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Development of an Enhanced Payback Function for the Superior Energy Performance Program

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ABSTRACT

The U.S. DOE Superior Energy Performance (SEP) program provides recognition to industrial and commercial facilities that achieve certification to the ISO 50001 energy management system standard and third party verification of energy performance improvements. Over 50 industrial facilities are participating and 28 facilities have been certified in the SEP program. These facilities find value in the robust, data driven energy performance improvement result that the SEP program delivers. Previous analysis of SEP certified facility data demonstrated the cost effectiveness of SEP and identified internal staff time to be the largest cost component related to SEP implementation and certification.

This paper analyzes previously reported and newly collected data of costs and benefits associated with the implementation of an ISO 50001 and SEP certification. By disaggregating "sunk energy management system (EnMS) labor costs", this analysis results in a more accurate and detailed understanding of the costs and benefits of SEP participation. SEP is shown to significantly improve and sustain energy performance and energy cost savings, resulting in a highly attractive return on investment. To illustrate these results, a payback function has been developed and is presented. On average facilities with annual energy spend greater than $2M can expect to implement SEP with a payback of less than 1.5 years. Finally, this paper also observes and details decreasing facility costs associated with implementing ISO 50001 and certifying to the SEP program, as the program has improved from pilot, to demonstration, to full launch.

Introduction

The U.S. Department of Energy (U.S. DOE) reports that the US industrial sector consumed nearly 25 quads of energy in 2014, over a third of total US end use energy consumption (LLNL 2015). Widely available and proven energy performance improvement practices have been estimated to potentially reduce industrial energy consumption by 7% with simple paybacks of less than two years (McKane, Scheihing, and Williams 2007). While economically feasible, these energy savings have not been fully realized (Eichhammer 2004, Enkvist, Naucler, and Rosander 2007, IEA 2008, IEA 2009). Experience has shown that energy performance gains from project based energy efficiency improvements do not deliver sustained energy performance improvements over time. This is due to a lack of monitoring and ongoing adjustments in response to operational changes that occur after implementation (Jeli et al. 2010, Ates and Durakbasa 2012, Galitsky and Worrell 2003, Therkelsen and McKane 2013). In order to ensure continual energy performance improvement, energy should not be considered a fixed operational expense but managed just as carefully as production, quality, and safety (Vikhorev, Greenough, and Brown 2013).

Published in June 2011, ISO 50001 – Energy Management System, is an international standard that provides a framework for the implementation of an energy management system (EnMS) for the purpose of continuously improving energy performance (ISO 2011). ISO 50001 provides guidance to industrial and commercial facilities for integrating energy efficiency into their daily management practices. For industrial facilities this includes fine-tuning production processes and improving the energy efficiency of industrial systems (McKane et al. 2009). The standard gives organizations management strategies that can be used to reduce energy consumption, carbon intensity, and costs, and to improve environmental performance. Organizations implementing ISO 50001 conduct an energy review, develop an energy policy, establish objectives, targets and action plans related to its significant energy uses, and engage top management in decision making. ISO 50001 can be implemented solely or be used in conjunction with other ISO management system standard such as ISO 14001 – Environmental Management and ISO 9001 – Quality Management. ISO 50001 is complementary yet different than other ISO management system standards as it has a focused structure to manage energy performance with a data driven emphasis. Globally there have been more than 3,500 ISO 50001certifications encompassing over 11,000 sites.[1]

Building on the foundation of ISO 50001, the U.S. DOE developed the Superior Energy Performance (SEP) program in collaboration with industry and other stakeholders. The SEP program requires participating industrial facilities to achieve ANSI/ANAB third-party verification of its ISO 50001 EnMS and meet pre-established energy performance improvement targets, currently at least 5% over 3 years (U.S. DOE 2013). The SEP certification program provides industrial facilities and companies a transparent, globally accepted system for verifying improvements in energy performance and management practices. As of May 2015, 28 facilities representing a diverse range of sectors, sizes, and locations are certified to SEP, improving their energy performance by almost 30% over 3 years (U.S. DOE 2015a). The success of the program's initial demonstration has led to a growing interest in SEP. The SEP program is expanding, details of which can be found in McKane et al. (2015).

