—indeed, some already had. This trend was also observed with the IEI.
- Participants observed that levels of participant engagement with CORE principles were related to the effectiveness of the energy team, the technical skill level of team members, the level of engagement with other employees, and the level of support from management. The IEI reported similar findings, especially with regard to management support.
- Many participants felt that the MT&R model was not easy to use, though they believed that it did provide them with useful information. Some participants had difficulty generating or accessing MT&R inputs, such as production and utility data. A few incurred a cost to obtain utility data electronically.
- Some participants were able to leverage the information provided by the MT&R to demonstrate the effect of the energy savings on the firm's bottom line to their management team.
- Participants generally did not see the benefit of certain energy planning activities such as developing an energy policy or energy management plan.
- Even though energy savings from capital projects were not included in CORE savings, and although some PDCs expressed concern that participation in CORE may cause customers to divert resources away from capital projects, participants reported that CORE enhanced their ability to initiate and follow through with capital projects. Specifically, participants reported that during the course of the project, techniques they learned through CORE either helped with the decision-making process or helped evaluate the effect of the capital investment on energy.
- Most participants had a positive existing relationship with their PDC and expressed a willingness to work with them on CORE-related projects. However, others were uncertain about the PDCs' role because they did not have an existing relationship with their PDC.
- Participants found the peer-to-peer networking activities to be one of the most beneficial aspects of the program. This was also a key finding for the IEI.
- Participants were critical of activities during group meetings that they felt did not use their time efficiently (such as filling out worksheets individually, which they could have done on their own time; and discussion of topics related to sustainability but not specific to CORE's focus on electricity or natural gas savings). By the same token, participants had very positive feedback about the on-site meetings because they got a lot of value out of the meetings and felt their time was spent effectively.
- Similar to the IEI, CORE participants gave universally positive feedback to the representatives from Triple Point.

Recommendations

<u>Enhancing the Usability of the MT&R Model</u>:

- Make the MT&R interface more user-friendly and conduct more targeted training on its use, particularly for customers with limited software ability. Training should include both the concepts of regression analysis and the use of Excel-based spreadsheets.

- Provide tools to assist participants with translating MT&R findings into compelling progress reports to their management teams. This could include templates or examples of reports or presentations that past participants have used successfully.

Promoting PDC Integration:

- Draw on the PDCs' experience and networks by integrating them more into CORE elements and processes that benefit from their expertise, such as energy scans and recruitment.
- Highlight mutual benefits of CORE to PDCs. For example, PDCs get credit for capital projects even if they were implemented because of CORE, and customers reported that CORE enhanced their ability to initiate and follow through with capital projects.
- For participants who have not had any contact with their PDC, Energy Trust should leverage the CORE as an opportunity to establish this relationship.

Maintaining or Increasing Participant Engagement:

- Sharpen the focus of the group meetings to use the time for activities that benefit most from having the entire group present, such as directed peer-to-peer interaction.
- Develop activities that make the benefit of participant activities that are strategic in nature more apparent to participants. For example, help participants understand the benefits of developing an energy policy and/or energy management plan.
- Cover the more individualized topics and basic technical coaching at on-site meetings.

Expanding Networking and Recruiting Efforts:

- Build upon existing peer-to-peer networking activities to make networking a more structured element of the program.
- Circulate a cohort roster to help participants communicate with each other outside of the pilot. Cultivate new networks among current and future participants, in order to leverage the goodwill generated by CORE participants to recruit effectively for future CORE cohorts.
- Promote the CORE concept and successes at industry events throughout the year to generate interest and build a waiting list of potential participants for future CORE cohorts.

Key Findings and Recommendations of MT&R Review

Findings

MT&R Review Findings:

- Participants have implemented MT&R systems and are actively using them to track energy consumption and savings. Generally, participants find that the reports and energy information make sense, are understandable to the customers and are useful and actionable.
- The reports contain enough information to reasonably use them for tracking energy consumption and savings, and the assumptions and models used to track energy usage and savings are reasonable.
- The reports establish a solid baseline for facility-level energy consumption against which energy savings can be measured. No baselines were established at the equipment level.

- Although IPMVP option C is not preferable for evaluating energy savings for those sites with predicted energy savings less than 10 percent, it is a necessary approach because other methods of estimating facility savings may be infeasible in the context of this program. If hourly energy consumption data and at least daily production data are available, evaluation using the facility level billing analysis described in IPMVP option C could be done with more accuracy.

Statistical Review Findings:

- Using pre/post statistical models, such as those used in the MT&R reports, is the best available practice for the CORE pilot. However, there exists a strong potential for omitted variable bias, due to temporal correlation of observable variables with the measurement period.
- Stepwise regression, where the choice of variables is carried out by a procedure of examining significance, is generally not preferred due to possible bias in parameter estimation, inconsistencies among model selection algorithms, and overreliance on a single best model where data are often inadequate to justify such confidence. Generally the econometric literature favors an alternative approach in which all relevant variables are included in the analysis.
- Standard errors[1] on savings estimates were not provided in the MT&R and have been estimated for purposes of this report. The estimated standard errors are generally large, though the 90% confidence bounds do not cross zero. Consequently, statistical confidence in the savings estimates is low. However, if daily usage data were available, it is likely that the standard errors would be smaller, and the confidence in savings estimates higher.

Recommendations

Recommendations for enhancing statistical confidence in the model include the following:

- Continue current practice of estimating baseline regression models at the end of the baseline period and sending them to Energy Trust (or a third-party evaluator) before the measurement period begins. The model should not be revised during any period of time in which savings are being estimated. However, a new baseline model should be developed any time changes in production or other factors that affect energy use occur. Related to this, current engineering estimates of the effects of activities during the measurement period can be verified in future estimates of the baseline model.
- Seek to track production and weather variables for all sites, to provide the opportunity to examine the sensitivity of savings estimates to model specifications.
- Standardize the treatment of weather in models. To the extent a weather variable deviates from the standard, an explanation should be provided. It is recommended to include AVE TEMP^2 in addition to AVE TEMP (or HDD^2 or CDD^2, in addition to HDD or CDD), to be able to capture a non-linear relationship.
- Provide standard errors on savings estimates for Triple Point and Energy Trust use. Standard errors provide a measure of precision and are the basis for confidence intervals.
- Use the most granular time period available, down to the day when possible. Increases in granularity are likely to reduce standard errors.

[1] Standard error is the standard deviation of the sampling distribution of a statistic.

- Ideally, for energy use which is seasonally driven, baseline and measurement periods are one full year each. Otherwise there is some risk that unobserved seasonal effects are biasing savings estimates.

1. Introduction

1.1 CORE Improvement Program Description

The CORE Improvement (CORE) pilot is an offering with Energy Trust of Oregon's (Energy Trust) Production Efficiency program that helps medium-sized industrial customers implement strategic energy management (SEM) practices at their facilities. Through this offering, Energy Trust provides technical training and energy modeling to encourage customers to implement energy-saving measures identified during participation and determine the energy impact of those measures. In return, customers commit to putting into place behavioral and operational changes that are expected to result in energy savings.

The CORE pilot is implemented by Triple Point Energy (Triple Point), an energy consulting firm specializing in delivering strategic energy management programs to the industrial market. Triple Point trains participants' management and staff on SEM practices and provides direct support to staff on energy management projects. Training and support is provided similar to the Resource Conservation Manager concept, but is shared across the cohort and focused entirely on energy in this case.

CORE services are delivered in a cohort environment, with each cohort attempting to recruit approximately 12 highly motivated medium industrial sites. Eligible sites are those spending $50,000 to $500,000 annually on electricity and natural gas combined. The CORE pilot consists of two cohorts; the first cohort began on July 24, 2012 and the second on August 7, 2013.

CORE participants are eligible to receive financial incentives through the pilot. Milestone incentives of $1,000 are offered for completion of each of three milestones (providing utility and production data, knowing and understanding how to use the MT&R model after the workshop, and tying the opportunities register and actions to the model) in the first months of the workshops. At the conclusion of the CORE workshops, participants receive an incentive of $0.02 per kWh and $0.20 per therm of energy savings realized through the CORE. Energy savings from operations and maintenance (O&M) measures are attributed to the CORE while capital projects go through the standard program tracks. Annual savings and customer incentive amounts are based on the level of O&M savings achieved in the last three months of participation in the pilot.

This report covers the activities conducted by the first cohort of participants during the first year of the pilot. We divide this report, which covers the first year of participant activities, into two main areas, the first focusing on the evaluation of the program thus far, as evidenced by interviews with the program management, Program Delivery Contractors (PDCs), representatives from Triple Point, and program participants; and an initial investigation of potential savings evaluation methods, in anticipation of a more formal impact evaluation to take place.

1.1.1 CORE History and Comparison with Industrial Energy Improvement

The CORE pilot is modeled after the successful Industrial Energy Improvement (IEI) initiative also offered by Energy Trust and implemented by Triple Point. The goal of the IEI is to put into operation at each participant facility a process of continuous energy management improvements which enable energy savings and reductions in energy intensity. Through IEI, participants can reduce their energy intensity by five to ten percent with little capital investment, and continuous improvement practices applied to energy can have other benefits for productivity, safety and environmental impact.

The primary difference between the two initiatives is that CORE participants are smaller than IEI participants in terms of energy usage, number of employees, and production capacity. This difference affects the participants and their ability to implement successful SEM practices in several ways:

- CORE participants have fewer employees. There are fewer employees to draw upon for CORE participation and time diverted from each firm's core functions is more pronounced;
- Smaller industrial customers may not have formal or documented business practices, procedures, or tracking systems. Each individual operator dictates O&M practices;
- Smaller firms may not have formal training programs or the resources to send their employees to outside training. Therefore, employees of smaller firms may have skill sets limited to their job functions;
- Smaller industrial customers are less likely to have sub-meters, SCADA systems, or receive 15-minute interval data from their utilities and many do not have a formal process in place to track production output;
- Firm leadership is likely more centralized with fewer levels between the owners or managers, making them more accessible to staff. Many leadership teams may be located on site; and
- Total facility energy use is less for the smaller CORE participants. The CORE cannot be as cost effective as the IEI if the same level of support and resources are needed to deliver CORE to each participant.

The CORE pilot is an experiment to see if the concepts of SEM can be successfully delivered to medium-sized industrial customers. Navigant Consulting has conducted several evaluations of the IEI in the past. Throughout this report, the evaluation team compares experiences between the CORE and IEI participants. Overwhelmingly, the CORE participants' experiences are the same as those of IEI participants.

1.1.2 Cohort One

The first cohort of nine pilot participants conducted activities throughout a 15-month process to identify, implement, and evaluate SEM practices. The schedule of activities is listed in Table 1.1 below. The cohort 1 pilot kick off was July 24, 2012 and the report out and celebration was held on October 29, 2013.

The activities were delivered through a combination of group workshops with the entire cohort, and individual workshops held at the individual participant sites. This is a refinement to the IEI delivery strategy, which was initially delivered through group workshops and group teleconferences, but has also adopted the practice of holding individual workshops at the participant sites.

Table 1.1 Cohort 1 Participant Activities during Year 1 of CORE Improvement Pilot

Event	Description	Timeframe and location
Kick-Off Workshop	Participants met and began to develop their SEM programs.	July 24, 2012 Energy Trust
Energy Inventory	Triple Point conducted walk-through of facility with each participant to identify energy-saving opportunities.	July 30, 2012 – October 5, 2012 At participant facility
Quick Strike Assessment	Triple Point conducted an additional on-site walk through to identify system and process improvements.	July 30, 2012 – November 2, 2012 At participant facility
MT&R Workshop	Participants were trained how to use the Monitoring, Tracking, & Reporting (MT&R) model to monitor and analyze their energy use.	November 6, 2012 Wilsonville
Onsite MT&R	Triple Point coached participants in using the MT&R at the participant's facility.	November 7, 2012 – January 11, 2013 At participant facility
Quick Strike Implementation	Triple Point helped participants implement low/no cost projects at the participant's facility.	December 3, 2012 – August 2, 2013 At participant facility
Organizational Engagement and Planning Workshop	Participants created an engagement plan for their organization. Participants were coached in employee engagement; specifically, how to raise awareness and desire for energy savings, and how to manage resistance and recognize achievements.	March 12, 2013 Wilsonville
Organizational Engagement Activities	Participants held planned activities at their facility to promote best practices and energy awareness.	March 12, 2013 – August 9, 2013 At participant facility
Wrap-Up Meetings	Participants finalized their data and activities and created a plan for continuous energy reduction and cost savings.	July 15, 2013 – August 9, 2013 At participant facility
Report Out and Celebration	Participants presented their achievements to other cohort members and Energy Trust of Oregon representatives. Participants received their Energy Trust Incentive from CORE Improvement.	October 29, 2013 Wilsonville

At the end of the first year, Triple Point reported the savings that were predicted by the MT&R reports from the SEM activities that the cohort 1 participants conducted during the first year. Table 1.2 and Table 1.3 show the predicted MT&R energy savings by site and the energy intensity reduction percentage for electricity and natural gas, respectively. Table 1.4 compares the energy savings to the program incentives. The participants are identified by an identification number to preserve their anonymity. Participants were relatively consistent in electricity savings, with the majority achieving savings between three percent and 10 percent. Gas savings were less consistent, with five participants achieving less than three percent savings and one achieving more than 30 percent savings (one participant did not use natural gas).

