ISO 50001: Energy Management Systems: A Driver for Continual Improvement of Energy Performance

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ABSTRACT

The International Organization for Standardization (ISO) has moved ISO 50001 Energy Management Systems to Final Draft International Standard (FDIS), to be published on June 15, 2011. ISO 50001 can play a unique role in accelerating and deepening improvements in energy performance in the industrial sector because of its emphasis on continual improvement both of energy performance as demonstrated by data collection and analysis and of the energy management system. Results from application of similar national energy management standards and the draft ISO 50001 have demonstrated facility-wide improvements in energy intensity, primarily from operating improvements, of 5-15%. ISO 50001 is applicable in all sectors. This paper explores some valuable insights for the industrial sector based on the methodologies used in the building sector.

ISO 50001 requires an energy planning process initiated by top management. The planning process drives data collection and analysis of energy use and consumption. This includes the development of energy baseline(s), which are used in conjunction with Energy Performance Indicators (EnPIs), to demonstrate energy performance. These EnPIs are developed to represent the organization at several levels including but not limited to, the facility, the energy system level, the processes, and the equipment level.

The paper concludes by noting the importance of requiring continual improvement in ISO 50001.

Introduction: What Is ISO 50001 and Why Does It Matter?

The publication by the International Organization for Standardization of ISO 50001 Energy Management Systems with guidance for use on June 15, 2011 will provide requirements for an organization to establish, implement, maintain, and improve an energy management system. This voluntary standard will apply to any organization that uses energy, including the industrial, commercial, institutional, transportation, and energy supply sectors. Its likely impact will be both large and broad. Uptake of ISO 50001 will likely be driven by companies seeking an internationally recognized response for sustainability programs, energy cost reduction initiatives, reducing the impacts of energy or emissions created along the manufacturing supply chain, future or current cap and trade programs, carbon or energy taxes, and the increasing market value of “green manufacturing” and a reduced carbon footprint.

There are also internal reasons why a company might consider adoption of ISO 50001. These may include:

- Energy cost savings beyond existing initiatives;
- Improved energy efficiency of operations and processes;

- Increased achievement and maintenance of energy savings;
- An internationally recognized structure and methodology to both support and report energy performance gains that allows consistent evaluation procedures for facilities across an organization.

The purpose of an Energy Management System (EnMS) is to provide organizations with a systematic approach for managing energy use and consumption based on measurement, planning, operational control evaluation, and management review processes. The goal for industrial facilities is to integrate continual improvement of energy performance into their management practices, including fine-tuning production processes and improving the energy efficiency of industrial systems and facilities. Energy management seeks to apply to energy use and consumption the same culture of continual improvement that has been used successfully by industrial firms to improve quality and safety practices, with the added advantage of data-driven decisions and demonstrated energy performance improvements.

Energy performance is a key concept of ISO 50001. Energy performance encompasses energy efficiency, energy conservation, energy intensity, energy use and energy consumption. The key elements to energy performance are listed in Table 1.

Table 1: Key Elements of Energy Performance

3.11	Energy Performance: measurable results related to energy efficiency, use and consumption NOTE 1: In the context of energy management systems, results can be measured against the organization's energy policy, objectives, targets and other energy performance requirements NOTE 2: Energy performance is one component of the performance of the energy management system
3.17	Energy Use: manner or kind of application of energy NOTE: Examples are ventilation, lighting, heating, cooling, transportation, processes, production lines.
3.7	Energy Consumption: quantity of energy applied
3.26	Significant Energy Use: energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement NOTE: Significance criteria are determined by the organization.
3.12	Energy Performance Indicator (EnPI): quantitative value or measure of energy performance as defined by the organization NOTE: EnPIs could be expressed as a simple metric, ratio or a more complex model.