A prior assessment of the costs and benefits of SEP certification was presented by Therkelsen et al. (2013). This current paper expands upon prior results by disaggregating "sunk EnMS labor costs" from costs attributable to SEP certification, revealing the highly cost-effective nature of the SEP program for industrial facilities. Results in this paper incorporate data from Therkelsen et al. (2013), as well as additional data provided by newly SEP certified industrial facilities. Due to the availability of data, the number and identity of facilities analyzed in each of this paper's three Results subsections varies slightly. Each results section includes a reference to the number of facilities included in the analysis.

Methodology

The previously developed cost/benefit analysis methodology has been expanded to gather and analyze data for the purpose of deepening the knowledge related to the cost of participating in the SEP program. Energy consumption and costs, energy performance actions, SEP implementation costs, the perceived value of third party facility certifications, as well as a more

[1] Analysis of ISO 50001 certifications based upon data from (DIN 2015) and as presented by Scheihing (2014)

disaggregated breakdown of internal costs associated and attributable to SEP participation data were collected by utilizing phone interviews and questionnaires. Facilities also provided up-to-date Energy Performance Indicator (EnPI) tools[2] containing energy consumption data as well as details about facility developed baseline models and energy performance improvement actions. These data were analyzed and if needed, additional information was collected via follow-up email and phone calls.

Quantifying Energy and Energy Cost Savings Percentages

The facility-supplied EnPI tools provide data necessary to calculate monthly energy savings. Energy cost savings are calculated using energy prices supplied by facilities or state-specific monthly industrial energy prices available from the Energy Information Administration (U.S. DOE 2015d, b).

Monthly energy and energy cost savings were calculated and aggregated into quarterly periods prior to and after the facility began participation in the SEP program, defined as the date of their first SEP training. Quarterly energy and energy cost savings percentages were calculated for each facility by comparing quarterly energy values and energy cost values to quarterly average baseline values. Conversion of energy and energy cost saving value to percentage values allowed for the direct comparison and averaging of facility savings by removing biasing due to differences in facility baseline energy consumption and cost. Quarterly facility energy and energy cost savings percentages were averaged to aggregated the results presented in this paper.

Averages of energy and energy cost savings percentage values for all facilities prior to the first SEP training provide a clear quantification of business as usual (BAU) energy performance improvement. After the first SEP training, savings values are disaggregated into BAU savings and savings attributable to SEP. To disaggregate savings attributable to BAU and SEP, the average calculated quarterly BAU value is subtracted from each quarter's energy and energy cost savings percentage value post first SEP training. As in the previous paper, four quarters worth of BAU savings percentage values are shown. In this paper, an additional fifth quarter after the first SEP training is also shown (+Q7) (Therkelsen et al. 2013).

Quantifying EnMS Implementation and Certification Costs

Four types of EnMS and SEP implementation related costs were collected during the interview process, as shown in Table 1. As previously reported, the majority of costs incurred for EnMS development and implementation was attributable to the facility staff wages. The expanded methodology disaggregates internal staff costs related to existing energy management activities already underway at the facilities (i.e. existing staff working to improve energy performance) from additional staffing costs incurred due to SEP program participation and certification. These existing staff costs are termed "sunk EnMS labor costs" and include costs associated with business-as-usual energy management or any energy management-related efforts prior to ISO 50001/SEP EnMS development and implementation. These sunk EnMS labor costs are not included in costs presented in this paper unless specifically noted.

To perform this disaggregation, facility officials were asked to provide (1) the person year equivalent of time (or dollar amount) spent on energy management related issues over a 12

[2] The EnPI tool is a regression analysis based tool developed by the U.S. DOE for use in industrial and commercial facilities: https://ecenter.ee.doe.gov/EM/tools/Pages/EnPI.aspx.

month period immediately prior to ISO 50001 EnMS implementation, and (2) the person-year equivalent of time (or dollar amount) spent on ISO 50001 EnMS development, including training, or any other energy related issues to meet the initial SEP certification requirements. Only internal staffing costs were disaggregated. The remaining cost categories (internal ISO 50001/SEP Audit preparation, external technical assistance to assist with EnMS implementation, metering and monitoring equipment, and third-party ISO 50001 audit and SEP performance verification) were assumed to be directly associated with ISO 50001/SEP implementation or certification. Table 1 provides a summary of the cost determination methodology.