Table 1.2. Cohort 1 Electricity Savings per Site

Participant ID	Actual Baseline Electricity Consumption kWh/year	Predicted Electricity MT&R Savings kWh	%
PE5397	1,170,600	0	0.00%
PE5399	4,275,010	195,209	4.57%
PE5398	4,617,869	261,223	5.66%
PE5402	1,575,800	72,148	3.53%
PE5404	2,233,178	0	0.00%
PE5405	7,067,300	342,792	4.94%
PE5407	786,528	52,682	7.90%
PE5408	2,071,232	59,976	2.63%
PE5409	2,704,538	243,296	7.81%
PE5411	5,292,479	837,115	10.97%

Table 1.3. Cohort 1 Natural Gas Savings per Site

Participant ID	Actual Baseline Natural Gas Consumption Therms/year	Predicted Natural Gas MT&R Savings Therms	%
PE5397	11,727	0	0.00%
PE5399	86,826	2,300	2.77%
PE5398	20,021	0	0.00%
PE5402	38,400	2,419	6.04%
PE5404	566,108	12,375	2.14%
PE5405	55,151	0	0.00%
PE5407	55,517	-	0.00%
PE5408	30,813	2,324	5.29%
PE5409	28,305	-	0.00%
PE5411	NA	-	-

Table 1.4. Cohort 1 Incentives versus Savings

Participant ID	Total Incentives $	Electricity Savings MMBtu*	Gas Savings MMBtu*	Total Savings MMBtu*	Cost per MMBtu Saved** $/MMBtu
PE5397	$33,352	0	0	0	N/A
PE5399	$38,576	666	230	896	$43.05
PE5398	$37,716	891	0	891	$42.33
PE5402	$35,279	246	242	488	$72.29
PE5404	$35,827	0	1238	1238	$28.94
PE5405	$40,208	1169	0	1169	$34.40
PE5407	$34,406	180	0	180	$191.14
PE5408	$35,017	204	232	436	$80.31
PE5409	$38,218	830	0	830	$46.05
PE5411	$50,094	2854	0	2854	$17.55
Total Incentives Across All Sites: $378,689					
Total Estimated Savings Across All Sites: 8982 MMBtu*					
Overall Incentive per MMBtu Saved: $42**					

*Equivalent

**The purpose of this figure is to illustrate the relative first-year payoff of the investment made at each site through CORE. This is not the way that Energy Trust calculates cost-effectiveness, nor is it intended to show the cost-effectiveness of this pilot.

1.2 Evaluation Objectives

The purpose of the CORE Improvement pilot evaluation is to verify whether small industrial customers can embrace and adopt SEM practices and embed them in their corporate culture given the inherent time and resource constraints of smaller industrial sites. The evaluation will test and refine the delivery model, compile feedback and lessons learned and determine which types of companies are successful with SEM. In addition, the evaluation will verify the energy savings resulting from the pilot, assess the persistence of those savings, determine how many customers follow through with capital projects, and identify the best methods for evaluating the impacts of the CORE.

Navigant will conduct evaluation activities annually, over three years. Table 1.5 lists the specific CORE evaluation objectives and research questions to be addressed over the course of the evaluation, indicating which will be addressed during each year. This report covers year 1 of the evaluation.

Table 1.5. Evaluation Objectives and Research Questions

	Year Addressed		
Research Topic	Year 1	Year 2	Year 3
Evaluation Plan Objectives			
Document the pilot processes and assess the performance of the delivery model.	●		
Determine what motivates firms to participate initially and maintain efficient practices later, and the best ways to recruit them.	●	●	●
Establish whether small industrial customers can successfully adopt SEM practices and embed them in their corporate culture.	●	●	●
Analyze the characteristics of companies that achieve and maintain significant savings and determine whether there are organizational or industry differences that drive success.	●	●	●
Assess the composition of energy teams in terms of roles at the company and skills and explore what makes an effective team.	●		
Assess corporate and employee level engagement with SEM and compile feedback and lessons from customers.	●	●	●
Determine which services provide the greatest benefit to small companies.	●		
Tabulate the cost to Energy Trust to deliver the pilot and achieve the projected energy savings.	●	●	●
Assess whether customer MT&R systems make sense and are useful once they are operational.	●		
Assess the persistence of SEM practices and O&M measures over the short term.		●	●
Verify the energy savings from customers engaged in the pilot.		●	●
Determine customer follow through with capital energy efficiency projects as compared to their baseline rate of energy efficiency activity.		●	●
Solicit participant feedback on the pilot materials, including the company workbook (MT&R and Opportunity Register) and workshop materials, with the goal of improving these materials for future CORE cohorts	●		
Pilot Business Brief Research Questions			
Can we embed a strategic approach to energy management in small industrial firms and sites? What is the subset of SEM activities that provide the greatest benefit to small companies? What are the characteristics of smaller companies who are more or less successful in implementing SEM?	●		
Is it possible to train/ engage employees deeply in energy efficiency given the staffing constraints in smaller industry? Can we change culture in small industry around energy efficiency with limited effort to embed management systems for efficiency at the executive level?	●		
Can we provide custom services to smaller industries cost-effectively? Can we save energy cost-effectively through this effort?	●		

	Year Addressed		
What are the levels of attrition, average savings for test group, and costs, which will help assess cost-effectiveness of a continued larger effort of this sort?		●	●
What opportunities can we identify to refine the approach?	●	●	●

1.3 Evaluation Methodology

Table 1.6 shows the timeline of evaluation activities Navigant is conducting to meet the evaluation objectives and research questions. The first set of annual evaluation activities began with the staff interviews, conducted in October of 2013. An interview with a pilot drop out was conducted on July 12, 2013 and interviews with the cohort 1 participants who completed the CORE pilot workshops were conducted between November 2013 and January 2014. We also interviewed Triple Point staff in October and November of 2013.

Table 1.6 Timeline of Evaluation Activities

2013	2014	2015
• Review of initiative materials, work plan and interview guides • In-depth interviews: ○ Energy Trust program staff ○ Triple Point staff ○ PDCs ○ Drop out participants (cohort 1) ○ Participating customers (cohort 1) • Review of MT&R systems • Analysis, reporting and project management	• In-depth interviews: ○ Energy Trust program staff ○ Triple Point staff ○ PDCs ○ Drop out participants (cohort 1) ○ Participating customers (cohorts 1 & 2) • Verification of realized energy savings • Assessment of follow-through on capital projects • Analysis, reporting and project management	• In-depth interviews ○ Participating customers (cohorts 1 & 2) • Verification of realized energy savings • Analysis, reporting and project management

1.3.1 Program Review

Navigant conducted in-depth interviews with several parties as part of the first-year program review. Interviews with Energy Trust, Triple Point, and PDC staff documented the pilot processes and operations and began to assess whether the pilot is operating effectively. Navigant also conducted telephone interviews with customers in cohort 1—those who finished the CORE pilot activities and one who dropped out of the pilot. Each of these interviews is described below.

1.3.1.1 Program Management Staff Interviews

The Navigant team interviewed representatives from Energy Trust Program Management staff responsible for the CORE Pilot program. One interview took place in October 2013. The interview covered the following topics:

- Major changes to the pilot since its launch.
- Challenges, lessons learned and future plans.

- Customer interest in CORE Improvement and estimated market potential.
- Success of customer targeting and recruitment efforts.
- Engagement with participating customers' employees on energy efficiency.
- Organizational acceptance of SEM principles and ITSP guidance.
- Characteristics of small industrial customers that are most successful with SEM.
- Subset of SEM activities that provide the greatest benefit to small companies.
- Adoption, reliability, and persistence of SEM practices.
- Ability of ITSP to accurately project SEM energy savings.
- Appropriateness of ITSP reimbursement and customer incentive levels.
- Engagement with customers about capital projects and efficient equipment.
- Satisfaction with ITSP contractor.

1.3.1.2 PDC Interviews

The Navigant team interviewed representatives from the PDC organizations serving the participants in the cohort. These interviews were conducted in December 2013 and January 2014, during the CORE implementation, and covered:

- Level of involvement with SEM projects and customers.
- Success of customer targeting and recruitment.
- Customer interest in SEM and estimated market potential.

1.3.1.3 Triple Point Interviews

The Navigant team conducted in-depth interviews with representatives from Triple Point who managed the pilot and worked directly with participants. Interviews were conducted over several sessions; we first interviewed three Triple Point team members in-person after the report out celebration, then held subsequent follow-up telephone interviews individually. The interviews covered the following topics:

- Triple Point processes, management, costs and operational issues.
- Major changes to the pilot since it launched and changes between cohort 1 and cohort 2.
- Challenges, lessons learned and future plans.
- Customer interest in CORE Improvement and estimated market potential.
- Success of customer targeting and recruitment efforts.
- Engagement with participating customers' employees on energy efficiency.
- Organizational acceptance of SEM principles and Triple Point guidance.
- Characteristics of small industrial customers that are most successful with SEM.
- Subset of SEM activities that provide the greatest benefit to small companies.
- Adoption, reliability and persistence of SEM practices.
- Ability of Triple Point to accurately project SEM energy savings.
- Appropriateness of Triple Point reimbursement and customer incentive levels.
- Engagement with customers about capital projects and efficient equipment.
- Satisfaction with Energy Trust processes and management.

1.3.1.4 Drop-Out Interview

The Navigant team conducted an interview in July 2013 with one participant who dropped out during the CORE pilot. Topics covered included:

- Why customers dropped out of the pilot.
- Whether customers will incorporate any SEM practices into their business.

- Customers' motivation for participating in the first place.
- Overall satisfaction with the CORE Improvement pilot.
- The value of participation in the pilot to customers.
- Satisfaction with Energy Trust and Triple Point's processes and management.
- Satisfaction with workshops and Triple Point's services, including on-site technical support meetings.
- Subset of SEM activities that provided the greatest benefit.
- Composition of the energy team, including roles and skills, its effectiveness and the organization's ability to maintain it.
- Capacity, resources and organizational support for making changes and adopting SEM.
- Other challenges and barriers customers faced in SEM implementation.
- Satisfaction with and appropriateness of Energy Trust incentives.
- Installation of capital projects and efficient equipment or plans to do so as a result of pilot.
- Characteristics of customers that drop out of pilot.

1.3.1.5 Participant Interviews

The Navigant team also conducted in-depth interviews with each of the nine participants after the end of their first year of participation. Interviews took place between November 2013 and January 2014 and ranged in duration from 30 to 90 minutes. Where possible, the interviews included some or all members of the participant's CORE energy team. The interviews covered the following topics:

- Customers' motivation for participating.
- Overall satisfaction with the CORE Improvement pilot.
- The value of participation in the pilot to customers.
- Satisfaction with Energy Trust and ITSP processes and management.
- Satisfaction with workshops and ITSP services, including on-site technical support meetings.
- Level of engagement of employees in SEM.
- Organizational acceptance of SEM principles and ITSP guidance.
- Creation of an energy management plan, energy team, and SEM policies and procedures.
- Composition of the energy team, including roles and skills, its effectiveness and the organization's ability to maintain it.
- Implementation and usefulness of MT&R system.
- Subset of SEM activities that provided the greatest benefit.
- Adoption, reliability and ability to maintain SEM practices and savings.
- Savings goals and whether they were met or exceeded.
- Capacity, resources and organizational support for making changes and adopting SEM.
- Other challenges and barriers customers faced in SEM implementation.
- Satisfaction with and appropriateness of Energy Trust incentives.
- Installation of capital projects and efficient equipment or plans to do so as a result of pilot.
- Characteristics of customers that were successful with SEM and saw the biggest savings.

1.3.2 Review of MT&R Systems

Navigant conducted a review of the MT&R tools and reports used by the participants as a first step towards the objective of verifying energy savings in subsequent evaluation years. These were detailed reviews to determine the state of participants' energy tracking and reporting capabilities. The primary focus of the reviews was to determine whether:

- Participants have implemented an MT&R system and are actively using them to track energy consumption and savings.

- The reports and energy information make sense, are understandable to the customers and are useful and actionable.
- The reports contain enough information to reasonably use them for tracking energy consumption and savings.
- The assumptions and models used to track energy usage and savings are reasonable.
- A solid baseline was established that energy savings can be measured against.
- O&M savings can be separated out from capital project savings and are reasonable given the activities recorded in customers' activity logs.
- Annual energy savings projections from SEM activities are reasonable and are in line with savings calculated in MT&R workbooks.
- SEM energy savings calculated in MT&R workbooks can be accurately verified after one year.

Navigant also reviewed four MT&R models from a statistical standpoint. This review was conducted to understand the level of statistical rigor and to determine if there are methods that can adopted to increase the MT&R's accuracy at predicting the participant energy savings. Navigant selected participants with large savings from both fuel types (electricity and natural gas) and included participants with capital project savings as well.

1.3.3 Future Evaluation Activities

Navigant will conduct evaluation activities annually for three years. For the second year evaluation, conducted one year after the first cohort completes their activities, Navigant will interview the participants a second time to gauge the degree to which they are continuing to practice SEM. The second round of evaluation activities will include site visits to the participants' locations to verify that the CORE measures are still being maintained by the participants. Navigant will also conduct a full impact evaluation to quantify the savings achieved by the participants and compare them to the savings predicted by the program. To facilitate this future impact evaluation, Navigant conducted an initial assessment of evaluation methods, which is discussed in this report.

2. Results of the Program Evaluation

In this stage of the program evaluation, Navigant conducted in-depth interviews with Energy Trust program staff, Program Delivery Contractors (PDCs) representing the pilot participants, representatives from Triple Point, and with each of the nine participants after the end of their first year of participation. Results of the interviews are discussed in the following sections.