Source: ISO Final Draft International Standard 50001 (numerical references from published draft Standard)

The basic elements of an EnMS can be summarized as follows:

1. *Energy policy:* top management's official statement of the organization's commitment to managing energy.
2. *Cross-divisional management team* led by a representative who reports directly to top management and is responsible for overseeing the implementation of the energy management system.
3. Energy Planning process which drives the energy management system through the use of the following steps:
   a) *Energy review* to assess current and planned energy use, energy sources and consumption and identify opportunities for improvement
   b) *Baseline(s)* of the organization's energy use.
   c) *Energy performance indicators* (EnPIs) that may be unique to the organization and are tracked against the baseline to measure progress.
   d) *Energy objectives and targets* for energy performance improvement at relevant functions, levels, processes or facilities within an organization.
   e) *Action plans* to meet those targets and objectives.
4. *Operating controls and procedures* for significant energy uses
5. *Measurement, management, and documentation* for continuous improvement for energy efficiency
6. *Periodic reporting of progress* to top management based on these measurements.

A truly unique feature of ISO 50001, as compared to other ISO management system standards, is the ***emphasis on a data-driven approach*** to demonstrating not only the continual improvement of the EnMS, as characterized by the Plan-Do-Check-Act approach, but also the *demonstration of continual improvement of the resulting energy performance*. As a practical matter, this dual emphasis means that an organization cannot remain in conformance with ISO 50001 solely through the creation and refinement of management policies, procedures, and processes, even when supported by documentation, records, training and other activities typically associated with a management system standard. ***The organization has to continually improve its energy performance based on measurement and other data***. While the method and amount of improvement is left to the organization, this emphasis on continual improvement of energy performance is what makes the potential impact of ISO 50001 so large.

An Innovative Approach to Developing a Suite of EnPIs

In addition to the requirements to track improvements in the energy performance of existing facilities, processes, systems, and equipment based on measurement, there is also a requirement to consider energy performance and operational control in design. This requirement applies to "new, modified, and renovated facilities, equipment, systems, and processes that can have a significant impact on its energy performance." Since these are typically for significant energy uses, the organization will need to take into consideration "other relevant variables", such as weather or production levels, that affect the energy consumption. This consideration may be accomplished using either regression analysis tools or through simulation models that range from very simple to very detailed.

For new or modified/renovated design, the use of EnPIs for *both simulation and post-installation measurement* provides better feedback to energy managers than exclusive reliance on one type of EnPI. The benefits of this approach of creating multiple EnPIs include a much greater understanding of energy performance. An example from the building sector is used to illustrate these benefits. The buildings sector example is relevant because:

- The energy performance of building types is better known than industry;
- The U.S. has three decades of experience and feedback from the field on how to standardize simulation programs and calibrate their performance to experimental results; and
- Energy performance depends on a somewhat narrower range of potential variables compared to most industrial processes.

Buildings are often rated for energy efficiency in terms of simulated energy performance. This process allows fair comparisons to be made of buildings using comparable levels of energy efficiency technologies. It further distinguishes the efficiency of the building from the behavior of the occupant and energy or climate control manager and from variations in weather or in functionality. Such ratings are called “asset ratings” because they measure the potential energy performance of the building as a fixed asset. Asset ratings are used for: energy code compliance, programs such as the US Green Buildings Council’s Leadership in Energy and Environmental Design (LEED) ratings, the Department of Energy’s Builders Challenge program (Department of Energy 2011), the Energy Star new homes program, and qualification with tax incentives programs that were enacted by Congress beginning with the Energy Policy Act of 2005.

Asset ratings are most useful to owners or perspective owners of buildings, since they rate performance independent of tenant type (retail, office, or other) and the quality of energy management effort. For commercial buildings, repeatable asset ratings can be defined by Commercial Energy Services Network (COMNET) standards (COMNET 2011). Residential buildings use the standards of the Home Energy Rating (HERS) index (RESNET 2011) for the programs mentioned above and in voluntary labels by builders.

Buildings can also be rated in terms of metered energy performance, potentially adjusted for variables such as weather and occupancy levels. A good example of such an “operational rating” is the Energy Star commercial buildings program (Energy Star 2011). This program is based on adjusting metered data for at least a full year of operation.

Asset ratings are essential in developing energy management programs and objectives, since they allow predictions of energy savings that will occur due to features that have not yet been installed. They also allow an “apples-to-apples” comparison of how far a building has gone in adopting efficiency measures and design techniques, as described below.