Table 1: Cost Determination Methodology

Cost Category	**Method of Quantifying Cost**
Internal staff time not attributable to SEP – "Sunk EnMS labor costs"	The estimated time (person-year equivalents and duration) was collected for staff engaged in energy management related issues over a 12-month period immediately prior to ISO 50001 EnMS implementation. One person year equivalent assumed to be equivalent to a fully-burdened annual salary of $125,000, equal to an average base salary for an energy manager of $96,622 (salary.com 2013), augmented by 30% to account for overhead costs associated with health insurance, 401k, leave, etc.
Internal staff time attributable to SEP – "Internal facility staff costs"	The estimated time (person-year equivalents and duration) was collected for staff to develop and implement the EnMS and prepare for third party certification and then the "sunk EnMS labor costs" value was subtracted. One person year equivalent assumed to be equivalent to a fully-burdened annual salary of $125,000, equal to an average base salary for an energy manager of $96,622 (salary.com 2013), augmented by 30% to account for overhead costs associated with health insurance, 401k, leave, etc.
External technical assistance to assist with EnMS implementation	Costs in dollars were directly collected when applicable. For some of the demonstration facilities where U.S. DOE provided free coaching, the associated cost was estimated to be $24,000/year, based on data collected from SEP demonstration facilities and internal U.S. DOE cost estimates.
Metering and monitoring equipment	Costs in dollars were collected directly for any metering and monitoring equipment installed to enable SEP participation.
Third-party ISO 50001 audit and SEP performance verification	Costs in dollars were collected directly.

SEP Program Payback

Payback for facilities participating in the SEP program are calculated in a similar manner as those in previously reported work and follows the below equation.

$$\text{Payback} = \frac{\text{Costs}}{\text{Benefits}} = \frac{\text{EnMS and SEP Implementation Costs}}{\text{Operational Energy Savings (attributable to SEP in the SEP reporting period)}}$$

Unless specifically mentioned, EnMS and SEP Implementation Costs do not include sunk EnMS labor costs. This provides a clear illustration of the return on investment associated with participation in the SEP program, not including any existing energy management-related activities at the facilities.

As in the previous paper, it could not be determined if capital based projects would have been implemented without participation in the SEP program. SEP has no specific requirements for capital projects, and the data to determine whether to attribute capital project decisions to SEP participation was not available. Since these decisions could not be connected to SEP participation, capital project costs and resulting energy savings were not utilized in the calculation of SEP payback. Costs and benefits resulting from implemented capital projects are included in all other results sections.

Results

Results are presented in four discrete sections: 1) energy and energy cost saving percentages, 2) attributing EnMS implementation and certification costs and 3) payback and 4) reduction of implementation costs. Each section is based upon a previously described methodology with data aggregated from varying industrial facilities. Care should be taken to observe the number of facilities that are being analyzed in each results section.

Energy and Energy Cost Saving Percentages

Energy and energy cost savings percentages include data aggregated from 10 industrial facilities with a 12-month baseline energy consumption ranging from 0.03 to 3.4 (site) TBTU and baseline energy spend from $0.3M to $21.7M. The 10 facilities include a wide range of industrial subsectors. Results are aligned across facilities so that the first quarter attributed to SEP starts when facilities received their first SEP training[3]. Four quarters of averaged data prior to the first SEP training as well as 7 quarters after this training (post first training) are presented.

Figure 1 presents average quarterly percentage energy savings as a function of average quarterly baseline energy consumption for 10 facilities. Each quarter of savings are presented as a percentage of averaged quarterly baseline energy consumption, not cumulatively quarter to quarter. Prior to the first SEP training (-Q4 to -Q1) BAU energy performance improved by an average of 3.2% against the baseline. Energy savings percentage increased to 7.4% per quarter during quarters +Q1 to +Q4 and 14.2% per quarter during quarters +Q5 to +Q7. As part of the SEP program, a functional EnMS results in more than four times the savings achieved through BAU activities.

These results are well aligned with previously reported data. The additional quarter of data shows that savings achieved with SEP are sustained as expected under the EnMS model of continuous energy performance improvement. Not only does the EnMS provide quantification of energy performance improvements, it provides confidence that savings will be maintained even after individual energy performance improvement actions are completed.