2.1 Program Management Staff Interview

After the first year, in October 2013, Navigant conducted an interview with representatives from the program management at Energy Trust. Key areas of feedback are described in the sections below.

2.1.1 Success of Expanding SEM to Small Companies

One major goal of the CORE pilot was to assess whether SEM principles implemented at large industrial companies through IEI could be expanded to smaller customers. Energy Trust believed that thus far, the pilot program has shown that small customers are just as capable of being successful at SEM as larger companies. Energy Trust identified positive and negative aspects of working with smaller customers, as well as changes in program implementation. One advantage was that CORE could represent a greater source of savings overall than IEI because there are limited a limited number of large industrial customers, whereas 87 percent of the industry consists of companies with fewer than 50 people.

Energy Trust acknowledged that working with smaller customers through the CORE pilot was more "high-touch" than they expected, in terms of management, PDC involvement, and interactions with clients. They noted that some innovations were adopted during CORE to help customers identify and quantify energy-saving opportunities on their own. These innovations included:

- Developing a curriculum and tip sheets focusing on nine sources of waste.
- Workbook compiled by Triple Point with a chapter added each time they held a workshop.
- Creating a data logger package to help customers monitor and understand their energy use.
- The milestone incentive as an additional motivator to complete activities.

2.1.2 Customer Targeting and Recruitment

Energy Trust identified the recruitment process as an area for improvement in future iterations of CORE. They found that recruiting was more difficult for the CORE program than for IEI because:

- Energy Trust had not worked with the customer base much, and did not have as many contacts as with IEI.
- It was unclear what criteria or characteristics of customers contributed to success—some companies they thought had good potential did not do well, and some companies they thought would fail were successful.
- Small customers are more concerned about time involvement or can become more easily distracted if they are undertaking other activities within their organization.

Energy Trust had several ideas for improving recruiting in the future, both to contact more customers and to recruit customers with a greater chance of success. Ideas included:

- Involving the PDCs more going forward, because they can draw on their networks (this was already taking place in subsequent cohorts).

- Gaining a better understanding of the customers before their first on-site meeting, by assessing their organizational readiness during an in-depth recruitment meeting.
- Marketing the program by emphasizing the customers who have already gone through the process, and promoting CORE as a continuous improvement program—a well-respected term.

2.1.3 Customer Engagement

Energy Trust noted that employee engagement of CORE in general was not as strong as in IEI; it tended to be more subtle. For instance, only one or two held a stand-alone event focused on energy. However, one major advantage of working with smaller companies is that Energy Trust found it easier to engage executive sponsors because they are more involved in the day-to-day business of the firm. Energy Trust noted that the executive sponsors were hands-on—for example, vice presidents are on site and would attend meetings. This also contributed to faster decision-making. Energy Trust felt that the fact that they have been able to engage so many dedicated executive sponsors has been very important and a big strength of the program.

2.1.4 Technical Service Provider (Triple Point)

Energy Trust was very impressed with Triple Point's work on the CORE pilot. In giving feedback, they focused on two main areas: communication and implementation. With respect to communication, Energy Trust said that Triple Point was "phenomenal" and believed Triple Point's mentorship was one reason customers were so successful. Triple Point formed close relationships with the participants and was very good about communicating—almost over-communicating—with customers, but if they were more hands-off, participants might not have achieved the level of savings that they did. In terms of implementation, Energy Trust believed the program materials Triple Point developed (the data logger package, tip sheets, and workbook) were really important to the program and have been very successful. Energy Trust gave "major kudos" to Triple Point's implementation, including staging of activities, tools, curriculum, and the MT&R. The only issue Energy Trust noted was that the drive to get savings and provide excellent customer service always outweighed the desire to keep program costs low, but they seemed to imply this was an acceptable trade-off to the degree that it had occurred thus far.

2.1.5 CORE Pilot Success and Initiative Expansion

Overall, Energy Trust believed that CORE had been a success in its first year. Markers of success included:

- The budget and schedule were in line with their expectations in the plan.
- Realized energy savings were impressive, especially how close they came to Energy Trust's expectations.
- Energy Trust was pleased with the level of engagement sustained with the participants throughout the year.
- The many similarities they saw between the IEI for larger customers and the CORE pilot supported the validity of the approach.

Energy Trust supported expansion of the CORE initiative, noting that it is a good complement to IEI and that it allows them to reach a different market segment of smaller customers. They said that their biggest limitation to expansion was recruitment, but a large part of this was informational—they have little understanding of the potential in the market for smaller customers. They noted the possibility of a regional CORE program, but had not yet expanded their view to the rest of the state at the time of the interview (they have since begun recruiting for cohorts in Central and Southern Oregon). One idea could be to recruit a larger "anchor" company to reach their small suppliers. Energy Trust anticipated that an

expanded CORE program would require more contracting staff, either through Triple Point or additional contractors.

2.2 PDC Interviews

Navigant conducted interviews with four representatives from two PDC firms early in the first year of the project (December 2012-January 2013). Key areas of feedback included the following:

2.2.1 Customer Targeting and Recruitment

In general, PDCs believed that they are well-positioned to leverage their existing relationships with customers to identify candidates and effectively recruit for the pilot program. PDCs felt that they already have good, consistent relationships with their customers and in some cases were able to identify good candidates from their customer base. PDCs agreed with the focus on small- and medium-size customers (manufacturing customers with utility spending between $50,000 and $500,000) because these customers are not well-served by similar programs for larger industrial companies. One PDC observed that small sites seem to have more flexibility than larger companies because they have less bureaucracy and fewer levels of management, allowing decisions to be made more quickly.

PDCs noted that successful customers tended to have a high level of "organizational readiness"—that is, organizational structure and behaviors that help them implement SEM more easily. For example, one PDC said that it was essential to an SEM program's success for the customer to have enough staff to implement the SEM program. Another PDC qualified this by saying that the willingness of a customer to find the resources was most important—including resources that the recruiter may not be aware of. Thus, although organizational readiness is important, PDCs felt that it is not easy to gauge.

2.2.2 Interaction between Capital Projects and SEM

PDCs are primarily involved in facilitating capital projects with customers, and thus commented on the interaction between capital projects and SEM measures implemented through CORE. On the one hand, PDCs believed that the CORE pilot would increase their customers' awareness of and interest in energy efficiency when initiating capital projects. On the other hand, some were concerned that participation in CORE may cause customers to divert resources away from capital projects already in progress. PDCs recommended that if they are involved in implementing the CORE program, Energy Trust should ensure that they get credit for energy savings from CORE so that PDCs do not view CORE as a competitive threat (this approach is being implemented in future initiatives).

2.2.3 Market Potential

PDCs felt that because they already work closely with customers on energy efficiency projects, they had a unique perspective on the market potential of CORE. First, PDCs noted that firms currently undertaking SEM initiatives tend to be larger customers participating in the IEI, leaving untapped potential in smaller customers that could be fulfilled by CORE. PDCs believed the majority of small- and medium-size manufacturing facilities would benefit from participating in SEM initiatives; however, they emphasized the need to scale down such initiatives for these smaller customers through the CORE program. Both PDCs thought that about a third of their active customers would be good candidates for CORE.

2.3 Triple Point Interview

Navigant conducted in-depth interviews with representatives from Triple Point. Key areas of feedback are described in the sections below.

2.3.1 MT&R Model

Triple Point discussed the challenge of achieving a balance between two different and sometimes conflicting purposes of the MT&R: to serve as a management tool for the customer, and to quantify program savings for Energy Trust. Regarding the first goal, Triple Point believed that the MT&R should be made as simple for the customer as possible, noting that it was more difficult than they had originally anticipated to train participants on the MT&R worksheet and identify production variables. They observed that some sites lacked detailed production data (some initially lacked *any* production data). They recognized the need for more support for participants who struggled with the MT&R, but questioned whether the extra effort would be justified based on the amount of savings achievable by smaller customers. On the other hand, Triple Point recognized that more detail may be needed to more accurately quantify program savings. However, the magnitude of savings may not be enough to justify the level of impact required to increase the precision of the model.

Triple Point observed that a standardized three-month measurement period (meaning all participants have the same three-month timeframe) was not ideal for this type of participant because of the various increments and formats in which energy and production data were reported (for instance, one participant had monthly energy bills and reported production data in two-week increments, making it difficult to normalize the data) and the variation in production schedules (some facilities shut down at certain times of the year or run production lines infrequently). Triple Point recommended increasing the flexibility in the MT&R savings measurement period to allow Triple Point to determine the best measurement period for each participant.

2.3.2 PDCs

Triple Point felt that the PDCs were a valuable resource because of the expertise they brought to the program. However, they made several observations about PDCs' role in the CORE program.

- Energy Trust should encourage the PDCs to participate fully in on-site activities that they attended. For example, Triple Point said that it was generally helpful if PDCs attended the energy scans because they can generate ideas and help participants calculate savings. However, in one instance, a PDC who attended the energy scan was not willing to offer their opinion or assistance when asked.
- In general, it was helpful for PDCs to review the MT&R model, but not all PDCs were familiar with modeling methods. In one instance, the PDC advocated for a complex change in the model that yielded only minor improvements and was not worth the time to pursue. Triple Point suggested holding a class or tutorial to train PDCs in the model if necessary.
- The interface among the PDCs, Triple Point, and Energy Trust was sometimes confusing to customers due to the number of players involved. Triple Point recommended that communication among the PDCs, Triple Point, and Energy Trust should be improved, and that the PDCs should keep Energy Trust informed about communications with customers to maintain a consistent message. Triple Point requested the ability to talk to PDCs directly in order to facilitate communication.

2.3.3 Recruiting

Triple Point recommended increasing recruiting efforts and attempting different recruiting methods. They believed that recruiting more participants (e.g., 15 to 20 customers per cohort) would increase the effectiveness of the CORE Project. Suggestions regarding recruiting included:

- Continue to recruit participants who have worked with Energy Trust on other projects, with the help of the PDCs.
- Conduct recruiting activities all year instead of just prior to the scheduled project kickoff.

- Potentially implement a marketing campaign to recruit participants who have not worked with Energy Trust before. This could involve attending industry events throughout the year.

2.4 Participant Interviews

Navigant conducted in-depth interviews with representatives from participants' CORE energy teams. This included a participant who dropped out of the CORE pilot mid-way through the year. Key topics included the following:

2.4.1 Participant Characteristics

The Navigant team first collected background information on participants, both through interviews and by reviewing CORE materials such as the Report Out meeting slides and opportunity registers and MT&R worksheets for each participant. The average participant:

- Operates only one or two facilities
- Owns the facility in which CORE was implemented
- Is either a private company (4 of the 9) or a subsidiary of a large conglomerate (5 of the 9)
- Spends a significant percentage of total costs on energy—from 2 percent to over 20 percent.

2.4.2 Recruitment of Participants

Successful recruitment of Cohort 1 participants occurred primarily through existing networks:

- Most of the participants had already worked with Energy Trust on capital projects and were directly approached by Energy Trust about the CORE initiative.
- Two were approached or recruited by their PDC, Portland General Electric, who specifically informed them about the CORE initiative.
- One had a mechanical contractor who referred them to Triple Point, who then contacted the company.

IEI recruitment also occurred through existing networks, such as utility representatives and vendors. However, due to the IEI's longer history, some IEI participants are referred to the initiative by past participants.

Participants gave a few main reasons for enrolling in the CORE program. First and foremost, every participant expressed a genuine desire to save energy at their facility and, at least initially, believed they could do so by implementing the CORE practices. Another, related reason, either stated or implied, was to burnish their "green" credentials—by enrolling in the program, companies hoped to show their commitment to sustainable practices. Still another was educational: at least two customers cited a desire to learn more about their energy use, particularly as it affected their operating costs, and be able to predict it more accurately. For these customers, a main appeal of the program was the tools they were given to track their energy use. These reasons were by no means contradictory—companies often cited more than one or all three.

2.4.3 Participant Expectations

For the most part, participants' main expectation was to save a certain percentage of their energy use. Participants cited figures ranging from 2.5 to 5 percent of their electricity and/or natural gas. Most participants with an electricity or natural gas savings goal said that they met or exceeded their target (one participant met their natural gas goal but not their electricity goal). Less quantifiable was the expectation of some participants that the CORE initiative could help them kick-start an energy program and learn how to implement sustainable practices in an effective way. These participants also believed

that participating in the CORE initiative had helped them meet their goal. CORE participant expectations are consistent the motivations of the larger IEI participants; while all expected to realize cost reductions through energy savings, some participants also wanted to support other sustainability efforts.

2.4.4 Customer Engagement

A key indicator of CORE engagement was the effectiveness of the energy team. Among members of the CORE energy team who were interviewed, some believed that they were highly engaged, mostly citing their attendance at meetings and completion of the various CORE activities. Others wished they had been more engaged, with the main constraint being time. One participant noted that they already had a structure built around a continuous improvement process, which had a slightly different focus than the CORE activities and responsibilities. This participant had difficulty adding the extra CORE activities to their existing responsibilities related to continuous improvement. Teams who completed the pilot generally believed they had the necessary skills and knowledge to undertake the CORE activities, and teams with multiple members seemed to be able to delegate responsibilities effectively to improve their level of engagement.

