Assessing the Costs and Benefits of the Superior Energy Performance Program

Peter Therkelsen and Aimee McKane, Lawrence Berkeley National Laboratory
Ridah Sabouni and Tracy Evans, Energetics Incorporated
Paul Scheihing, U.S. Department of Energy

ABSTRACT

Industrial companies are seeking to manage energy consumption and costs, mitigate risks associated with energy, and introduce transparency into reports of their energy performance achievements. Forty industrial facilities are participating in the U.S. DOE supported Superior Energy Performance (SEP) program in which facilities implement an energy management system based on the ISO 50001 standard, and pursue third-party verification of their energy performance improvements. SEP certification provides industrial facilities recognition for implementing a consistent, rigorous, internationally recognized business process for continually improving energy performance and achievement of established energy performance improvement targets.

This paper focuses on the business value of SEP and ISO 50001, providing an assessment of the costs and benefits associated with SEP implementation at nine SEP-certified facilities across a variety of industrial sectors. These cost-benefit analyses are part of the U.S. DOE's contribution to the Global Superior Energy Performance (GSEP) partnership, a multi-country effort to demonstrate, using facility data, that energy management system implementation enables companies to improve their energy performance with a greater return on investment than business-as-usual (BAU) activity.

To examine the business value of SEP certification, interviews were conducted with SEP-certified facilities. The costs of implementing the SEP program, including internal facility staff time, are described and a marginal payback of SEP certification has been determined. Additionally, more qualitative factors with regard to the business value and challenges related to SEP and ISO 50001 implementation are summarized.

Introduction

The U.S. Department of Energy (U.S. DOE) estimates 7% of total U.S. industrial energy consumption can be saved through the application of proven best practices. These opportunities are widely available, typically with simple paybacks of less than two years (McKane, Scheihing, and Williams 2007). Literature and facility experience show that the industrial sector has made improvements in energy performance, but that economically feasible savings have not been fully realized (Eichhammer 2004, Enkvist, Naucler, and Rosander 2007, IEA 2008b, IEA 2009). Often this is because energy performance is viewed as a secondary concern to ensuring production and planning long-term market growth (Galitsky and Worrell 2003). Industrial companies are increasingly using available energy more efficiently due to public awareness of environmental sustainability and rising energy supply costs and volatility (Rudberg, Waldemarsson, and Lidestam 2013, IEA 2008a, Tanaka 2008, Bunse et al. 2011).

Evidence of this trend can be found in a number of recent reports indicating that top-level industrial managers now regard energy performance as an important issue. A global survey by Deloitte (2012) found that energy tops the list of sustainability issues for CFOs in 14 countries (including the U.S.), both in terms of energy management as a challenging issue and energy prices as a significant risk. Energy costs are also identified as a top financial concern among U.S. CFOs surveyed by Bank of America Merrill Lynch (2012).

Experience has shown that energy performance gains from various one-off energy efficiency projects do not deliver sustained energy performance improvements if they are not monitored and adjusted in a continuous manner (Jeli et al. 2010, Ates and Durakbasa 2012). In order to ensure sustained energy performance gains, energy should not be considered a fixed operational expense but managed just as carefully as production, quality, and safety (Vikhorev, Greenough, and Brown 2013). To do so, industrial managers require quantifiable energy performance data. Only 12% of CFOs in Deloitte's survey consider the level of their sustainability data to be excellent. Industrial companies could benefit from the implementation of data driven business practices that will result in continual energy performance improvements.

Published in June 2011, ISO 50001 – Energy Management Systems 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). The U.S. DOE has developed the Superior Energy Performance (SEP) program in which facilities implement an EnMS based on the ISO 50001 standard, and pursue third-party verification after achieving established energy performance improvement targets. ISO 50001 and SEP are data driven, using measured energy and relevant data to calculate energy performance.

This paper presents the business value of SEP through a detailed cost/benefit analysis using data from nine SEP certified U.S. industrial facilities. These nine facilities encompass a variety of industrial sectors and have greatly varied baseline energy consumption levels. Results of this study are beneficial to policy makers as well as mangers and energy users at industrial facilities and companies wishing to better understand the value of implementing an ISO 50001-conformant EnMS and establishing energy performance targets. Results from this study will help inform EnMS activities developed through the Global Superior Energy Performance (GSEP) international partnership Energy Performance Database project currently under development.