Energy savings percentages attributable to SEP are calculated by subtracting the average BAU quarterly energy savings percentage from quarterly post-first training energy savings percentages. Average energy savings percentage attributable to SEP above BAU improvement in the first year after the initial SEP training is 4.1%. The average energy savings percentage attributable to SEP increases to 11.1% in the first three quarters of the second year.

The trend of varied and relatively low BAU energy performance improvement prior to SEP training is common to all studied facilities, as is the significant improvement in energy performance after the first SEP training. As previously reported, it can take between 9 and 18 months to implement a fully functional EnMS. For this reason there is a lag (+Q1) between the first SEP training and an increase in energy performance improvement. However, as EnMS implementation progresses, energy performance improvement actions are implemented and recorded, resulting in significant gains (+Q2 through +Q4 and +Q5 through +Q7).

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[3] As part of the SEP pilot and demonstration phases, the U.S. DOE offered in person trainings to participating facilities. These trainings included content regarding ISO 50001 EnMS and SEP certification requirements.

Figure 1: Average Quarterly Energy Savings Percentages

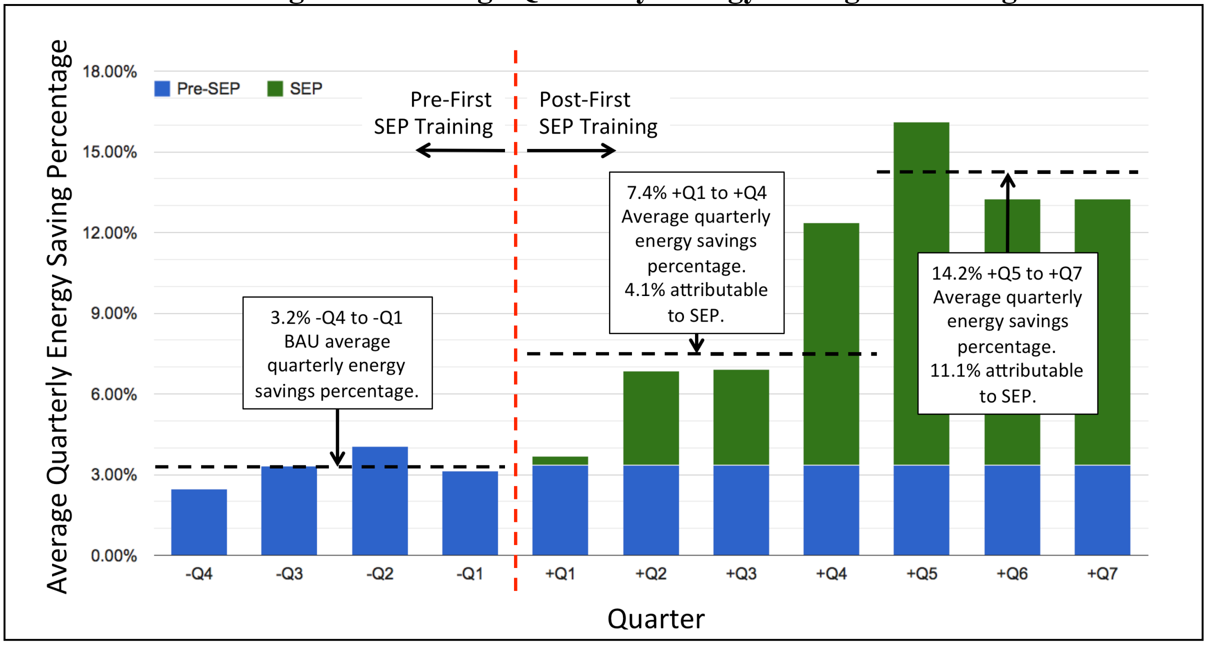
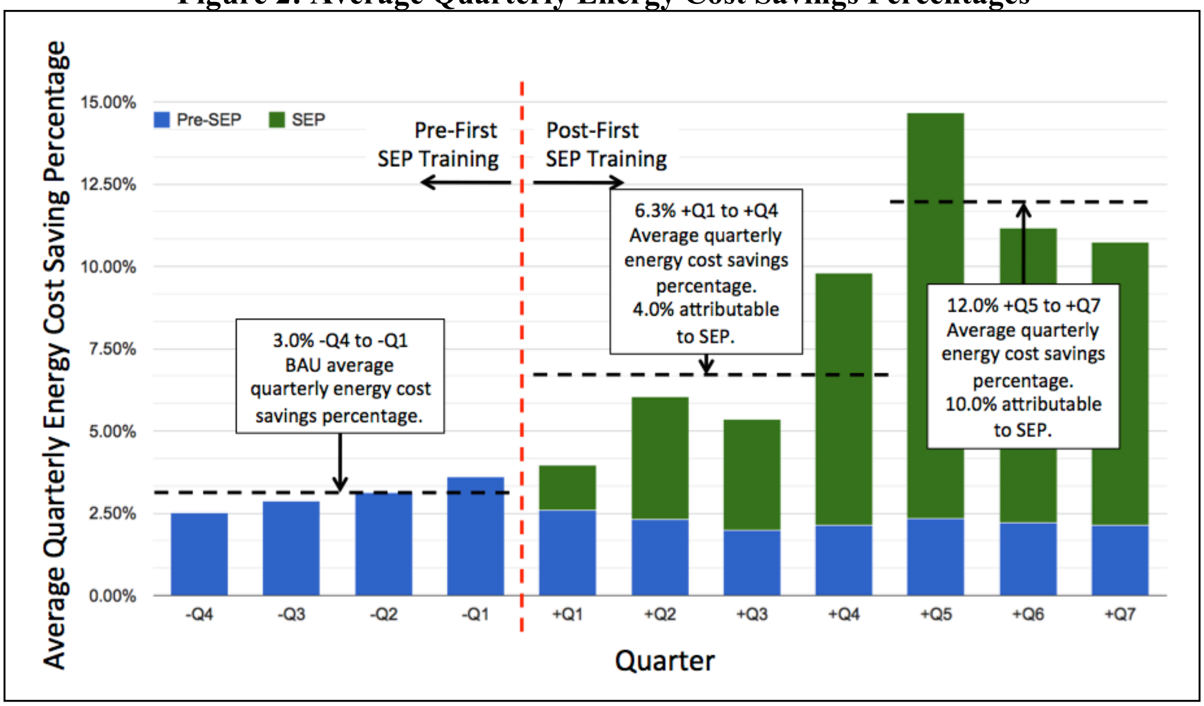