Engagement with the CORE activities was also affected by the technical skill levels of the energy team. Judging by participant responses, the most important skill was knowledge of how to use Microsoft Excel—the software program in which the monitoring, tracking, and recording activities took place. Two of the energy teams specifically noted one or more members' skill with the model as the one that was relied on the most when implementing the CORE initiative. Two others cited "engineering" and "technical knowledge" as the most-relied-upon skill, which may have been related to the model. One participant said that they did not have anyone on the team with Excel experience and this hindered their ability to use the MT&R tool. The participant who dropped out also said that their energy team's effectiveness was reduced by their lack of an employee with the resources and skills to fulfil the role of managing the energy data.

Three participants believed they could have improved engagement with employees in departments such as maintenance, operations, and production. By the same token, many participants believed that having someone from one of these departments on the energy team would have been extremely useful in conducting CORE activities and promoting engagement throughout the company. (Some participants' energy teams did include representatives from these departments. We observed that participants with a representative from maintenance tended to have higher energy savings, though this may have been coincidental.)

The level of engagement among management was also mixed. Three participants reported a high level of engagement on the part of management, while four others said that upper management supported the project but was not actively involved. Two participants, including the one who dropped out of the pilot, said that they could have used better management support, particularly in prioritizing the resources needed to carry out the tasks. Several participants said that the executive sponsor helped influence the level of support from the management, and the one aforementioned participant who lacked adequate management support also said that their executive sponsor was not very involved. One participant pointed out that the main reason for management's interest was that the effect of energy savings on the company's bottom line was immediately apparent, thanks to the energy tracking tool. We observed that participants with higher levels of involvement by the executive sponsor tended to have higher energy savings, though this may have been coincidental. The experiences related to executive support are similar across the CORE and IEI. IEI participants frequently report that upper management or corporate support is a key success factor. IEI energy teams whose upper management was engaged in the process

found it was easier to get employees to take time away from their other responsibilities to support the IEI.

2.4.5 Strategic Energy Management Activities

The Navigant team discussed several types of strategic energy management activities that participants may have conducted: tracking energy use and using the MT&R model; identifying energy projects using the Opportunity Register; conducting team and company engagement activities; and undertaking energy planning or "awareness" activities.

2.4.5.1 Tracking Energy Use and Using the MT&R Model

All participants used a model to track their energy use over time, with eight of the nine using the MT&R model that Triple Point developed, and one using their own regression model that was modeled after Triple Point's MT&R model. Six participants specifically stated that the MT&R was useful to them. One even noted that it was their "primary reason for continuing on the project" because of the information it gave them. Specific ways in which participants used the model included the following:

- Verifying that even the smallest actions can count toward energy savings.
- Showing the energy impact of a particular behavioral change.
- Helping them realize how much energy was being lost through gas leaks, which was "completely off our radar."
- Tracking the benefit of major capital projects and new equipment installations.

Three participants noted that the MT&R model had a very high impact on their ability to save energy, while one said that they did not have much control over their energy use in general, and another said that the model was helpful in areas other than energy, such as tracking revenue.

Participants felt that the MT&R model and workbook were easy to understand, but not very easy to use. In terms of understanding the model, one participant said that the clarity of the model's output particularly appealed to their management because the model was able to show them continual improvement in energy. Another participant had difficulty in the beginning understanding how the information was correlating with the output, but was ultimately able to understand the graphs in the MT&R and could successfully update information by the time of the interview.

Very few customers found the MT&R model easy to use. Three participants had difficulty tying production variables to their energy use, at least initially, with two stating that the variable affecting energy was "not what we expected" and they had to try many different variables; another noting that they had to try a couple different units of measure for their production variable; and the third saying that "there doesn't seem to be a correlation" between production and energy use. Two participants specifically stated that they required significant help from Triple Point in using their MT&R model, with one saying that Triple Point "did all the legwork." One noted some technical difficulties with the model crashing frequently, but acknowledged that could have been an internal IT problem.

Participants also commented on the ease or difficulty of gathering data, both production data and energy data. Participants who tended to be more successful were those who had an accountant or other dedicated member of the energy team who could access production data and update the numbers in the model. One of the participants who had initial difficulty choosing production variables acknowledged that after the variables were chosen, they were relatively easy to gather. Another said that the variables were not particularly easy to gather but they were accessible; another worked with their IT department

to set up a system for accessing production data. Another participant, however, found that their main production variable was difficult to quantify and that other aspects of the facility were easier to quantify, and they believed that these aspects had a greater impact on energy use than production variables. IEI participants experience some of the same obstacles obtaining production data, though a few IEI participants are very large and have SCADA systems that provide them with the necessary data. Generally IEI participants have production data that is easily available once they locate the source of the data and set up a process for regular updates.

Customers experienced varying levels of difficulty obtaining utility data. One said that they received an hourly energy report from their utility, Portland General Electric (PGE) that they had to pay for; however, the data were easy to retrieve. On the other hand, another participant said that getting natural gas data was easy, but had difficulty getting electrical data from PGE; they had to wait for PGE to send a spreadsheet, then they had to build a formula to interpret the usage data, and PGE also lost some of their data accidentally. This participant said that digital access to the information would have cost $800 per month, so they contacted PGE directly for the information. They recommended that CORE participants should be equipped with smart-meters or another program to collect their own data, rather than relying on the utility for data. Similar to CORE, some IEI participants opt to purchase interval data from their utility while others work with their accounting departments to receive regular updates.

Participant suggestions for improving the model to make it easier to use included:

- Improving the clarity of the model by splitting up the worksheet so there was not so much data in one area (e.g., separating the model into three phases of exercises instead of having all the information delivered together);
- Providing more technical guidance in order to understand the formulas, e.g., additional training in the Excel program; and
- Expanding the model to include water and sewer.

Some customers underwent process changes during the CORE pilot and commented on the adaptability of the model to process changes. One participant said that they did not have guidance on how to maintain the model given production changes and that the utility of the program was much lower than it could have been as a result. Another said that updating their model in light of process changes took a lot of work, and did not achieve a perfect fit, but they needed to move forward. They noted that this worked better for natural gas than for electricity. Another thought the model did help give them reliable information after process changes but it was not yet at the point where they could look at the data in the way that they wanted to. Two other participants said that their tracking system did still provide them with reliable information after changes to their production process, while two others said that their production process and equipment did not change over the course of the CORE project.

Despite some critical feedback, seven of the nine participants said that they were likely to continue using the MT&R model after the CORE pilot. Three predicted that they were planning to use it to track the impact of an upcoming capital project. Three others mentioned that they would use it to show whether they were continuing to maintain savings from ongoing or previously-implemented projects. Several participants planned to continue presenting the model output in energy team meetings or internal energy evaluations. This finding is similar to the IEI, where six of eight participants in one cohort reported continuing to use the MT&R (or comparable tracking tool) after one year.

2.4.5.2 Tracking and Managing Energy Projects Using the Opportunity Register

Most participants thought that the Opportunity Register was an important contributor to their energy savings. They chiefly used it for identifying, reviewing, and prioritizing projects that would be easy to

implement but may not have been immediately apparent due to their perceived lack of impact; three separate participants used the term "low-hanging fruit" to refer to these items. One pointed out that the opportunity register was an effective tool for getting buy-in from their management on projects (presumably because it was a way for the energy team to justify the expenditure of time and money to management). Although most participants said that they were already considering doing some of the items on the Opportunity Register before CORE, they stressed the importance of the Opportunity Register in actually getting the projects done. One participant said that without the Opportunity Register, they would likely "lose sight" of a key energy saving measure; another one said that the Opportunity Register helped them "reach out to other team members to get involvement." Another mentioned that the Opportunity Register helped "formalize some of the stuff they had already been thinking of" and help move from "thoughts" to "nice, neat projects." Five participants also said that the Opportunity Register helped them identify additional projects that they had not considered before CORE. Only one participant did not seem to feel that the Opportunity Register had a large impact on savings; they acknowledged that one of the opportunities they identified and implemented has saved energy but has not yet realized the expected scope of savings, while the other opportunities they identified with the Opportunity Register did not have a large impact.

2.4.5.3 Team and Company Engagement Activities

Other strategic energy management activities involved team and company engagement. One of these was holding regular energy team meetings. Participants who held meetings did so with varying degrees of regularity or formality. One participant who held energy team meetings once or twice a month said that they "helped in sharing awareness as well as bringing data and information together." Others held more informal meetings; one noted that all the members of the energy team sit together and discuss CORE activities on an ad-hoc basis; they believed this "definitely helped save energy." However, three of the participants rarely or never held team meetings, while another began by holding meetings, which were "helpful when we were having them," but was unable to continue because of limited time available. There was no observable correlation between the reported frequency of team meetings and energy savings.

Likewise, participants were mixed on whether employee engagement activities were useful to saving energy. They mostly referred to efforts to engage production employees. One believed this was "important to being successful," while another noted that "[production employees] are the ones using the equipment; they'll notice the waste." Others were skeptical of the impact, with one saying employee engagement activities "helped with energy but were not instrumental," another noting that "aside from reporting an air leak, there's not much [production employees] can do," and still another saying that they were "fighting a production mentality" (implying that energy efficiency goals were competing with production goals). Two participants already had internal employee engagement programs that covered a wide range of topics, one of which was energy. IEI participants had similar, divergent opinions on employee engagement. Some IEI participants reported that employee engagement was key to their successful energy savings, though others saw limited value. Communications with IEI participants suggested that SEM could even benefit companies beyond energy savings: some noted that SEM improves employee engagement in general, which increases overall productivity.

2.4.5.4 Energy Planning or "Awareness" Activities

Other elements of strategic energy management involve energy planning and awareness activities. The most useful of these to participants was setting a numeric energy reduction goal—nearly all of the participants had a numeric energy reduction goal going into the CORE pilot. Some participants set their own goal, while others used Triple Point's prediction of the savings they would achieve as their goal.

Participants who found the numeric goal useful said that it "got people excited," "really made us conscious of what we were doing," and "was a useful tool for tracking." Other participants who did not find the numeric goal useful had difficulty connecting their actions to the goal—one said that "we were skeptical we'd achieve that" while another said "we didn't understand [in the beginning] how to get there." One participant already had a corporate-wide savings goal but substantially exceeded that goal. Two participants did not have a numeric energy-savings goal during the CORE pilot. Seven of the nine participants exceeded their goal (including the two who did not have a goal). However, there was no observable relationship between the energy savings goals and the actual energy savings achieved by the participant—participants who exceeded their goals did so by very different amounts.

The benefit of energy planning activities such as creating an energy policy and an energy management plan was unclear to some participants. Of the nine participants, three had a formal, written policy or plan, three had an informal or unspoken policy or plan, and three did not report having a policy or plan. Of those participants that had a formal energy management plan, one did not believe it helped them save energy, while another said that it had not really been implemented. Two participants, however, responded positively to this element. One said that developing a written energy policy for CORE was a benefit to them because it forced them to articulate their approach. Another said that developing an energy management plan helped get management involved in the initiative, which was "essential to getting it done." We did not observe a relationship between having an energy policy or plan and the ability to achieve energy savings, but recognize that the benefit of this activity may take more than a year to manifest itself in energy savings.

2.4.5.5 Maintaining Strategic Energy Management Activities after the CORE Pilot

Almost all customers said that they would continue to incorporate at least some of the strategic energy management practices into their business even after the conclusion of the pilot.
Specific actions that participants had taken or would take in order to do so include:

- Adding energy-related items to preventative maintenance lists;
- Documenting procedures for production employees;
- Establishing monthly air leak detection audits;
- Making energy considerations a part of the equipment procurement process;
- Considering energy savings with all big decisions; and
- Putting into place a system for auditing or checking that employees were continuing to practice energy-saving behaviors.

Challenges to continuing the SEM practices include:

- Resources, both in terms of time and personnel availability – a factor cited by four of the participants; and
- Behavioral challenges: such as encouraging facilities and maintenance workers to take action towards long-term goals instead of focusing on short-term fixes, and helping employees understand why SEM practices were important so that they would be more willing to continue those practices.

One participant said that an effective way to overcome these types of challenges would be the "leadership team making it apparent that it's important." They suggested that the leadership could signal their interest by linking significant energy savings to the bottom line, potentially by offering bonuses to employees.

IEI participants reported similar specific actions and challenges to continuing SEM practices after the initiative ended. Documenting energy-related operating procedures and including energy as a consideration in the procurement of capital projects were frequently cited as likely ongoing activities. Lack of time and lapsing into old ways (or staff turnover) were frequently cited challenges.

2.4.6 Capital Projects

Most of the participants were undertaking capital projects around the time of their participation in CORE, or were planning to do so in the near future. Two participants reported that participation in CORE did not significantly affect their capital investment decisions. However, for others, CORE either helped with the decision-making process or helped evaluate the effect of the capital investment on energy. Similar to the IEI, two CORE participants noted that being able to advertise the expected cost savings to management helped facilitate the approval of capital projects. One noted that because of CORE, they now take a closer look at energy usage, especially when making machinery purchases. Two participants said that participation specifically pushed them to make certain capital investment decisions, one for lighting and one for a VFD air compressor. The second respondent also used the MT&R to track the degradation in performance of a piece of machinery and its effect on energy use, which influenced the decision to have it replaced. With respect to future projects, one participant said that suggestions they got through the CORE initiative have affected their capital investment planning for the future.