The Superior Energy Performance (SEP) Program

The SEP certification program for U.S. industrial facilities provides a transparent, globally accepted system for verifying improvements in energy performance and management practices. Facilities that achieve SEP certification obtain ANSI-ANAB accredited third party verification for conforming to the ISO 50001 energy management standard and for achieving a defined level of energy performance improvement (U.S. DOE 2013a).

ISO 50001 provides guidance to industrial and commercial facilities to integrate energy efficiency into their management practices, including fine-tuning production processes and improving the energy efficiency of industrial systems (McKane et al. 2009). The standard gives organizations and companies technical and management strategies to reduce energy, carbon intensity, costs, and improve environmental performance.

SEP encourages a *rigorous* approach to implementing of ISO 50001 that leads to greater energy and cost savings. Companies participating in SEP voluntarily collect data, measure and monitor their energy performance, and receive third party verification and external recognition for their energy performance improvements. When a manufacturing facility enrolls in SEP, it commits to implement an ISO 50001 EnMS and within a three year achievement period strives to reach one of three energy performance improvement targets[1] during a defined reporting period relative to a baseline period: Silver (≥5% to <10%), Gold (≥10 to <15%), or Platinum (≥15%).

During the SEP demonstration program, facilities pursue ISO 50001 certification and third party verification of energy performance by an ANSI-ANAB accredited verification body.[2] When entering the SEP demonstration program, facilities received a series of training sessions to assist with EnMS implementation. The U.S. DOE Energy Performance Indicator (EnPI) software tool is provided to facility staff to assist in calculating improvements in energy performance. The tool normalizes energy consumption for relevant variables such as weather, production, moisture content, etc. Additionally DOE has supported a number of these demonstration facilities by arranging for external technical assistance and third party certification audits. To date, 28 facilities have completed SEP training. An additional 25 facilities are currently pursuing certification and 14 are SEP certified. Nine SEP-certified facilities are studied in this paper.

Methodology

A methodology has been devised to quantify the costs and benefits associated with SEP participation. This methodology has been applied to nine SEP certified demonstration facilities. A questionnaire was developed and sent to staff at each facility ahead of a one-hour phone interview and the facility's SEP EnPI tool containing energy consumption, baseline models, and performance actions was also requested. The questionnaire focused on facility identification, energy consumption and costs, energy performance actions, SEP implementation costs, and the perceived value of ISO 50001, SEP, and other third party facility certifications. Following the interview, collected data were analyzed and if needed, follow-up information was collected via email. In this paper both quantitative and qualitative analyses are presented. Four groups of EnMS and SEP implementation related costs were collected during the interview process, as shown in Table 1. Capital project costs were also collected, but were not utilized in the calculation of SEP marginal payback.

Table 1. Cost Determination Methodology

Cost Category	Method of Quantifying Cost
Internal staff time associated with EnMS implementation, audit preparation, and SEP data collection	The estimated time (in FTE and duration) was collected for staff to develop and implement the EnMS and prepare for third party certification. 1 FTE was assumed to be equivalent to a fully-burdened annual salary of $125,000 (salary.com 2013).
External technical assistance to assist with EnMS implementation	Costs in dollars were collected directly when available. For some of the demonstration facilities where U.S. DOE provided no-cost coaching, the associated cost was estimated to be $24,000/year for the duration of the coaching sessions, based on 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.

1 The SEP Mature Energy Pathway gives participants with more mature energy management programs an alternative method to achieve SEP certification, but is not the focus of this paper.
2 A self-declared pathway will be available in the later part of 2013.

Quantifying Benefits

The facility-supplied EnPI tool provided baseline year energy consumption and regression models necessary to calculate subsequent monthly energy savings. Energy cost savings are calculated using energy prices supplied by facilities or state-specific monthly energy prices available from the Energy Information Administration (U.S. DOE 2013b, c). Other productivity gains are not quantified, though are known to result from EnMS and energy performance improvement actions (Gordic et al. 2010).

Monthly energy and energy cost savings are calculated for periods prior to and during participation in the SEP program. Energy cost savings includes savings from capital and operational improvement actions. As the nine facilities in this study initiated their participation in the SEP at different times, a common SEP program starting point based upon each facility's first SEP training served to normalize each facility's energy performance to each other. Monthly energy data was aggregated by three-month quarterly periods before and after the SEP training. Quarterly energy and energy cost savings percentages were calculated for each facility by comparing quarterly energy values and energy cost values to a quarterly average baseline value. Energy and energy cost savings are converted to percentage values allowing for the direct comparison and averaging of facility savings and to remove biasing due to differences in facility baseline energy consumption. Facility specific quarterly energy and energy cost savings percentages are averaged to create the aggregated results that are presented in this paper.