Figure 2: Average Quarterly Energy Cost Savings Percentages



Quarterly energy costs saving percentages vary each quarter in a manner similar to energy saving percentages as seen in Figure 2. The 3.0% BAU (-Q4 to -Q1) quarterly average energy cost saving percentage value increases to 6.3% during the first year (+Q1 to +Q4) and 12.0% savings percentage during quarters +Q5 to +Q7. Post-first SEP training BAU energy cost savings percentages are calculated by multiplying average energy cost savings by actual quarterly energy prices so quarterly energy savings fluctuate, result in unequal BAU values.

These energy cost savings values align closely with prior reported results. SEP participation results in an additional 4.0% energy cost savings over BAU during the first year after SEP training (+Q1 to +Q4) and an additional 10.0% savings in quarters +Q5 to +Q7.

EnMS Implementation and Certification Costs

Previously reported costs associated with ISO 50001 EnMS implementation and SEP certification were based upon a very conservative cost-accounting approach (Therkelsen et al. 2013). To correctly attribute costs associated with EnMS implementation, additional interviews and analyses were conducted with specific focus on facility staff effort and costs related to energy management activities prior to and after the start of the EnMS development. Cost results presented in this paper do not include sunk EnMS labor costs unless specifically mentioned. Cost data were collected from 13 SEP certified facilities (4 more than previously reported results) with four of the facilities belonging to one company.