Asset ratings for buildings are based on the concept of a “reference building”, defined as a building with the same floor area as the building being rated and efficiency features at the level prescribed in a base case. The base case may, in turn, be based on a model energy code or on the features of a typical building. The proposed or actual building and the reference building are both modeled using identical prescribed assumptions for a typical weather year.

A building that employs the same energy efficiency features as the reference building will have the same asset rating as that of the reference building. Thus one with greater efficiency features will be rated as having lower energy consumption than the reference building. U.S. national systems for rating both residential and commercial buildings offer an index of efficiency that is calculated as the ratio of the energy use or annual energy cost of the proposed building to that of the reference building. This ratio allows fair comparisons of buildings across sizes and occupancy types. A large office building that scores 20% lower energy use than the reference can be considered more efficient than a small retail building that scores 10% higher energy use than the reference.

This ability to compare across building types, occupancy categories (such as office or assembly space or retail), and sizes allows an organization with a varying portfolio of properties seeking to show continual improvement through ISO 50001 by benchmarking their buildings performance as part of their planning process. This is recognized as a "valuable input to an objective energy review and consequent setting of energy objectives and energy targets" (International Organization for Standardization 2011).

The benefit from benchmarking performance for users of ISO 50001 applies to both new construction and retrofits, because a complying organization must take into consideration both energy performance improvement opportunities based on design and equipment choices as well as those based on operational control. Depending on the needs of the organization, this might lead the organization to look at data concerning what a good efficient building is expected to score (Department of Energy 2011; New Buildings Institute 2011) and set a goal commensurate with that data; or predict the outcome of different potential retrofit projects and choose the one closest to the organization's energy policy and goals.

Asset ratings are relatively simple to generate for buildings because they are based on the same physical characteristics and diagnostics as would be required to demonstrate compliance with energy codes, and because the software standards for these systems require that most of the inputs be fixed automatically in the software. Data entries required from users are mainly limited to the parameters that would appear on energy code compliance forms, such as U-values and areas of envelope assemblies, rated efficiencies of heating and cooling equipment, power ratings of fans and lights, etc. These requirements take a lot less time to collect and require a more modest level of expertise than running energy simulation tools directly, where the user has to input hundreds of variables that are set as defaults in asset rating software. (Note: such software systems are not in widespread use for nonresidential buildings outside of California, so some readers may not be familiar with them, and instead may have a mental image of asset ratings requiring engineers to run complex building simulation programs manually.)

Asset ratings, although useful, do not address some critical elements of energy management. There is considerable variation from building to building in the ratio of metered energy consumption to simulated energy use as computed for asset ratings, although the *averages* of metered results are consistent with the simulations (New Buildings Institute 2003 and 2008).

One important reason for this variation is related to variations in operation. If the goal of an organization's energy policy is actually to save energy, or merely to demonstrate compliance with ISO 50001, then its EnPIs must consider its buildings' operation. An energy plan that considers both capital assets and operational effectiveness will perform better than one that looks at only one component of the issue. In sum,

- Asset ratings alone can tell you how good the energy efficiency technology in a building is, however good technology does not assure low energy consumption.
- Operational ratings alone can tell you how your building compares to itself in previous years or to other buildings, but:
  - Low energy consumption buildings are not necessarily better buildings;

– High energy consumption ratings offer no guidance as to whether the building is in need of mechanical improvements, better operation, or is being used in a way that is inherently more energy-intensive.

Synergies from Using Both Asset and Operational Ratings

Deriving both types of ratings offers insights that neither one can do on its own. A building that is efficient in construction and design will have a low energy consumption asset rating. The use of an asset rating based on standardized operating assumptions can help an organization review its performance at constructing or retrofitting its buildings to high levels of efficiency.

Predicted low energy consumption coupled with measured average or high consumption is often an indicator of bad operating procedures; however:

- It may also be due to different energy uses or different occupant needs;
- It may mean that actual construction is less efficient than was planned and should be remediated or retrofitted;
- Comparisons of predicted and actual energy consumption can improve the accuracy of simulation, and increased accountability for simulation inputs leads to better asset ratings.