2.4.7 Operations and Maintenance Measures

As with capital projects, several participants were implementing operations and maintenance measures during their CORE participation, some as a result of CORE participation, and tracking them using the Opportunity Register. Several participants noted that certain measures involved some amount of production employee engagement and education, for example, reporting air leaks, turning off machinery during breaks, and turning off lights during non-production hours. Participants said that maintenance and operations personnel were key to other measures, such as regularly inspecting for air leaks, adjusting set points, and installing valves. This also tied into the challenges participants experienced, which mainly consisted of finding enough time among the people who would be responsible, and overcoming the "conventional wisdom"—one participant said that changing set points, for instance, took a few meetings to overcome a "'not sure that's going to work' mentality." These experiences are not unique to smaller customers as the IEI participants reported almost identical experiences. CORE participants were optimistic about continuing to save energy through operations and maintenance measures, with seven of the nine reporting that they had a plan to keep at least some of the O&M changes in place.

2.4.8 Relationships with PDCs

Participant feedback indicated a strong potential for the CORE program to interact with PDCs, but suggested that more relationship-building may be necessary. In general, about half the customers had worked with their PDC before engaging in the CORE, and these customers expressed a desire to continue working with their PDC. The remainder of the customers had not worked with their PDC before. In two cases, the participant had not formally met their PDC (though had been introduced at one of the meetings) and the PDC had not reached out to contact them. Most customers who had not worked with their PDC were willing to contact them about future energy projects. However, one was reluctant to work with their PDC because they did not know their PDC well and they "know how to get projects done without PDCs."

2.4.9 Group and On-Site Workshops

2.4.9.1 Group Workshops

Participants were, on the whole, satisfied with the group workshops, though they made several suggestions for improvement. Participants who responded positively to the group workshops said that they were "organized and ran smoothly," "content was well thought out," and had a "lot of real world examples." However, some participants did not feel that what they got out of the meeting was worth the time it took to attend. Two participants did not like the half-day format because with travel, it took most of a day to attend, but there was not enough content covered to make it worth the time for them. Several participants were unhappy with the location and felt that it was very inconvenient to get to.

In terms of specific feedback on activities and content, one of the participants noted that there was a lot of content on how to be more "environmentally friendly, but [the discussion] was not specific to energy savings," which the participant did not find helpful. Another said that there was a lot of individual "packet work" during the meetings, where the time could have been better spent with more collaboration among participants. Three participants provided feedback on the group MT&R workshop in particular: two believed it was a valuable topic and important to cover, while another said that the workshop was confusing and did not contribute to their understanding.

The peer-to-peer learning and networking was one of the main positive aspects for participants; this is true for the larger IEI participants as well. CORE participants felt that the peer exchange at the group meetings was a good way to learn from other participants, as well as to pass along their own knowledge. Two specifically referred to employee engagement as an area where the exchange of ideas was particularly helpful to them. Several participants suggested specific ways to improve opportunities for peer-to-peer networking, which included:

- Providing more structure to the peer interactions, rather than just unorganized mingling (two participants suggested this).
- Matching participants intentionally; in other words, "connect companies that aren't performing well with companies doing much better."
- Giving detailed introductions at the beginning of the process, such as "a briefing and presentation of what type of company they were."
- Providing an updated roster of points-of-contact for each company (this would be particularly helpful as many companies' energy teams changed over the course of the pilot).
- Facilitating more plant tours to see energy solutions in action.

2.4.9.2 On-Site Workshops

In general, participants had much more positive feedback about the onsite workshops and felt that this was a particularly effective way of conveying information. Comments included:

- "Representatives from CORE…took the time to walk us through and [help us] understand energy data and usage and process."
- "Every time they came out, we learned something."
- "Focused on what are [our] problems, what do [we] need to do."
- "Had the rubber meeting the road…good job of explaining things with actual examples."
- "Really successful."

In terms of suggestions for improvement, participants were mostly coming from the perspective of making a good thing better. One particularly liked the on-site meetings that involved some sort of

training or specific tool, and wanted to include more of these activities. Another suggested "improving on what they already did by doing it more often." One suggested that Energy Trust convey more information on what they would cover during each on-site workshop, so that the participant could prepare ahead of time.

Additional topics participants would have liked to cover, either in the group workshops or on-site workshops, included:

- "More about implementation of measures others made that had a lot of impact—wanted to see the process of the change."
- Techniques on how to "jump through the hoops" to get electrical data from utilities.
- Specific technical issues such as:
    - Power factor correction
    - Regression analysis and statistics for better understanding of the MT&R
    - How to use data loggers

2.4.9.3 Overall Workshop Feedback

Participants were extremely sensitive to how their time was used; this was true for both the CORE participants and the IEI participants. They were particularly sensitive to this during the group meetings, as the group meetings were in some cases inconvenient to get to and took significant time away from their work. Participants were most critical of activities that could have been done on their own time, such as filling out forms, and topics that were not directly related to CORE, such as discussions of sustainability without an energy focus (although some participants did find such discussions helpful). Also, the varying levels of technical skill among participants meant that MT&R activities may not have been a good group topic, as the less technically skilled participants tended to require more explanation in order to understand the concepts, while the more technically skilled did not tend to benefit from these activities. By the same token, participants were pleased with the on-site meetings primarily because they were focused on the participants' individual needs and were run very efficiently in terms of the amount of content covered during the time spent.

2.4.10 Program Incentives

For most of the participants, the incentives were a nice perk but not essential to their participation. Regarding the milestone incentives, participants felt that "free money" was always good, but one noted that it didn't compensate them for the amount of work involved. The more important function was to have a specific goal and a tangible reward. One participant said it "opened management's eyes;" another said that having a proverbial "shiny object" made the project more visible within their company. One participant said that although they were "committed to the program already," the milestone "deadline gave structure and focus." Likewise, the energy savings incentive was a motivator that gave participants "more incentive to save," but for the majority of participants, the cost savings from utility bills far outweighed the energy savings incentive. Some participants had trouble determining why they got the amount they did; others felt that they would have gotten more if the measurement period had been different. IEI participants also indicated that the incentive was not as much of a motivator as the potential energy savings, but that the possibility of delivering an incentive check sometimes caught the attention of their management team. It should be noted that IEI participants did not receive milestone incentives.

2.4.11 Technical Service Provider

Triple Point's representatives received universally high marks from every participant, including the one who dropped out. For several, they were one of the most positive aspects of the program. This trend continues from the IEI where participants also praised Triple Point for their support and knowledge. One CORE participant gave their level of service and support a "10 out of 5."

Participants specifically commented on Triple Point's:

- Technical skill: They "understood their subject matter thoroughly" and their "quality level was good."
- High-quality service and support: They were "engaging, professional, prompt;" were "supportive, responsive;" they "went out of their way," and were "dedicated" and "constantly engaged." Several participants noted that if they had a question or problem, Triple Point would respond right away.
- Good management of the pilot: They were "organized" and "had a good plan."
- Straightforwardness about what participants could expect: "Everything they told us was true and we met our goals."

2.4.12 Opportunity for Program Expansion

Overall, the participants who completed the first year of CORE activities believed that the value received from the CORE program outweighed the cost of participating in terms of time and effort. Every single participant said that they would recommend CORE to other firms, and some had already started advertising CORE among peer companies. This trend was also observed in the IEI where some cohort two participants were recommended by satisfied cohort one participants. CORE participants believed that other firms could benefit from CORE, not only from an energy savings perspective but also from an educational perspective. One participant summed it up neatly: "There is a lot of potential out there. People don't know…that something as simple as fixing a hose for $5 can save you thousands of dollars a year."

2.5 Program Evaluation Findings and Recommendations

2.5.1 Findings

- **<u>Program Management Findings:</u>**
    - Thus far, the pilot program has shown that medium-sized industrial customers are just as capable of being successful at SEM as larger companies.
    - Although employee engagement of CORE in general was not as strong as in IEI, one major advantage of working with smaller companies is that Energy Trust found it easier to engage executive sponsors because they are more involved in the day-to-day business of the firm.
    - Energy Trust was very impressed with Triple Point's work on the CORE pilot.
    - Energy Trust noted that the program savings estimates were slightly higher than they expected, but they have had a difficult time substantiating the savings.
    - Energy Trust supported expansion of the CORE initiative, noting that it is a good complement to IEI and that it allows them to reach a different market segment of smaller customers.

- **<u>PDC Interview Findings:</u>**

- In general, PDCs believed that they are well-positioned to leverage their existing relationships with customers to identify candidates and effectively recruit for the pilot program.
- PDCs believed that the CORE pilot would increase their customers' awareness of and interest in energy efficiency when initiating capital projects, but some were concerned that participation in CORE may cause customers to divert resources away from capital projects already in progress.
- In terms of expanding the CORE program, PDCs thought that about a third of their active customers would be good candidates for CORE.

- **Triple Point Interview Findings:**
  - Triple Point spent more time and had more difficulty than they anticipated in training participants to use the MT&R and identifying production variables (some sites lacked detailed production data, requiring additional work to generate this MT&R input). However, they recognized the need to balance keeping the MT&R simple for participants and gathering enough data to quantify program savings. Triple Point observed that a pre-defined measurement period was not appropriate for smaller production facilities because of the variation in production schedules and increments of the energy and production data.
  - PDCs have the potential to be a valuable resource, particularly in activities that can benefit from their expertise, such as on-site energy scans. PDCs can also assist in recruiting by drawing on their existing networks.

- **Participant Interview Findings (Including Drop-out):**
  - Most participants felt that they had received value from their participation in CORE, and most anticipated that they would continue with many of the energy-saving practices they had learned through CORE. Additionally, all of the participants who completed the pilot said that they would recommend CORE to other companies in the future—indeed, some already had. This trend was also observed with the IEI.
  - Participants observed that levels of participant engagement with CORE principles were related to the effectiveness of the energy team, the technical skill level of team members, the level of engagement with other employees, and the level of support from management. The IEI reported similar findings, especially with regard to management support.
  - Many participants felt that the MT&R model was not easy to use, though they believed that it did provide them with useful information. Some participants had difficulty generating or accessing MT&R inputs, such as production and utility data. A few incurred a cost to obtain utility data electronically.
  - Some participants were able to leverage the information provided by the MT&R to demonstrate the effect of the energy savings on the firm's bottom line to their management team.
  - Participants generally did not see the benefit of certain energy planning activities such as developing an energy policy or energy management plan.
  - Even though energy savings from capital projects were not included in CORE savings, and although some PDCs expressed concern that participation in CORE may cause customers to divert resources away from capital projects, participants reported that CORE enhanced their ability to initiate and follow through with capital projects. Specifically, participants reported that during the course of the project, techniques they learned through CORE either helped with the decision-making process or helped evaluate the effect of the capital investment on energy.

- Most participants had a positive existing relationship with their PDC and expressed a willingness to work with them on CORE-related projects. However, others were uncertain about the PDCs' role because they did not have an existing relationship with their PDC.
- Participants found the peer-to-peer networking activities to be one of the most beneficial aspects of the program. This was also a key finding for the IEI.
- Participants were critical of activities during group meetings that they felt did not use their time efficiently (such as filling out worksheets individually, which they could have done on their own time; and discussion of topics related to sustainability but not specific to CORE's focus on electricity or natural gas savings). By the same token, participants had very positive feedback about the on-site meetings because they got a lot of value out of the meetings and felt their time was spent effectively.
- Similar to the IEI, CORE participants gave universally positive feedback to the representatives from Triple Point.

2.5.2 Recommendations

Enhancing the Usability of the MT&R Model:

- Make the MT&R interface more user-friendly and conduct more targeted training on its use, particularly for customers with limited software ability. Training should include both the concepts of regression analysis and the use of Excel-based spreadsheets.
- Provide tools to assist participants with translating MT&R findings into compelling progress reports to their management teams. This could include templates or examples of reports or presentations that past participants have used successfully.

Promoting PDC Integration:

- Draw on the PDCs' experience and networks by integrating them more into CORE elements and processes that benefit from their expertise, such as energy scans and recruitment.
- Highlight mutual benefits of CORE to PDCs. For example, PDCs get credit for capital projects even if they were implemented because of CORE, and customers reported that CORE enhanced their ability to initiate and follow through with capital projects.
- For participants who have not had any contact with their PDC, Energy Trust should leverage the CORE as an opportunity to establish this relationship.

Maintaining or Increasing Participant Engagement:

- Sharpen the focus of the group meetings to use the time for activities that benefit most from having the entire group present, such as directed peer-to-peer interaction.
- Develop activities that make the benefit of participant activities that are strategic in nature more apparent to participants. For example, help participants understand the benefits of developing an energy policy and/or energy management plan.
- Cover the more individualized topics and basic technical coaching at on-site meetings.

Expanding Networking and Recruiting Efforts:

- Build upon existing peer-to-peer networking activities to make networking a more structured element of the program.
- Circulate a cohort roster to help participants communicate with each other outside of the pilot.
- Cultivate new networks among current and future participants, in order to leverage the goodwill generated by CORE participants to recruit effectively for future CORE cohorts.

- Promote the CORE concept and successes at industry events throughout the year to generate interest and build a waiting list of potential participants for future CORE cohorts.

3. Results of the MT&R Review

This section presents findings from the review of the MT&R tools and reports. Per the CORE evaluation plan, Navigant reviewed the MT&R tools and reports from both an engineering and a statistical perspective as a first step in verification of energy savings. Navigant's goals in this review were to determine the state of the participants' energy tracking and reporting capabilities, to understand the level of statistical rigor of the regression analysis, and to identify methods to increase the MT&R's accuracy at predicting participant energy savings. These goals include determining whether:

- Participants have implemented an MT&R system and are actively using it to track energy consumption and savings.
- The reports and energy information make sense, are understandable to the customers and are useful and actionable.
- The reports contain enough information to reasonably use them for tracking energy consumption and savings.
- The assumptions and models used to track energy usage and savings are reasonable.
- A solid baseline was established that energy savings can be measured against.
- O&M savings can be separated out from capital project savings and are reasonable given the activities recorded in customers' activity logs.
- Annual energy savings projections from SEM activities are reasonable and are in line with savings calculated in MT&R workbooks.
- SEM energy savings calculated in MT&R workbooks can be accurately verified after one year.