When averaged together, energy and energy cost savings percentages prior to the aligned first SEP training provide a clear quantification of BAU improvement. Savings percentages after the first SEP training are an aggregation of BAU savings and savings attributable to SEP. To disaggregate these values, the calculated BAU value is subtracted from each quarter's energy and energy cost savings percentage value.

Savings associated with implemented capital energy performance improvement projects are identified. Energy savings not accounted for by capital projects are assumed to be the result of operational (no or low-cost) energy performance improvement actions associated with EnMS implementation.

The marginal payback of participating in the SEP program is calculated using the below equation. Costs and benefits associated with implemented capital projects are not considered in this calculation, since SEP implementation has no specific requirements for capital projects.

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

Results

Implemented Energy Performance Improvement Actions

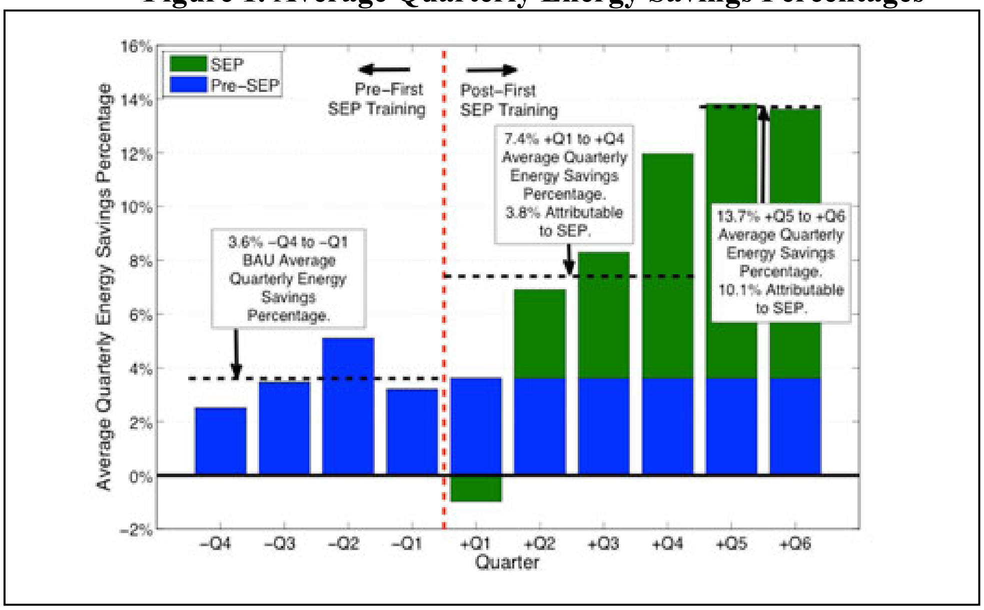
The split between energy savings due to capital and operational energy performance actions changed following facility participation in the SEP program. Prior to SEP participation the average split between capital/operational projects was 36/64, which shifted to 26/74 after EnMS implementation. Each of the nine facilities implemented operational actions and three facilities achieved SEP certification by implementing operational actions alone. Only one facility achieved greater than 50% of their energy savings from capital actions (66%). *Facilities reported that ISO 50001 helped identify operational improvements that previously had gone unnoticed.*

Energy and Energy Cost Saving Percentages

Energy saving percentages. Figure 1 presents average quarterly percentage energy savings as a function of average quarterly baseline energy consumption for all nine facilities. Results are aligned across facilities so that the first quarter starts when facilities received their first SEP training. Prior to the first SEP training (-Q4 to -Q1) BAU energy performance improved by an average of 3.6% against the baseline during each quarter. Energy savings percentage increases to 7.4% for the year during quarters +Q1 to +Q4 and 13.7% during quarters +Q5 to +Q6. The increase in percentage energy savings from the first year to the second year after SEP training coincides with the time facilities require to design and implement their EnMS. There may be further benefit from maintaining energy savings realized from previously implemented energy performance improvement actions – a feature of a fully functional EnMS.