The problem of differences in user needs can be addressed analytically by establishing a second asset-rating EnPI that is user-dependent: the projected energy consumption of the building operated not at standard conditions but rather at *the conditions that are actually expected or occurring.* Operational effectiveness can then be measured by comparing this EnPI with the operational rating. Thus a school building with a swimming pool will be analyzed in a way that models the pool and its related water heating, pumping, and dehumidification energy consumption. An office building with a law office on the 20th floor will be modeled with some of the offices illuminated and conditioned until midnight and on Saturdays or Sundays. A building with a data center or a laundry facility will be modeled considering planned operations, including the process energy.

This new EnPI—the simulated energy as modeled under actual, individual conditions—may not offer much guidance on how efficient the building is, but it offers considerable management value as a basis for comparison with the operational rating EnPI. If both ratings are the same, this is likely to be an indication of good energy management practices. If the operational energy consumption is substantially larger than the user-dependent asset EnPI, it suggests that the next step in the energy plan should be to improve operations. If the operational EnPI is lower than the asset EnPI, this might suggest exemplary energy management, but it might also suggest that energy services are being compromised. For example, ventilation levels may be below specification or uncomfortable temperatures are common.

Comparisons between the three EnPIs—the asset rating under standard operating conditions, the simulated energy under actual operating conditions, and the metered usage—might also uncover errors in estimating any one of the three, including:

- Poor input data for the simulations;
- Input assumptions that are not backed by measurement (such as air leakage rates that are not based on pressurization tests); or

- Metering inaccuracies such as faulty metering equipment or careless tracking of which circuits or fuel purchases are being recorded.

The use of these three EnPIs addresses all of the identified reasons why standardized asset ratings may be poorly correlated to operational ratings. The first set of reasons is concerned with differences in building physical characteristics:

- Variations in window area;
- Variations in indoor air quality;
- Needs for higher levels of lighting based on space use;
- Variations in amount of low intensity space (atria, storage areas, etc.); and
- Variations in solar exposure due to shading.

In addition, errors in inputting simulation models may also have an effect. (For buildings, these are likely to be significant in the data used by currently published studies, but are likely to diminish considerably when the potential for error or manipulation is reduced by COMNET-compliant automated software.)

Thus, a building with high window area, high ventilation rates, and with occupancies such as a jewelry store or an office space for computer graphics designer teams will score high energy consumption on an operational rating even if the levels of efficiency are identical to that of a similar size building with more convention characteristics and tenant uses. The system proposed here addresses this problem by providing the standard-assumptions asset EnPI to assess relative efficiency and the user-dependent asset EnPI to address comparisons between simulated and metered performance.

The second set of reasons for weak correlation between asset ratings and metered consumption is concerned with differences in operations:

- Operating hours for some or all parts of the building may vary from standard assumptions, and may also vary by month;
- Occupancy may vary due to employee travel or working offsite;
- Controls, energy systems, and /or equipment may not work properly;
- Planned operation of energy-using systems may be affected by occupant actions;
- Energy-intensive processes like food preparation, data processing, washing, etc, may occur onsite or offsite.

The methodology presented here for buildings could work equally well for industrial operations, assuming the availability of adequate data. For the case of industry, plant-specific simulation models of the energy performance of each production process can be constructed. These models may be as simple as a linear equation with a baseline energy use independent of output, adjusted for weather as appropriate, coupled with fixed energy consumption intensities per unit output for each of the major products produced at the facility. They also can be more complex, such as full chemical-engineering models that are based on the details of process design and operation. The ISO 50001 standard encourages the use of information at the facility, system, processes, and equipment levels. As EnPIs are developed from these different viewpoints, the ability of the organization to control and manage energy and make fact-based decisions will improve.