This work was also a preliminary step to help determine the best methods for evaluating savings next year.

During the pilot, CORE participants tracked their energy use intensity, relative to production, using an MT&R model developed by Triple Point for their use. The model uses a regression analysis to predict the savings due to the behavioral measures or O&M changes implemented through SEM, independent of other factors that may affect energy use, such as weather. While the model may facilitate the identification and pursuit of capital improvements, as discussed in section 2.4.6, the pilot does not incentivize or claim these savings (this is done through the PE program's other tracks). The ex-ante capital measure savings estimates are deducted from the MT&R estimates for purposes of estimating CORE savings and calculating incentives.

The MT&R tool is used by the participants to track and report their energy use intensity and energy savings over time. Triple Point uses the MT&R tool to estimate each participant's first year energy savings and CORE incentive. Navigant's findings from the statistical review of the MT&R tool apply to use of the tool specifically and to billing analysis in this application more generally.

3.1 Findings from the Review of Participants' MT&R Tools

Navigant reviewed the MT&R tools and reports of all participants who reported energy savings (eight of the nine) to determine the state of participants' energy tracking and reporting capabilities. Navigant observations from the engineering review of the MT&R systems with respect to the research questions are detailed below; each observation follows the research objective, which is provided in bold italics:

- ***Participants have implemented an MT&R system and are actively using it to track energy consumption and savings.***
  Navigant's engineering review of the provided MT&R reports confirms that all the participants have implemented an MT&R system. The MT&R spreadsheets also confirm that the participants have been actively tracking their energy consumption and savings. Most of the MT&R tools (spreadsheets) have monthly energy consumption and production data on monthly basis from 2011 through summer 2013.

- ***The reports and energy information make sense, are understandable to the customers and are useful and actionable.***
  The overall report and energy information are clear and easy for analysts with the appropriate training to navigate and understand. The method used for calculating energy savings is in line with IPMVP[2] option C. However, many participants found the MT&R workbooks complex to use. Section 2.4.5.1discusses participant feedback on the MT&R model.

- ***The reports contain enough information to reasonably use them for tracking energy consumption and savings.***
  For the calculation method used (regression analysis of energy consumption with statistically significant individual variables), the reports contain enough information to reasonably use them for tracking energy consumption and savings.

- ***The assumptions and models used to track energy usage and savings are reasonable.***
  This varies on a case by case basis. For most of the projects, the assumptions and models are reasonable. From an evaluation perspective, in cases where only one measure is implemented under the CORE initiative, IPMVP option B is a preferred option to evaluate energy savings if metering can be installed on the affected equipment. Cases like this are an excellent opportunity to compare direct savings calculations to the MT&R model.

- ***A solid baseline was established that energy savings can be measured against.***
  The MT&R tools (spreadsheets) establish solid baselines for facility level energy consumption. No baselines were established at the equipment level. Facility level baselines are reasonable to calculate facility level energy savings when the savings are large enough (typically more than 10 percent of baseline energy consumption) and there is a high degree of interaction between installed ECMs or between ECMs and the rest of the building, or the isolation and measurement of individual ECMs impractical[3].

- ***O&M savings can be separated out from capital project savings and are reasonable given the activities recorded in customers' activity logs.***
  The capital savings can be separated out from total energy savings calculated through the MT&R workbooks to get a reasonable estimate of O&M savings. The capital projects referred to here are the projects these sites have completed under the Production Efficiency program, receiving separate incentives.

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[2] International Performance Measurement and Verification Protocol (IPMVP) is the leading international standard in M&V protocols. It provides an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects in commercial and industrial facilities. It may also be used by facility operators to assess and improve facility performance.
[3] IPMVP, page 28 (http://www.nrel.gov/docs/fy02osti/31505.pdf)

- ***Annual energy savings projections from SEM activities are reasonable and are in line with savings calculated in MT&R workbooks.***
  Navigant attempted to assess this in preparation for verification of savings next fall to determine what information about participant activities was being collected and available. However, with the current amount of data available in the MT&R reports and equipment inventories, it is not possible to calculate all energy savings through engineering algorithms on a measure level basis. It may be possible to calculate measure-level annual energy savings through engineering estimates after site visits, depending on the amount of data available.

- ***SEM energy savings calculated in MT&R workbooks can be accurately verified after one year.***
  This will depend on the upkeep of the data included in the MT&R workbooks. It will not be possible to answer this question conclusively until we can review the MT&R after a year has passed or after the site visits are complete.

To summarize the findings of the engineering review, the best method for evaluating projects varies on a case-by-case basis. Most of these projects involve multiple measures with high correlation between them. Against this criterion, IPMVP option C, whole facility energy analysis, is applicable. The important thing is that the expected or estimated energy savings should be large enough (typically more than 10 percent of baseline facility energy consumption) to filter out the random or unrelated energy variations that are normally found at a whole facility meter.

Out of eight MT&R files reviewed by Navigant, seven projects qualify for evaluation using IPMVP option C, i.e. whole building analysis, on the basis of complexity of measures and high interactions among the measures and also between the facility and measures. PE5404, which involved only one measure—boiler capacity turndown—would be better evaluated using IPMVP option B, retrofit isolation.

Of the seven projects that qualified for IPMVP option C, only three projects have predicted energy savings close to or more than 10 percent. The other projects have estimated energy savings less than 10 percent of total baseline energy consumption. For these projects, although IPMVP option C is not preferable, it is necessary because other methods of estimating facility savings may be infeasible in the context of this program (for example, quantifying energy savings for each measure using engineering algorithms will be impractical due to the amount of data required, and many behavioral measures may be difficult to quantify using engineering algorithms). If hourly energy consumption data and at least daily production data are available, evaluation using the facility level billing analysis described in IPMVP option C could be done with more accuracy.

3.2 Findings from the Statistical Review of MT&R Tools

Navigant conducted a detailed case study of a sample of four participant MT&R tools to understand the level of statistical rigor and to determine if there are methods that can adopted to increase the MT&R's accuracy at predicting the participant energy savings. With respect to the detailed case studies, Navigant was able to successfully reproduce the results reported with the data provided in the MT&R tools and reports. Detailed numerical results of Navigant's MT&R review can be found in Appendix A. Additionally, Navigant conducted a standardized review process with all four case studies to examine robustness of methods and results. The results are summarized in Table 3.1.

Table 3.1 Statistical Review Process Summary

	PE5405	PE5404	PE5399	PE5411
Determinants of inclusion in the analysis	Second largest gas savings; did not use production data	Largest gas savings	Inter-mediate level of electric savings	Largest electric savings
Does the basic modeling of the relationship between the dependent variable and the specified explanatory variables conform to industry standard?	Yes	Yes	Yes	Yes
Is the treatment of outliers satisfactory?	Yes	Yes	Yes	Yes
Are standard errors for savings estimated?	No	No	No	No
Are results in report reproducible from data provided?	Yes	Yes	Yes	Yes
Are estimates of savings insensitive to reasonable changes in the model specification (alternative models generate savings within 10 percent of the estimate generated by the MTR model)?	No	No	Yes	Yes

3.2.1 Detailed Findings from the Statistical Review of MT&R Tools

The following paragraphs discuss specific findings in relation to the MT&R Tools and a billing analysis evaluation approach in the context of the CORE.

3.2.1.1 Pre/Post Approach to Estimating Savings

The statistical approach to estimate savings relies on regression analysis to compare energy use before and after program activities are undertaken—often called the "pre/post approach"—while controlling for observable variables such as weather and production output. In this approach, the pre-program period is the source of the baseline energy use against which program savings are measured. One significant limitation of the pre/post approach is that unobservable factors that change systematically over time can bias savings estimates, as they are absorbed by the estimate of program savings. However, Navigant could not identify a reasonable alternative to this approach to estimate savings of individual customers that would be appropriate in the CORE program. For instance, a matched control approach in which the concurrent energy use of matching customers during the measurement period provides the baseline is not feasible for customers of this size, because it is virtually impossible to find matching customers within the jurisdiction of the program implementer whose energy use is consistently similar enough to a program customer during the pre-program period to generate with any reasonable statistical confidence the effect of the program during the measurement period. Therefore, Navigant believes the pre/post approach is the best option for this program.

3.2.1.2 Variables Used in the Regression Analysis

Theory should drive the selection of model variables. The current MT&R reports use a step-wise regression approach to develop a final model for estimating savings. The main problems with stepwise regression include possible bias in parameter estimation, inconsistencies among model selection algorithms, and an inappropriate focus or reliance on a single best model, where data are often inadequate to justify such confidence.[4] Generally the econometric literature favors an alternative approach in which all relevant variables are included in the analysis. So, for instance, if a weather variable is hypothesized to influence energy use, it should be included in the regression model, regardless of whether its effect is statistically significant. The logic for this approach is that the cost of including irrelevant variables in the analysis (inefficient estimates) is lower than the cost of mistakenly excluding relevant variables (bias). Navigant recommends this alternative approach to improve confidence in the model.

A past evaluation of the IEI raised a similar concern. This report noted that independent MT&R variables appeared to have been considered but dropped. It recommended more transparency in the process used to select and eliminate independent variables.

There may be instances where it is not known which production variables are the best indicators of energy use. It is still Navigant's top recommendation to, if possible, include all of the possible production variables, despite the likelihood of multicollinearity, as all production processes contribute to energy use (in other words, they should be in the model because they have an effect on energy use), and the statistical cost of this multicollinearity is lower precision in the estimate of measure savings, whereas the cost of omitting variables is to potentially bias the estimate of measure savings. In addition, if some production variables are omitted, and future measures are taken on those variables, then there could be a biased estimate of savings.

Understanding that a parsimonious specification has the advantage of reducing the burden on the participant, a reasonable alternative is to select the best several production variables by asking the participant (a) which ones provide the best index for the effect of production on energy use, and, if possible, (b) which ones are most likely to be correlated with measure savings. To avoid biased estimates of measure savings, these are the variables that are most important to include in the model. Another alternative is to compare the out-of-sample forecasts (or "backcasts") of several models involving different sets of production variables, to see if any one stands out as superior to the others. If none stands out, then the preferred model would be the one that imposes the lowest burden on the participant.

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[4] References:

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- Steyerberg, E.W., Eijkemans, M.J.C. & Habbema, J.D.F. (1999) Stepwise selection in small data sets: a simulation study of bias in logistic regression analysis. Journal of Clinical Epidemiology, 52, 935–942.

3.2.1.3 Timing of Regression Model Development

As is currently being conducted, it is always best to estimate the regression model *before* the start of the measurement period, to avoid the temptation to adjust the model to obtain a more favorable estimate of savings. Ideally the model would be estimated for the baseline period and then, before the start of the measurement period, sent to Energy Trust or a third-party evaluator for additional verification. Adjusting the regression model after the measurement period begins would require a strong justification. Navigant recommends this approach to strengthen the defensibility of the regression model.

3.2.1.4 Standard Errors

Standard errors on the savings estimates were not presented in the MT&R reports. Navigant recommends reporting of standard errors in the future to promote effective evaluation of savings estimates. Standard errors should be developed and used for the purposes of understanding the level of statistical confidence of the savings estimates by Triple Point and Energy Trust, not as a component of the participant's MT&R tool. As discussed in Appendix A, Navigant estimated the standard errors on savings for four reports, and generally they are large, though 90% confidence bounds do not cross zero. The results of the error analysis are summarized in**Error! Reference source not found.** Table 3.2.

Table 3.2 Results of Statistical Review Including Estimated Errors

Participant	Lower 90% Bound	Savings Estimated by Navigant	Upper 90% Bound	Estimated Error
Electricity (kWh)				
PE5399	54,056	**93,059**	130,261	23,638
PE5411*	188,888	**267,165**	345,442	47,440
Natural Gas (therms)				
PE5405	1,327	**2,151**	2,974	499
PE5404	853	**9,222**	17,591	5,072

*Total savings including capital projects and O&M measures. For a breakdown, see Appendix A.

Due to the relatively large errors, statistical confidence in savings estimates is low. Standard errors can be reduced by improving the data intervals, where possible. For example, if daily data were available, standard errors on savings would be smaller –and consequently confidence in savings estimates higher. However, Navigant realizes that interval data may not be easily attained for customers of this size and collecting these data may be burdensome for some customers. Navigant recommends that daily data be used where possible, balancing the improvement in statistical confidence with participant burden. Energy Trust may be able to assist customers in gathering some data; for instance, helping customers purchase interval data from their utility (see section 2.4.5.1).

3.2.1.5 O&M Savings vs. Capital Project Savings

For projects where companies have capital project investments outside of CORE, savings from these projects are separated out from the savings from changes in O&M activities. Navigant reviewed the MT&R report for participant PE5411, which had two capital projects conducted in 2012, which is outside of the baseline period and therefore their savings are not included in the model. Savings from these

projects were subtracted from the measurement period savings. This method seems appropriate to net out the capital projects' savings from the O&M savings. In the case of participant PE5411, the capital projects' annual savings totaled 222,833 kWh, and were netted out of the total estimated annual savings from O&M activities of 1,059,948 kWh.