Subtracting the BAU quarterly energy savings percentage from quarterly post-first training energy savings percentages reveals savings attributable to SEP. Energy saving percentages attributable to SEP in the first year after SEP training is 3.8% and 10.1% in the first half of the second year. Identification and implementation of deeper energy savings, coupled with their persistence once implemented, is an expected outcome from the ISO 50001 EnMS.

Figure 1. Average Quarterly Energy Savings Percentages

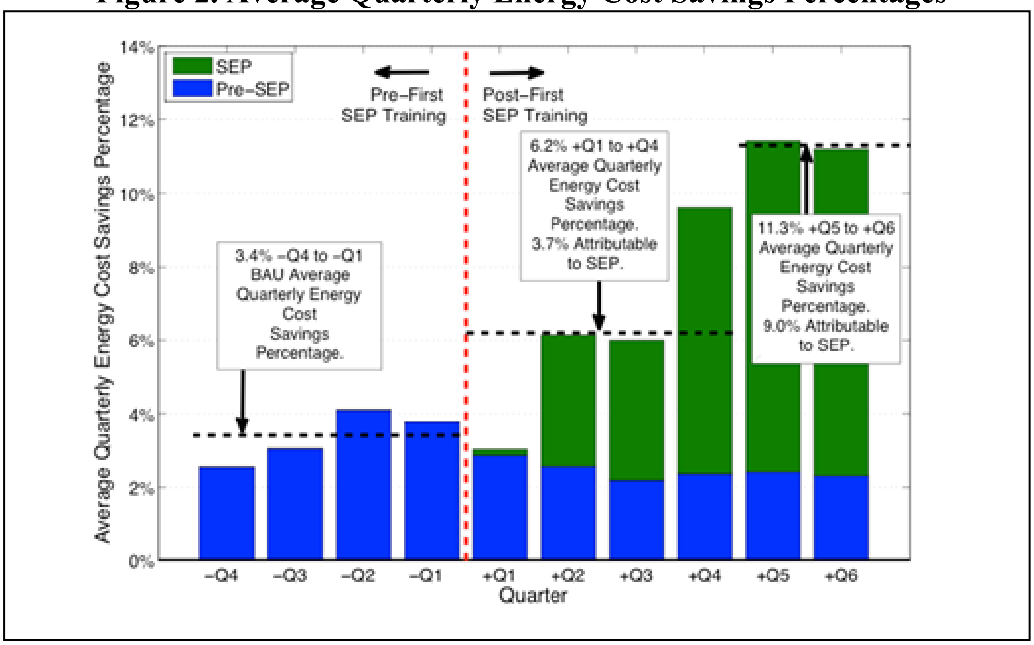


During the first quarter following the initial SEP training session (+Q1), SEP facilities are still in the initial stages of designing and implementing their EnMS. As the EnMS has not been implemented fully to identify energy performance improvement actions in +Q1, the average quarterly energy savings percentage value in +Q1 is not expected to be appreciably different that the BAU value. In fact the energy savings percentage value in +Q1 is lower than the average BAU value, similar to the variations in BAU seen prior to the first SEP training. As explained in the methodology, SEP attributable energy performance gains are calculated by subtracting the average pre-first SEP training BAU value from post-first SEP training values. The result of this methodology is that for quarter +Q1 SEP is attributed to a negative energy savings percentage value. Energy savings greater than BAU are realized starting two quarters after the first training.

Energy cost saving percentages. Quarterly energy costs saving percentages vary each quarter in a manner similar to energy saving percentages as seen in Figure 2. The 3.4% BAU (-Q4 to -Q1) quarterly average energy cost saving percentage value increases to 6.2% during the first year (+Q1 to +Q4) and 11.3% savings percentage during the first half of the second year (+Q5 to +Q6). Using the same methodology as with energy saving percentages, SEP attributable quarterly average energy cost savings values are calculated. SEP participation results in an additional 2.8% savings percentage over BAU during the first year after SEP training (+Q1 to +Q4) and an additional 9.0% savings during the first half of the second year (+Q5 to +Q8).

Detailed in previous literature, many energy use and consumption choices made by industrial facilities (including the selection of types of energy to purchase) are driven solely by energy costs (McKane, Scheihing, and Williams 2007). SEP program improvement targets are based upon energy savings, not energy cost savings. Even with this shift in focus, SEP results in greater levels of energy cost savings than were realized by BAU practices.