Figure 3: ISO 50001 and SEP Program Implementation Participation Costs

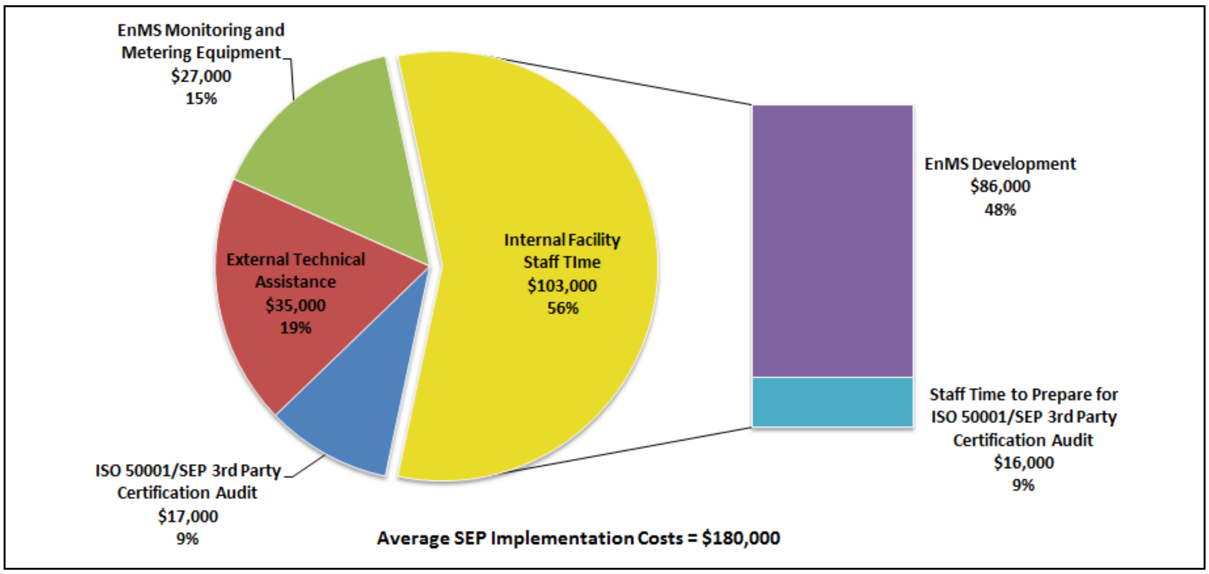


Figure 3 shows the resulting breakout of costs incurred as part of the SEP program. The overall average cost per facility was $180,000, with values ranging from $89,000 to $313,000. Costs that are direct functions of facility size, such as third party auditing, and monitoring and metering equipment are a relatively small portion of overall costs as seen in Figure 3.

Internal Facility Staff Time. Internal facility staff time represents the largest SEP implementation cost. The average staff time *attributable* to SEP is 0.8-person year, ranging from 0.3 to 2-person year or an average internal cost of $103,000 with a range of $35,000 to $247,000. The composition of the energy team responsible for SEP implementation and certification varied. During preparation for ISO 50001 and SEP third party certification, additional internal staff was required for an average duration of 3.5 months. As seen in the bar chart of Figure 3, the additional certification preparation costs accounted for 9% of average SEP implementation costs and almost 16% of internal facility staff costs.

Of the $103,000 average internal staff cost, $86,000 is associated with the costs of existing staff internally that were not engaged in energy management related activities reassigned to assist in implementing ISO 50001 EnMS and meet SEP certification requirements.

Outside of the internal staff costs attributable to SEP certification, an average cost of $114,000 can be attributed to sunk EnMS labor costs. This sunk cost is not attributable to SEP and is not included in the overall average implementation cost of $180,000.

External Technical Assistance. All thirteen facilities utilized the expertise of external consultants and trainers. The concepts of an integrated EnMS were new to many of the facilities and external technical assistance was helpful in reaching certification to the SEP program. In cases where a second facility owned by a parent company was pursuing SEP certifications, external technical assistance was forgone in favor of utilizing newly developed internal staffing assets. External staffing costs were on average $35,000 (19% of program implementation costs) per facility with a range of $0 to $68,000. By removing companies that did not use external technical assistance, the average cost per facility rises to $47,000 with a low value of $26,000.

EnMS Metering and Monitoring Equipment. The SEP program requires that facilities meter, monitor, and record energy consumption data for the facility as a whole, as well as identified significant energy uses. Seven of the thirteen facilities did not install any additional metering or monitoring equipment, while one facility reported taking the opportunity to install a far greater level of metering than needed to meet the certification requirements of SEP. The average cost of metering and monitoring equipment for the 13 facilities was $27,000 (15% of costs) with a range of $0 to $159,000. When the facility that reported purchasing a far greater amount of metering than needed is excluded, the average cost was $16,000.