3.2.1.6 Time Periods

Typically, one year of baseline data is preferred for forecasting a year of savings, due to seasonality in energy use. For the four reports examined by Navigant, the baseline periods exceeded this criterion:

- PE5399: 25 months
- PE5405: 25 months
- PE5404: 19 months
- PE5411: 19 months

The accuracy of the baseline model can be expected to deteriorate over time. As both program and non-program interventions are added, they can be included as variables in the model, with the model updated to reflect these observable changes. So, for instance, if new capital equipment is added to a facility, a variable can be included in the model to capture its effect on energy use.

If the measurement period is shorter than one year, the savings estimate may not be especially good as an annual estimate, due to unobserved seasonal effects. If the measurement period is greater than one year, there arises the possibility that the baseline model deteriorates as a good counterfactual in the period after the initial 12 months due to unobserved time-correlated effects (such as installation of capital for which relevant data are not supplied). Past evaluations of the IEI program have noted these concerns as well.

All four MT&R reports reviewed by Navigant involved measurement periods well short of one full year:

- PE5399: 25 (weeks)
- PE5405: 3 (months)
- PE5404: 9 (months)
- PE5411: 3 (months)

Observations for one full year of measurement would generate greater confidence in the savings estimates. However, Navigant realizes that it may not be practical to allow for a full year of measurement.

3.2.2 Strengths and Limitations of Regression Analysis

Overall, the Navigant team tentatively believes that, from a statistical perspective, the regression analysis currently being conducted is an effective method for estimating energy savings of CORE, with some caveats. Advantages of the approach are that it is relatively simple to conduct an evaluation of claimed energy savings given the available data. Given the program budget, this simplified approach may be preferable. Additionally, the approach was effective in evaluating a unique aspect of the CORE pilot – the need to separate out capital savings from O&M savings.

However, there are several limitations to the approach specific for this program. Some customers do not have access to energy usage data at short intervals, such as daily data; this is especially true for the smaller customers in the CORE. Some CORE participants only had monthly data available. This can

reduce the statistical confidence in savings estimates. We observed that the limits of error on the savings were a significant proportion of the savings themselves—up to 55 percent of the savings in one case—because data at daily intervals were not available. Additionally, the verification period is limited to a few months, while a full year would generate greater confidence in the savings estimates. We recommend that Energy Trust explore options to mitigate these factors without excessively burdening participants with additional data gathering requirements.

3.3 Consideration of Alternative Methods for Evaluating Impacts

As part of Navigant's investigation into appropriate evaluation methods, we assessed whether alternative approaches to estimating energy savings could be utilized to provide greater confidence in the energy savings estimates. One alternative, an engineering analysis of individual measures, may be a useful complement to a billing analysis in cases where the measures do not fall clearly within the defined parameters of IPMVP option C.

As part of the review of participant MT&R tools and reports, Navigant attempted to identify engineering algorithms which would aid in evaluating the energy savings achieved through each measure. Overall, Navigant found that there are not enough data in the project files at this point to evaluate the measures using engineering algorithms. This finding was not unexpected, as collecting detailed data about each measure was not within the scope of the CORE pilot. We also acknowledge that the time and paperwork burden is one of the more frequently cited barriers by participants, so the need for data to support program evaluation needs to be considered against the potential drawbacks. Additional requirements should be added only if they provide a clear benefit to the participant or can be made very easily.

Suggestions for facilitating a measure-level engineering review, with limited burden to the participants, Energy Trust, and the program implementer, could include:

- Gathering details only for measures which would contribute significantly towards the energy savings and for major energy-consuming equipment that would be significantly affected by the implemented measures. Frequently, when about 10 measures are implemented, two or three of the measures contribute 70 to 80 percent of the energy savings.
- Encouraging the implementation contractor or site personnel to collect key details about affected equipment as part of the existing CORE activities, such as equipment size or capacity, operating schedules, and set points, both in the baseline and efficient case. Simple details coupled with standard approximations or estimations would provide a sanity check for the claimed energy savings. (For example: In general, for industrial facilities, repairing air leaks measure saves about five to 10 percent of the annual energy consumption by the compressor. With minimal details on compressor capacity and schedule, the energy savings for this measure can be estimated.)
- Collecting key equipment information during site visits that are already planned for year 2 evaluation activities.

As the evaluation progresses, other factors may arise that suggest further advantages or disadvantages of the various evaluation methods. Throughout the evaluation, the evaluation team will investigate opportunities to identify the best methods for evaluating the impacts of CORE, and, more generally, SEM programs for small to medium customers, whether by adapting existing approaches or developing alternative or complementary methods.

3.4 Evaluation Review Findings and Recommendations

3.4.1 Findings

MT&R Review Findings:

- Participants have implemented MT&R systems and are actively using them to track energy consumption and savings. Generally, participants find that the reports and energy information make sense, are understandable to the customers and are useful and actionable.
- The reports contain enough information to reasonably use them for tracking energy consumption and savings, and the assumptions and models used to track energy usage and savings are reasonable.
- The reports establish a solid baseline for facility-level energy consumption against which energy savings can be measured. No baselines were established at the equipment level.
- Although IPMVP option C is not preferable for evaluating energy savings for those sites with predicted energy savings less than 10 percent, it is a necessary approach because other methods of estimating facility savings may be infeasible in the context of this program. If hourly energy consumption data and at least daily production data are available, evaluation using the facility level billing analysis described in IPMVP option C could be done with more accuracy.

Statistical Review Findings:

- Using pre/post statistical models, such as those used in the MT&R reports, is the best available practice for the CORE pilot. However, there exists a strong potential for omitted variable bias, due to temporal correlation of observable variables with the measurement period.
- Stepwise regression, where the choice of variables is carried out by a procedure of examining significance, is generally not preferred due to possible bias in parameter estimation, inconsistencies among model selection algorithms, and overreliance on a single best model where data are often inadequate to justify such confidence. Generally the econometric literature favors an alternative approach in which all relevant variables are included in the analysis.
- Standard errors[5] on savings estimates were not provided in the MT&R and have been estimated for purposes of this report. The estimated standard errors are generally large, though the 90% confidence bounds do not cross zero. Consequently, statistical confidence in the savings estimates is low. However, if daily usage data were available, it is likely that the standard errors would be smaller, and the confidence in savings estimates higher.

3.4.2 Recommendations

Recommendations for enhancing statistical confidence in the model include the following:

- Continue current practice of estimating baseline regression models at the end of the baseline period and sending them to Energy Trust (or a third-party evaluator) before the measurement period begins. The model should not be revised during any period of time in which savings are being estimated. However, a new baseline model should be developed any time changes in production or other factors that affect energy use occur. Related to this, current engineering estimates of the effects of activities during the measurement period can be verified in future estimates of the baseline model.

[5] Standard error is the standard deviation of the sampling distribution of a statistic.

- Seek to track production and weather variables for all sites, to provide the opportunity to examine the sensitivity of savings estimates to model specifications.
- Standardize the treatment of weather in models. It is recommended to include AVE TEMP and AVE TEMP^2. To the extent a weather variable deviates from the standard, an explanation should be provided.
- Provide standard errors on savings estimates for Triple Point and Energy Trust use. Standard errors provide a measure of precision and are the basis for confidence intervals.
- Use the most granular time period available, down to the day when possible. Increases in granularity are likely to reduce standard errors.
- Ideally, for energy use which is seasonally driven, baseline and measurement periods are one full year each. Otherwise there is some risk that unobserved seasonal effects are biasing savings estimates.

Appendix A. Detailed MT&R Results for Four Analyzed Participants

Navigant reviewed the MT&R results for four participants in detail: PE5399, PE5405, PE5404, and PE5411. The following sections contain detailed results for each participant.

A.1 PE5399 (Electric Model)

The MT&R report for participant PE5399 includes documentation and estimation of savings for 2 buildings at the facility.

A.1.1 PE5399 MT&R Model Specification

Model:
Electricity (in kWh) = b_0 + b_1(1015 - TRK - Large Winch Mfg (LGWN) - Quantity) + b_2(1025 - TRK - Fabrication Mfg (TFAB) - Quantity) + b_3(Holiday Weeks) + b_4(Decommissioning of Large Robotic Welder),

where,

- "1015 - TRK - Large Winch Mfg (LGWN) - Quantity" is a production variable indicating the quantity of large winch units produced.
- "1025 - TRK - Fabrication Mfg (TFAB) - Quantity" is a production variable indicating the number of winch mounting kits produced.
- "Holiday Weeks" is avariable indicating how many days the plant is closed in a given week.
- "Decommissioning of Large Robotic Welder" is a binary variable indicating whether a large robotic welder was not in service.

A.1.2 Comments on the MTR Model, and Model Variants Examined

<u>Comments on the report presentation and model:</u>

- The Intervention period was listed in the report as, 7/30/2013 – 7/28/2013. However, since the Baseline period ends 7/29/2012 and the Measurement period begins 2/4/2013, it is believed the Intervention period is actually 7/30/2012 – 2/3/2013.
- The variable "Holiday Weeks" was found in the supporting Excel file to actually consist of the number of days that the plant is closed.
- Graphs: Closer attention should be given to the scaling and presentation of graphs. For instance:
    - In Figure 2.5e the cumulative sum of residuals always lies between about -25,000 and +25,000, and yet the graph is scaled to -200,000 and +200,000.
    - The relationship in Figure 2.3b is clearly heavily influenced by the several outliers for which the control variable is zero. That this is the case is supported in the regression analysis itself. Whereas the slope of the line in Figure 2.3b is about 12, the coefficient in the regression is much lower, 6.82.
    - The scaling in Figure 3.2b lies in the interval [0, 100,000] in both dimensions, even though all but about 6 observations appear to be in the interval [60,000, 100,000] in both dimensions.
    - Also with respect to Figure 3.2b, the blue-dashed line and the red-dashed lines are not defined. The accompanying narrative should note that the solid red line is in fact the 45-degree line from the origin, i.e., a line from the origin with a slope of 1.

Investigation of the sensitivity of the savings estimates to model specification:

A significant concern in any regression analysis is whether the model is misspecified and therefore generates biased estimates of savings. Although one cannot assert that estimates of savings are free of model misspecification bias, whether the issue is an important concern can be addressed by comparing savings estimates across different reasonable model specifications, and using different subsets of the baseline data in the estimation of models. If savings estimates are insensitive to these estimation alternatives, model misspecification bias is not an important concern. Navigant examined this issue in two ways:

- Estimating the model on a sub-period of the baseline: When there are sufficient data, a good sensitivity check on the model is to estimate the model on a portion of the baseline period. Navigant estimated the model from the start of the baseline period through the end of the decommissioning period. See **Error! Reference source not found.** below for results.

- Inclusion/exclusion of observable variables. A good sensitivity check on the savings estimate is to estimate several alternative reasonable specifications of the model. For this purpose Navigant estimated models that included weekly mean temperature and squared weekly mean temperature as control variables.

Table A.1**Error! Reference source not found.** displays the results of various model specifications. The first model is the baseline model –the model presented in the MT&R report (hereafter, the MT&R model). T-statistics are in parentheses. Concerning the model variants:

- The first variant in the table is structurally the same as the MT&R model, but estimated on the subset of baseline data through the end of the decommissioning period. Coefficient estimates depart slightly from the MT&R model, and all are still statistically significant at any standard confidence level.
- The second variant adds average weekly temperature to the MT&R model. Again, coefficient estimates are slightly different than in the MT&R model, and all original variables remain statistically significant, while the new average temperature variable is not.
- The third variant adds average weekly temperature and squared average weekly temperature to the MT&R model, on the grounds that energy use is typically nonlinear in temperature, falling and then rising. The model intercept changes significantly, while the other terms change slightly. Coefficient estimates for the temperature variables are both statistically significant.

Table A.1: PE5399 Model Variations (Coefficients stated, with T-statistics reported in parentheses)

	Intercept	Large Winches	Winch Kits	Holidays	Decommis-sioning	Ave Temp	Ave Temp^2
MT&R Report	59,310.45 (22.50)	6.82 (8.82)	1.99 (4.04)	-19,651.43 (-9.34)	-4,111.11 (-4.49)	-	-
Model Variant 1: Estimated on a subset of the baseline data (through the end of the Decommissioning period)	59,282.97 (18.24)	7.03 (6.69)	1.90 (2.79)	-19,580.38 (-8.03)	-4,395.04 (-3.42)	-	-
Variant 2: Ave Temp added	56,804.10 (13.36)	6.98 (8.68)	2.03 (4.10)	-18,942.02 (-8.20)	-4,080.53 (-4.44)	34.25 (0.75)	-
Variant 3: Ave Temp and Ave Temp^2 added	94,648.92 (6.34)	6.84 (8.73)	1.72 (3.45)	-21,179.14 (-8.82)	-4,223.74 (-4.72)	-1,330.47 (-2.56)	12.35 (2.64)

A.1.3 PE5399 Savings Analysis

The MT&R report estimates savings of 93,059 kWh in the measurement period. Total energy use in the measurement period was 1,953,082 kWh, and so savings is 4.5 percent of what energy usage would have been without the savings.

The first model variant estimates savings of 100,333 kWh, which is 108 percent of the MT&R result. The corresponding estimate of the Intensity Improvement value increases from 4.57 to 4.93.