Figure 2. Average Quarterly Energy Cost Savings Percentages

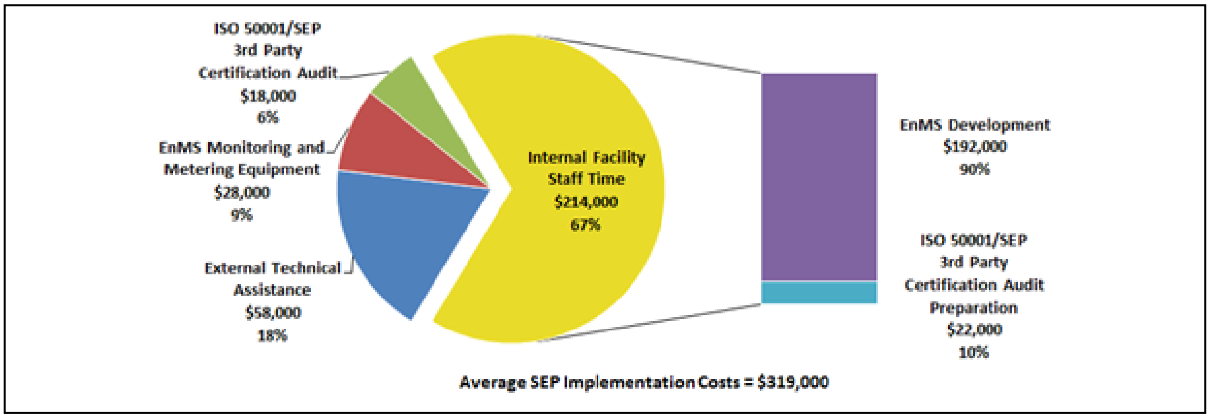


Post-first SEP training BAU energy cost savings percentages are calculated by multiplying energy cost savings by energy prices. Temporal energy price fluctuations result in unequal BAU values.

Costs Associated with SEP

Costs related to participation in the SEP program were analyzed. Figure 3 shows a breakout of average costs incurred as part of the SEP program. Including internal staff time, the overall cost per facility was $319,000, with values ranging from $207,000 to $498,000. Facilities with smaller baseline energy consumptions tended to have lower SEP implementation costs. The facility with the greatest implementation cost was one of the initial five facilities certified as part of the SEP pilot program. 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 and discussed below.

Figure 3. ISO 50001 and SEP Program Implementation Participation Costs



Internal facility staff time. Internal facility staff time represents the largest SEP implementation cost. Average staff time was 1.7 FTE and ranged from 1.1 FTE to 3.5 FTE or an average internal cost of $214,000 with a range of $141,000 to $432,000 over 1.1 years.

The composition of the energy team responsible for SEP implementation and certification varied. On average, each facility required a total of 1.5 person-years to develop, implement and maintain the EnMS. Typically the majority of positions on the energy team include staff already employed and the costs of their employment would have been incurred regardless of SEP participation. During preparation for ISO 50001 and SEP third party certification, additional support was required for a short duration. As seen in the bar chart of Figure 3, the additional certification preparation costs accounted for 10% of internal facility staff costs.

External technical assistance. All nine facilities utilized the expertise of external consultants and trainers. As part of the SEP program demonstration the U.S. DOE Advanced Manufacturing Office usually covered the costs of external technical assistance. These costs are included in this work as described in the methodology.

External staffing costs were calculated on average to be $58,000 per facility with a range of $26,000 to $167,000. The concepts of an integrated EnMS were new to many of the facilities and all facilities reported that external technical assistance was crucial in reaching a successful completion of the SEP program. External consultants were able to keep facilities on their established timelines, assist with the EnPI tool, and help in the design and organization of documentation. The continued support of an external technical assistant is not anticipated by facilities planning on recertifying in the SEP program.

EnMS metering and monitoring equipment. The SEP program requires that facilities meter, monitor, and record energy consumption data for identified significant energy uses (SEUs), as well as the facility as a whole. In most cases facilities used utility revenue meters along with a mix of preinstalled and new sub meters for their SEUs. Four of the nine 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 nine facilities was $28,000 (9% of total costs) with a range of $0 to $159,000. Excluding the facility that purchased a far greater amount of metering than needed, the average cost was $15,000.

Facilities identified that the installation of metering and monitoring equipment would have long-term benefits with relatively low maintenance costs. The use of metering was highlighted by facilities as a key part of proving the value of their EnMS and the SEP program.