The first stage of improvement in energy management is typically from using facility and system level EnPIs and will occur as a result of the comparison of actual vs. expected energy consumption at the facility level. This comparison requirement contributes to the organization's understanding of energy use and consumption across time, thus contributing to continual improvement of energy performance. As the EnMS matures, the organization's measuring and monitoring ability and capacity also improves, thus allowing the organization to add process and equipment level EnPIs that support enhanced decision making.

Over time, the output of the ISO 50001 conformance process should provide better control, understanding, and decision making information related to products and customer needs. An organization that is serious about meeting its objectives will be encouraged to refine its EnPIs and related models to improve the quality and integration of these data, thus contributing to enhanced competitiveness. At the first stage, the user-independent asset EnPI may be difficult or impossible to estimate accurately because of a lack of information about comparable facilities. Developing methods for estimating user-independent asset ratings will require benchmarking across a representative sample of the industry.

While recognizing the inherent challenges in obtaining data for benchmarking entire industrial facilities, such models are already in use for a few industrial processes and are beginning to be used as a tool for managing the energy efficiency of major renovations of existing systems, such as compressed air and steam. The models eventually could be developed and operated under industry average conditions, or at best-in-class conditions, to establish a benchmark with which to compare the relative energy performance of proposed processes or systems. Due to the proprietary nature of operational data, each user of the model would either have to develop their own reference case or collaborate within a particular industry group to develop these reference cases by pooling proprietary data in a way that prevents disclosure.

Ideally, the models would be deployed to predict operational energy expected, either prospectively or retrospectively for a particular year, given inputs or product mix produced, level of operations, weather, or any other relevant variable. The results from application of these models could then be compared to metered energy. Reviewing energy performance from the perspective of the facility, process, and equipment levels ensures a management data-driven decision-making tool that can provide real market value to industrial organizations. Such a system of EnPIs could facilitate both the use and the effectiveness of ISO 50001 by providing more information on what numerical targets for improvement in EnPIs are possible.

One of the biggest challenges in managing energy in industrial facilities is that the energy use and consumption change frequently, and can be affected by many factors that are not all under the facility's control. In addition to routine production changes, such as the moisture content of incoming raw materials, there are other unforeseen factors, such as an economic recession or a natural disaster that can have a dramatic impact on the year-to-year improvement in energy performance of any given facility.

ISO 50001 accommodates these changes by allowing an organization to adjust its energy baseline if major changes occur. The Superior Energy Performance (SEP) program, which has been developed by DOE in collaboration with industry, has specific energy performance targets that must be achieved over a 3-year achievement period. The energy performance improvement is based on the SEP Measurement and Verification Protocol, which includes a methodology for modeling energy performance that allows a facility to compare "like to like" over the achievement period, so that any changes in conditions are normalized and actual changes in energy performance are clear.

This approach was tested during the initial demonstration program in Texas in the midst of the 2008-2009 global recession. Because some of the companies were operating at historically low levels of production and they had a fixed base load of energy consumption to maintain operations, metered energy use per unit of production rose. Without the ability to model to comparable conditions, these facilities would not have been able to demonstrate the actual improvements in energy performance that resulted from their efforts. The structure of EnPIs suggested here would have helped these facilities to understand whether or not they were meeting their energy plan's objectives in 2009 and 2010.

The Power of Continual Improvement

It is widely accepted that the potential to improve efficiency in the industrial sector is in the neighborhood of 14-22% cost effective savings by 2020[1] (National Academy of Sciences 2010). Such estimates are of necessity constrained by the availability of data on how major energy using processes are designed and on the technologies available to improve efficiency. There are additional constraints to identifying *operational* improvements that can be documented on an industry-wide basis or derived from the performance of individual plants. Many industrial firms apply more stringent payback periods on energy efficiency projects than they do on other capital projects, typically less than two years. The projected energy savings from proposed operational improvements may be heavily discounted by the firm and are typically excluded from consideration for public benefit fund incentives. These restrictions are indicative of the peripheral importance that energy holds in the management of many industrial firms, especially those outside of the most energy-intensive sectors. The focus in many firms is on the cost and security of energy supply.