The third model variant generates savings of 96,636 kWh, which is 104 percent of the MT&R result. The corresponding estimate of the Intensity Improvement value increases from 4.57 to 4.75.

Overall, Navigant does not find that estimated savings are unduly sensitive to the model specification.

The reported estimate of savings is statistically significant at the 90% confidence level. The standard error on cumulative savings over the measurement period is 23,638 kWh, and so the 90% confidence bounds on savings in kWh is [54,056, 130,261].

A.2 PE5405 (Gas Model)

A.2.1 PE5405 MT&R Model Specification

Model:
Natural Gas (in therms) = b_0 + b_1(Utility Mth Avg HDD) + b_2(Summer) + b_3(Coldest Months) ,

where,

- "Utility Mth Avg HDD" is defined as the difference of 55 and the daily temperature summed across the days within each month's natural gas billing period.
- "Summer" is a binary variable indicating summer months (June through September) in which very little or no heating degree days occurred.
- "Coldest Months" is a binary variable indicating the coldest month of the year (Dec- Jan).

A.2.2 Comments on the MTR Model, and Model Variants Examined

Comments on the report presentation and model:

- Monthly Data: The PE5405 model used monthly data, presumably due to monthly readings of gas meters. Savings estimates would be statistically more precise if weekly data were available.

- Weather Variables: A critical issue in the model is the effect of weather on energy use.
    - In the C&I sector the effect of temperature on energy use is often best modeled using a quadratic expression in temperature (temperature and squared temperature), to allow for a non-linear relationship with minimal structure.
    - The report does not state the rationale for using 55 degrees as a baseline for the HDD variable. Figure 2.3b indicates a strong positive relationship between energy use and HDD down to 0 HDD, with the observations at zero lying below the fitted line, indicating the model could be improved by using a base for HDD lower than 55.
    - The Coldest Month variable does not seem to be properly defined. While December 2011 is indicated in the MT&R report to be the coldest month of 2011, January of 2011 was colder. Navigant could not develop a reasonable explanation for a binary variable applying only to the consecutive months of December 2011 and January 2012. If the objective is to allow for the nonlinear effect of temperature on gas use, an obvious option is to replace HDD with a nonlinear expression of temperature. An alternative is to use a dummy variable for months when HDD above a certain threshold, such as 400.
- Production Variables: Production variables were included in the electric model (mold pieces, stamp pieces, and plates), but were not added to the gas analysis. Ideally these variables would be provided for analysis of both fuel types, to allow for sensitivity analysis.
- Graphs: Closer attention should be given to the scaling and presentation of graphs. For instance:
    - Concerning Figure 2.3b: The many observations at zero, and the positive correlation above zero, suggest that either (a) HDD should be rescaled to a base value less than 55, or (b) a nonlinear function of temperature would be a better control variable in the regression.
    - In Figure 2.5c the blue-dashed line and the red-dashed lines are not defined. The accompanying narrative should note that the solid red line is in fact the 45-degree line from the origin, i.e., a line from the origin with a slope of 1.
    - In Figure 2.5e the cumulative sum of residuals always lies between about -500 and +500, and yet the graph is scaled to -3,000 and +3,000.

Investigation of the sensitivity of the savings estimates to model specification:

A significant concern in any regression analysis is whether the model is misspecified and therefore generates biased estimates of savings. Although one cannot assert that estimates of savings are free of model misspecification bias, whether the issue is an important concern can be addressed by comparing

savings estimates across different reasonable model specifications, and using different subsets of the baseline data in the estimation of models. If savings estimates are insensitive to these estimation alternatives, model misspecification bias is not an important concern.

Table A.2**Error! Reference source not found.** displays the results of various model specifications. The first model is the baseline model –the model presented in the MT&R report (hereafter, the MT&R model). T-statistics are in parentheses. About the model variants:

- The first model variant adds HDD^2, and omits the other weather variables (Summer and Coldest Month). The coefficient is negative and statistically significant and combined with the linear term indicates that in the range of the data, gas use increases with HDD at a slowly decreasing rate.
- The second model variant adds to the first variant by including a dummy variable for the months where HDD is greater than 400. This variable is not statistically significant.
- The third variant adds to the first variant by including the Summer indicator.
- The fourth variant adds to the third variant by including the HDD>400 indicator.

Based on coefficient values and the statistical significance of the added variables, it does not appear that the energy use predicted by these models is much different than that predicted by the MT&R model.

Table A.2: PE5405 Model Variations (Coefficients stated, with T-statistics reported in parentheses)

	Intercept	HDD	HDD^2	Summer	Coldest Month of Year	HDD>400
MT&R Report	2,405.06 (17.56)	14.43 (29.9)	-	-1,630.70 (-9.76)	1,339.55 (5.53)	
Model Variant 1: HDD^2	1,111.60 (5.82)	24.21 (8.52)	-0.01 (-2.15)	-	-	-
Model Variant 2: HDD^2 and HDD>400	1,108.17 (5.69)	24.77 (7.81)	-0.02 (-1.78)	-	-	352.40 (0.43)
Model Variant 3: HDD^2 and Summer	2,371.60 (8.24)	14.12 (4.97)	0.003 (0.53)	-1,597.10 (-4.94)	-	-
Model Variant 4: HDD^2, Summer and HDD>400	2,364.94 (8.01)	14.41 (4.66)	0.002 (0.22)	-1,590.57 (-4.80)	-	154.76 (0.27)

A.2.3 PE5405 Savings Analysis

The measurement period is only three months, ending in June 2013, when gas use and thus savings are expected to be low. The MT&R report estimates savings of 2,151 therms in the measurement period. Total energy use in the measurement period was 4,746 therms, and so savings is 31 percent of what energy use would have been without the savings. Future field work could verify this level of savings.

A savings of 713 therms is found using the first variant of the model, which is just 33 percent of the result from the MT&R model. The fourth variant estimated savings of 2,079 therms, which is 97 percent of the MT&R result. This variation indicates the model is sensitive to specification. It is clear that results are unduly influenced by the truncation of HDD at 55, which is corrected with the inclusion of the

summer dummy variable. Navigant recommends the addition of temperature as a candidate variable for the analysis, so that a model that replaces the HDD and the summer dummy variable with a quadratic form for average monthly temperature can be estimated to check whether the model is sensitive to reasonable alternatives in the treatment of weather. Alternatively, the model would include HDD and temperature terms together, or would raise the base for HDD above 55 °F.

The report is unclear about the treatment of the barrel plating line brought on line in April 2013. The report states in Section 3.3 that "savings associated with this project are included in the electricity model and analysis and are not being claimed on the natural gas model". But the measurement period appears to include April 2013, and the discussion of the estimate of savings in Section 4 does not appear to account for the barrel plating line.

The reported estimate of savings is statistically significant at the 90% confidence level. The standard error on cumulative savings over the measurement period is 499 therms, and so the 90% confidence bounds on savings (not accounting for the issue of the barrel plating line described above) in therms is [1,327, 2,974].

A.3 PE5404 (Gas Model)

A.3.1 PE5404MT&R Model Specification

Model:
Natural Gas (therms) = b_0 + b_1(Vacuum system) + b_2(OSA Temp) + b_3(Total Washed Weight),

where,

- "Vacuum System" is a binary variable indicates period after vacuum system was installed.
- "OSA Temp", which is the average monthly temperature (taken from the daily averages)
- "Total Washed Weight", in pounds, of linen washed (by tunnel washer 1 & 2 and the smaller pony washers)

A.3.2 Comments on the MTR Model and Model Variants Examined

Comments on the report presentation and model:

- The baseline period is presented as covering the interval 9/1/2010 to 7/31/2012. The report later states that "Once total washed weights was determined to be the dominate production variable, the baseline had to be reduced to start January 2012 because of the missing data." The date should be changed to January 2011, and the baseline start date should be changed in the text and in the table in Section 2.0 as well. The baseline model includes 19 weeks, from 1/1/2011 to 7/31/2012.
- The commentary for Figure 2.5b indicates that the histogram demonstrates the normality of the residuals. This is not obvious.
- The MTR model presents gas use as linear in monthly average temperature, but this is unlikely.
- As with other reports, graphs are generally poorly scaled.

Investigation of the sensitivity of the savings estimates to model specification:

A significant concern in any regression analysis is whether the model is misspecified and therefore generates biased estimates of savings. Although one cannot assert that estimates of savings are free of model misspecification bias, whether the issue is an important concern can be addressed by comparing savings estimates across different reasonable model specifications, and using different subsets of the

baseline data in the estimation of models. If savings estimates are insensitive to these estimation alternatives, model misspecification bias is not an important concern.

Table A.3 displays the results of various model specifications. The first model is the baseline model –the model presented in the MT&R report (hereafter, the MT&R model). T-statistics are in parentheses. About the model variants:

- The first variant adds a quadratic term for temperature. While the MT&R model results show that energy use decreases at a constant slow rate as temperature increases, this model instead shows that energy use falls at a decreasing rate as temperature increases.
- Model variants 2 and 3 add in seasonal dummy variables, none of which show significance.

Table A.3: PE5404 Model Variations (Coefficients reported, with T-statistics in parentheses)

	Intercept	Vacuum System	Ave Temp	Washed Weight	Ave Temp^2	Spring	Summer	Fall
MT&R Report	23,110.63 (2.17)	2,283.21 (2.95)	-217.68 (-6.72)	0.0173 (3.34)	-	-	-	-
Model Variant 1: Ave Temp^2	34,632.71 (2.28)	2,564.46 (3.14)	-715.58 (-1.51)	0.0181 (3.47)	4.54 (1.06)	-	-	-
Variant 2: Seasonal Dummies	21,015.21 (1.85)	2,229.80 (2.52)	-181.67 (-2.02)	0.0178 (2.98)	-	-1,141.04 (-0.79)	-1,237.31 (-0.50)	-1,326.17 (-1.19)
Variant 3: Ave Temp^2 and Seasonal Dummies	47,871.76 (2.00)	2,265.53 (2.62)	-1,188.42 (-1.48)	0.0169 (2.89)	9.84 (1.27)	-998.77 (-0.71)	-3,517.28 (-1.17)	-1,276.94 (-1.18)

A.3.3 PE5404 Savings Analysis

The MT&R report estimates savings of 9,222 therms in the measurement period. Total energy use in the measurement period was 421,493 therms, and so savings is 2 percent of what energy usage would have been without the savings.

The first model variant estimates savings of 10,725 therms, which is 116 percent of the MT&R result, and the second model variant estimates savings of 10,822, which is 117 percent of the MT&R result. This suggests savings are slightly sensitive to the model specification. Navigant recommends using the quadratic temperature term in future models.

The reported estimate of savings during the measurement period is statistically significant. The standard error on cumulative savings over the measurement period is 5,072 therms, and so the 90% confidence bounds on savings is [853, 17,591].

A.4 PE5411 (Electric Model)

A.4.1 PE5411 MT&R Model Specification

Model:
Predicted Electricity (kWh) = b_0 + b_1(frozen per day) + b_2(Monthly Avg OSA Temp),

where,

- "Frozen per day" is the average pounds of frozen yogurt produced per day in a given monthly period (monthly production was divided by number of days in month)
- "OSA Temp" is the average monthly temperature (taken from the daily averages).

A.4.2 Comments on the MTR Model, and Model Variants Examined

Comments on the report presentation and model:

- The commentary for Figure 2.5b states that the histogram demonstrates the normality of the residuals. In fact the histogram is right-skewed.
- As with other reports, graphs are often poorly scaled.

Investigation of the sensitivity of the savings estimates to model specification:

A significant concern in any regression analysis is whether the model is misspecified and therefore generates biased estimates of savings. Although one cannot assert that estimates of savings are free of model misspecification bias, whether the issue is an important concern can be addressed by comparing savings estimates across different reasonable model specifications, and using different subsets of the baseline data in the estimation of models. If savings estimates are insensitive to these estimation alternatives, model misspecification bias is not an important concern.

Table A.4 displays the results of two model specifications. The first is the baseline model –the model presented in the MT&R report (hereafter, the MT&R model). T-statistics are in parentheses. The second model adds the Ave Temp^2 variable. While the MT&R model results show that energy use increases at a constant slow rate as temperature increases, the alternative model instead shows that energy use escalates quickly as temperatures increase, and then as temperatures get higher, the rate of increase lessens. In both models the production variable is strongly statistically significant.

Table A.4: PE5411 Model Variations (Coefficients reported, with T-statistics in parentheses)

	Intercept	Frozen Per Day	Ave Temp	Ave Temp^2
MT&R Report	216,724.01 (6.21)	0.4944 (7.50)	1,754.18 (2.70)	-
Model Variant 1: Ave Temp^2	124,691.43 (0.48)	0.4860 (6.77)	5,296.30 (0.53)	-31.96 (-0.35)

A.4.3 PE5411 Savings Analysis

The MT&R report estimates savings of 267,165 kWh in the measurement period. Total energy use in the measurement period was 1,655,962 kWh, and so savings is 14 percent of what energy usage would have been without the savings.

A savings of 264,414 kWh is found using the Variation 1 model, which is 99 percent of the MT&R result and provides some evidence that the model is not sensitive to specification bias.

The reported estimate of savings during the measurement period is statistically significant. The standard error on cumulative savings over the measurement period is 47,440 kWh, and so the 90% confidence bounds on savings is [188,888, 345,442].

After subtracting out the savings from the capital projects over the measurement period (55,708 kWh), the O&M savings during the measurement period are 211,457 kWh, with 90% confidence bounds of [133,180, 289,734].