ISO 50001/SEP third party certification audit. Third party verification of EnMS conformity with ISO 50001 and achievement of SEP energy performance improvement targets is an SEP certification requirement. The average cost for all third party auditing and certification was $19,000, ranging between $16,000 and $20,000 due to the size of the audited facility. The cost of ISO 50001 and SEP program certification is marginally higher than ISO 50001 certification alone. Certification costs are comparable to other standards such as ISO 14001.

Facilities indicated that the cost of certification was not cost prohibitive and provided greater confidence in their EnMS and energy performance results. Third party certification also enabled facility staff to more credibly communicate the value of their EnMS to top management, as well as demonstrate to the supply chain and others a willingness to invest in sustainability and reduce production costs.

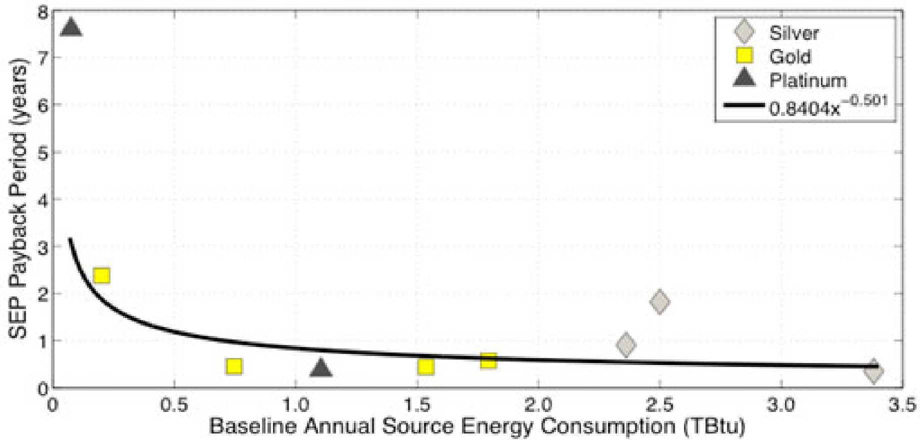
Costs moving forward. As the major cost of SEP participation is tied to the staff time required to develop an EnMS, it is anticipated that costs realized by certified SEP demonstration facilities will be lower when they recertify to the SEP program. Metering costs will shift from purchases of new meters to maintenance of existing meters. Consultant expertise will still be valued, particularly before an external audit, but dependency on external assistance will reduce. For a company seeking to certify a second facility to SEP, interviewees estimated that staff time would be 20 to 30% lower than needed at the first facility, reducing the largest cost of SEP participation. In addition, the U.S. DOE is developing cost-reduction strategies including improvements to online tools, utility support, and working with the U.S. DOE Better Plants partners to scale SEP across the corporation to gain economies of scale.

Payback

SEP payback was determined for each of the nine facilities and plotted against facility baseline source energy consumption in Figure 4. These data indicate that SEP participation is expected to have a less than 2-year payback for facilities with an annual energy consumption level greater than 0.20 TBtu. A curve was developed and fitted to the data. Data points for 2 facilities, each with a baseline source energy consumption of approximately 2.5 TBtu, do not fit well with the trend line. These points represent facilities that achieved significantly lower than average energy performance improvements. Including all facilities the developed function has an R^2 value of 0.56. Removing these facilities and including only facilities, that achieved the Gold or Platinum levels of certification (≥ 10% improvement) the R^2 value increases to 0.90. With additional data, separate payback functions are expected to develop for each achievement level.

Increasing the benefits (energy cost savings) or reducing the costs (detailed above) will reduce SEP payback. As previously discussed, the costs of implementing SEP are expected to decrease, shifting the developed function in Figure 4 to the left and down.

Figure 4. Payback Period



Qualitative Benefits

In addition to quantitative benefits, all facilities indicated that they realized qualitative benefits from SEP certification. Identified benefits varied from facility to facility, but common themes emerged. Facilities were often able to uncover previously overlooked no or low-cost operational energy performance improvement actions and more effectively communicate the value of continuously improving energy performance across the facility (from energy end-user to top facility and corporate management).