ISO 50001 is designed to help top management integrate energy management into their other management systems, to commit the resources needed to effectuate their energy policy, and to realize demonstrated benefits in energy performance. It is anticipated that companies that actively manage their energy will be more receptive and strategic in investing in new energy efficient technologies than formerly because they will have a framework and a context for making high quality energy management decisions that are data-driven.

The standard's requirement of continual improvement offers some additional insights into the possible size of the efficiency resource. The SEP program is requiring complying industrial facilities to commit to at least a 5% energy savings over three years. This is an annual improvement rate of 1.6%. The best available estimates for business as usual place the "autonomous" improvement rate at 0.7-1.0% per annum (Senternovem 2009).[2] One could reasonably assume that for a new program trying to attract participants, the bar needs to be set conservatively low. One could also assume that a minimum goal of 1.6% annual improvement in EnPIs could result from market acceptance of ISO 50001.

If utilities or government agencies were able to incentivize organizations for both capital and operational improvements that are well documented and supported by an EnMS, this might

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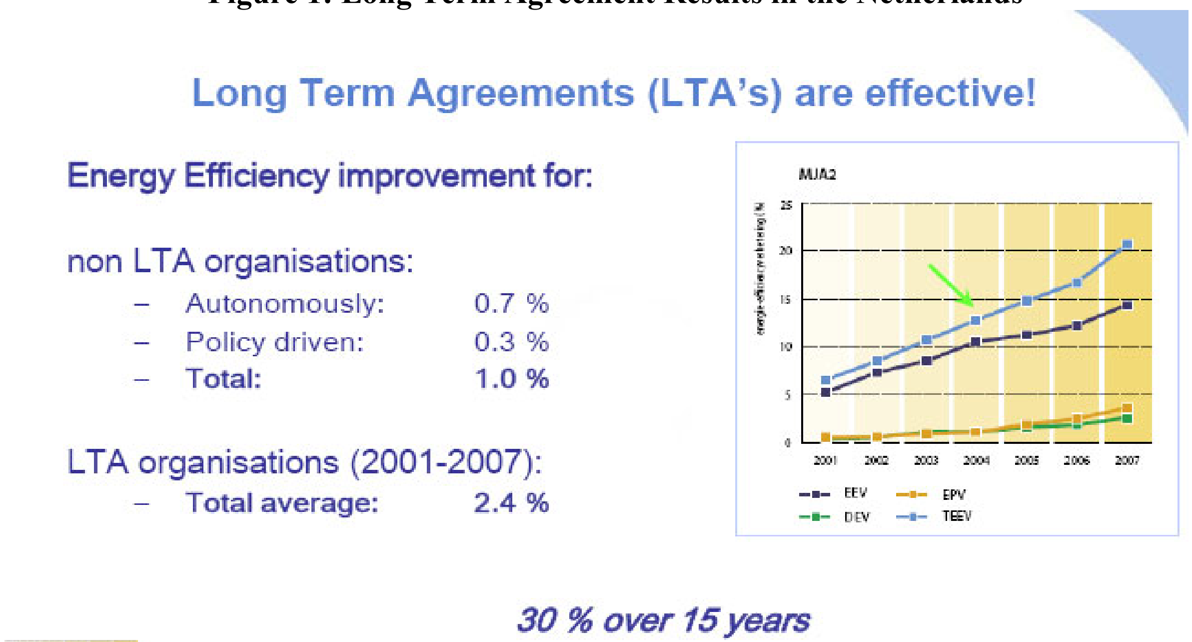
[1] Estimates of savings are not made for later years because of a lack of information on what additional efficiency options may be available, so in practice, this study does not find any greater potential for savings in 2030 than in 2020.

[2] Industrial Program Experts panel discussion (UK, Japan, Netherlands, Korea, US), UNIDO/SAC Towards an International Energy Management Standard, Beijing, April 2008.

further accelerate the rate of improvement. If data from the SEP program could be protected and aggregated, it could be used to develop sector-specific best practices for EnPIs that might help with this acceleration.

One could argue that maintaining such improvement rates is unlikely because once the low hanging fruit has been picked, the remaining savings are subject to diminishing returns. But this argument is contradicted by the evidence. Where continuing policies have been adopted to promote efficiency and energy management, industry does continue to improve, as illustrated in Figure 1.