ISO 50001/SEP Third Party Certification Audit. Third party verification of EnMS conformity with ISO 50001, additional SEP requirements and achievement of SEP energy performance improvement targets is an SEP certification requirement (ANSI 2013). The average cost for all third party auditing and certification was $17,000 (9% of costs), ranging between $7,300 and $20,000. This cost variance is generally based upon the size of the audited facility. The cost of ISO 50001 and SEP program certification is marginally higher than ISO 50001 certification alone though certification costs are comparable to other standards, such as ISO 14001, as reported by facilities also certified to that standard.

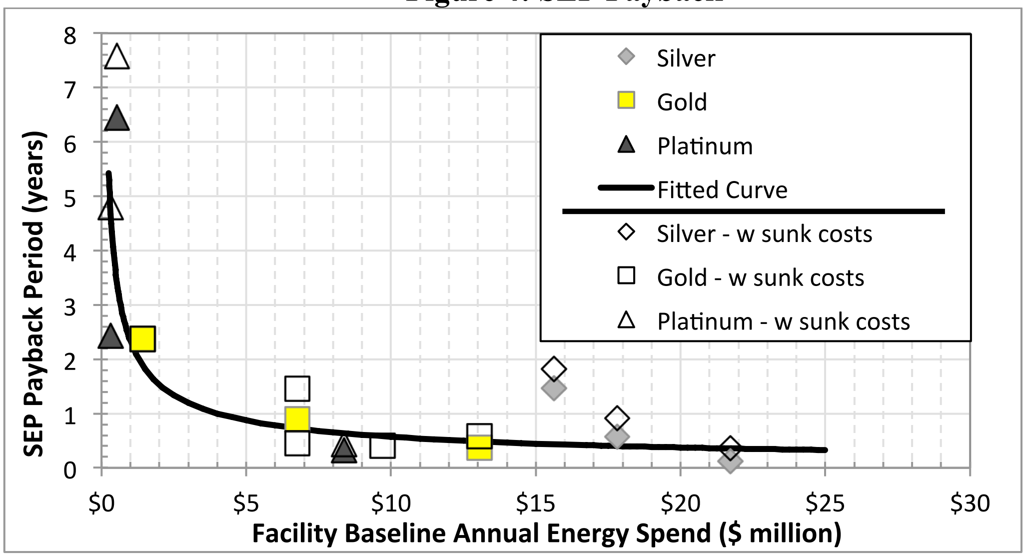
Payback

SEP payback was determined with and without the inclusion of “sunk EnMS labor costs” for 11 facilities. Results are plotted against total facility energy spend in Figure 4. A fitted curve based upon implementation costs attributable to SEP (not including sunk costs) are also shown.

Facilities with annual energy spend greater than approximately $2 million can expected to have a less than 1.5-year payback. SEP participation is cost-effective—regardless of whether payback is determined based upon SEP attributable costs only or with the addition of sunk EnMS labor costs. The imposed fitted curve indicates that multiple facilities’ payback align well with one another, providing confidence that other facilities can expect similar results.

Increasing the benefits or reducing the costs of ISO 50001 EnMS implementation and SEP certification will reduce SEP payback. As the costs of implementing SEP are expected to decrease, the developed function in Figure 4 is expected to shift to the left and down.