External verification and certification provided top management with confidence in the energy performance improvement results, which led to a greater willingness to provide additional resources for further energy performance improvement actions. Third-party certification gave credibility to energy savings claims and made the local community aware of sustainability efforts. Consistently cited during the interviews, these benefits were a result of having third party certification of the EnMS and verification of the resulting energy performance improvements. Facilities related that *while the ISO 50001 EnMS provided a strong business process to manage energy, the addition of SEP energy performance improvement targets and third party certification provided significantly enhanced value, making the program worthwhile.*

Future Work

The methodology developed for this study will be refined and used in future work. As additional facilities are certified, data will become available for analysis, building confidence in the results presented in this work. Focus will be placed on studying small and medium facilities, as well as facilities that did not receive assistance as part of the demonstration program.

Future studies will require a different research approach. The current data collection process of conducting phone interviews and processing facility data on an individual basis is not scalable. To address this issue and provide value to participating facilities the U.S. DOE is examining integrating the developed costs/benefits methodology into future versions of its EnPI tool. This action will standardize and streamline data collection and analysis, allowing facility specific cost/benefit results to be available immediately for facilities.

To build on the positive experience from SEP, U.S. DOE initiated the GSEP partnership, which currently includes 11 participant countries. Though similar in name, GSEP is not a global extension of the U.S. based SEP program, but an initiative to enable the sharing of best practices of national programs and policies that encourage the adoption of energy management systems and ISO 50001. By expanding the body of knowledge pertaining to the costs and benefits of ISO 50001 EnMS and energy performance improvement targets, this work evidences the cost/benefits and value of EnMS implementation. This work highlights results achieved by the U.S. domestic EnMS program, providing insights other countries may wish to use when developing or modifying their own EnMS program. Additionally, other countries can use the methodology developed as a common EnMS analysis framework to allow for comparative evaluation of EnMS programs. The methodology, analysis, and results of this study are being used to inform the creation of a framework for a planned GSEP Energy Performance Database that will be used to collect and analyze EnMS program and energy performance data from around the world.

Conclusions

Participation in the Superior Energy Performance (SEP) program requires implementation of and certification to ISO 50001 EnMS and achievement of specific energy performance improvement targets as verified by an accredited verification body. A methodology was developed to quantify the costs and benefits of participation in the SEP program. Energy consumption, cost, and saving data were gathered from nine U.S. facilities that operate in different industrial sectors and have annual baseline source energy consumptions ranging from 0.075 to 3.380 TBtu. Qualitative responses to a series of questions about the value of the ISO 50001 EnMS, SEP program, and third party certification were also collected.

The EnMS process begins by identifying current energy practices and energy performance opportunities. Facilities indicated that the data driven SEP program enabled them to identify additional operational (no or low-cost) energy improvements and quantify the impact of these actions on energy performance. The majority of energy and energy cost savings (74%) can be attributed to operational energy performance improvement actions. Three facilities studied implemented only operational actions, achieving average energy savings of 9.2%.

Analysis of data showed that all nine facilities achieved greater energy savings percentages during participation in the SEP program than beforehand. SEP is attributed with increasing average quarterly energy saving percentages an additional 10.1% above the BAU of 3.6% during the second year after the first SEP training. Similar saving levels were realized with respect to energy cost savings. Quarterly average energy cost savings of 8.7% were calculated for the 8 quarters following the first SEP training of which 6.2% is attributable to SEP. *The implementation of ISO 50001 coupled with SEP energy performance targets results in quantifiable and significant energy (0.174 TBtu per year, on average) and energy cost savings ($503,000 per year, on average).*

The costs for facilities to develop, implement, and certify to ISO 50001 and SEP was $319,000 on average. The bulk of this cost is associated with internal staffing time. Since a large portion of the total facility costs associated with achieving initial SEP certification stem from establishing the EnMS and from the purchase of new energy monitoring and metering equipment, it is anticipated that recertification in the SEP program will have a lower cost.

Payback rates for implementing the ISO 50001 EnMS and SEP certification were found to be a function of facility baseline source energy consumption. Based upon this study, facilities with baseline source energy consumption greater than 0.20 TBtu can expect a less than two-year marginal payback for SEP participation. This facility energy consumption threshold is expected to lower as SEP implementation costs are reduced by normal continual improvement processes within companies in adopting SEP at multiple facilities. All facilities interviewed in this study stated their interest in pursuing recertification of SEP and expressed that SEP certification provided a high value for both internal and external reasons. Additionally, several plants stated that other corporate facilities would be pursuing SEP. As industry develops a greater knowledge of EnMS, payback periods for the SEP program are anticipated to decrease.

The methodology developed for quantifying SEP costs and benefits can be applied to EnMS programs and in the development of the GSEP Energy Performance Database project.

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