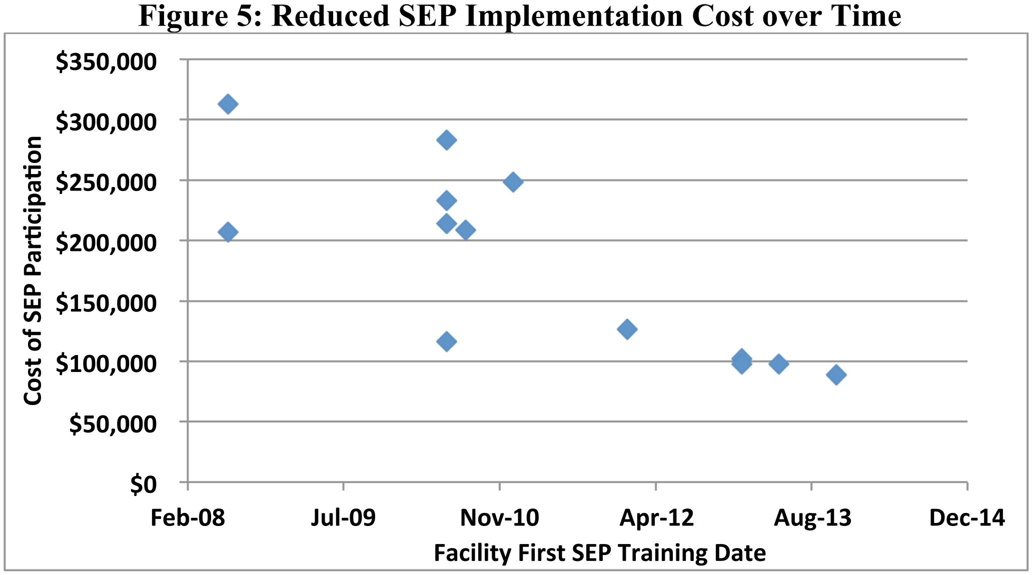
Figure 4: SEP Payback



Reduction of Implementation Costs

Using data collected from 13 facilities, Figure 5 shows that costs incurred by facilities certified to SEP have declined as the program has matured from pilot, to demonstration, and to full launch. This cost reduction is believed to be due to improved effectiveness and understanding of how the SEP program works as well as EnMS consultants and internal staff.

Figure 5: Reduced SEP Implementation Cost over Time



Additionally, total incurred cost decreases further for SEP certified facilities as they shift from EnMS implementation to EnMS improvement and recertification. Following SEP certification, plant officials were asked to estimate the annual level of staff time that would be required to maintain and improve the EnMS. The average person year effort from eleven facilities to maintain the SEP program was 0.3-person year equivalent (or $41,000), ranging from 0.08 ($10,000) to 0.75 ($94,000). This predicted maintenance cost is less than half the initial cost to develop and implement SEP. This result confirms that the ISO 50001 EnMS will be an asset in making day-to-day operations more efficient and effective, rather than more difficult. Efforts required to maintain and improve the EnMS should continue to become simpler and lower costs as the EnMS becomes an integrated part of organizational culture.

To further reduce costs, DOE has launched a SEP *Accelerator* program aimed at reducing costs further by deploying SEP across three or more facilities within one corporate entity. Implementing SEP and ISO 50001 across several facilities is expected to create opportunities for companies to benefit from economies of scale. Early results from this Accelerator are showing that implementation costs at these facilities are being reduced even lower than the costs reported in this paper as the company is taking advantage of internal expertise and lessons learned at the initially certified facilities (U.S. DOE 2015c).

Future Work

The current data collection process of conducting phone interviews and processing facility data on an individual basis is not expected to be scalable, therefore future studies will require a different research approach. To address this issue, the DOE has included selected elements of the presented cost/benefit analyses in an expanded version of its EnPI tool. Additionally, SEP-certified facilities are invited to provide voluntary data in a reporting tool, that was designed based upon the data needs identified in this study.

Conclusions

SEP certification requires implementation of and certification to ISO 50001 and achievement of energy performance improvement targets as verified by an accredited verification body. An enhanced methodology based upon previous work was developed to quantify the costs of and a payback for SEP program participation. This enhanced methodology was specifically formulated to disaggregate sunk EnMS labor costs from other SEP implementation costs. Energy consumption, cost, and saving data were gathered from multiple U.S. facilities that operate in a variety of industrial sectors.

Using this methodology, the cost incurred by facilities to develop, implement, and certify to ISO 50001 and SEP was found to be $180,000, on average. This cost is significantly reduced from previously reported data that did not disaggregate sunk EnMS labor costs. In addition, SEP costs have been decreasing as the program has transitioned from pilot to full launch.

Payback periods for implementing the ISO 50001 EnMS and SEP certification were confirmed to be a function of facility source energy spend. Facilities with baseline source energy spend greater than $2M can expect a less than 1.5 year marginal payback for SEP participation.

SEP provides a structured approach to help organize and focus facility staff energy management efforts, resulting in dramatic increases in energy savings percentages. SEP is attributed with increasing average quarterly energy saving percentages an additional 11.1% above the business-as-usual (BAU) of 3.2% during the second year after beginning SEP participation. Similarly, quarterly average energy cost savings of 12.0% were calculated for the second year after the beginning of SEP participation, of which 10.0% is attributable to SEP.

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