Figure 1: Long Term Agreement Results in the Netherlands [3]



Source: Senternovem (now known as NL Agency) 2009.

The Netherlands initiated Long-Term Agreements (LTAs) with industry in 1992. These voluntary agreements between the Dutch Ministries and industrial sectors consuming more than 1 petajoule (PJ) per year were established in support of achieving an overall national energy efficiency improvement target of a 20% reduction in energy consumption between 1989 and 2000. For what became known as LTA 1, a total of 29 agreements were signed involving about 1,000 industrial companies representing about 90% of industrial primary energy consumption in the Netherlands. LTA 1 ended in 2000 with an average improvement in energy efficiency of 22.3% over the program period (Niujen 2002).

The initial focus of the program was on energy efficiency, but as it transitioned into LTA 2 for the period from 2001 to 2012, the approach included an Energy Management System which included many of the key elements of ISO 50001. By 2006, 90% of companies complied with either an energy management system specification or ISO 14001. The scope of LTA 2 included

[3] Dutch Abbreviations: EEV (energy efficiency improvement); DEV (renewable energy production improvement (on-site production and purchase); EPV (energy efficient product design improvement (efficiency improvement in the product chain); TEEV (total energy efficiency improvement (the total improvement of the above-mentioned indices).

life cycle efficiency, renewable energy, supply chain efficiency, and sustainable production. LTA 2 was subsequently extended to 2020 and LTA 3 (2009-2020) was developed specifically for energy intensive industries. It seeks a 30% energy efficiency improvement in the period 2005-2020 though sector roadmaps aimed for long-term innovation, provision of technical support from the government, implementation of an Energy Management System.

The success of the program in the Netherlands has been measured over 15 years with more than a 2 % average energy efficiency improvement annually based on a structure supplied by an Energy Management System (Senternovem 2009).

ISO 50001 could serve as a foundation for other policies that will allow both wider and faster acceptance of the standard and for an increase in the rate of EnPI improvement to which organizations are willing to commit. Utilities and other efficiency program administrators have run industrial efficiency programs for decades. But these programs have tended to focus on particular devices rather than facility-wide performance, and even the program elements that addressed whole plants did not usually take into account savings from operations and maintenance, or other non-capital-asset-based improvements. With the ISO 50001 framework for evaluating all the elements of facility energy performance, financial incentives can help organizations overcome even more of the market barriers and challenges that limit efficiency gains and energy performance improvements.

Incentive programs administered by agencies such as utilities or states could help overcome some of the barriers to efficiency investment that ISO 50001 does not address directly, such as access to capital that is consistent with maintaining the organization's financial ratings, or accepting projects with payback periods much longer than three years. Such programs that build on ISO 50001 and SEP can produce substantially larger savings than the nation could expect from a program that is voluntary but not incentivized.

If, for example, a very strong, well-funded, and comprehensive program of incentives and voluntary agreements to complement ISO 50001 were established in the U.S., results similar to that of the Netherlands (2.4% per annum) could be expected. If this result were applied to the whole industrial sector, industrial energy use would be cut by 35% by 2030 (compared to business-as-usual growth in industrial output). This is a reduction of at least 22% compared to the "autonomous" improvement rate of 0.7-1.0% per annum cited above, and is larger than the maximum industrial sector-wide savings found in the National Academy of Sciences study of the savings from energy efficiency (National Academy of Sciences 2010).

Conclusions

ISO 50001 offers a new tool to help organizations improve their energy performance. This tool has the potential to be used synergistically in conjunction with other policy efforts by utility and other efficiency program administrators, by educational institutions, and by state, regional, and national government agencies to promote energy efficiency and improved energy performance in the industrial sector by expanding the focus of programs from individual technologies to whole-facility performance.

ISO 50001 offers requirements for both management systems effectiveness and for energy analysis and improvement technologies, designs, and operational plans. Its primary focus in doing the latter is to require the development of EnPIs that are relevant to the organization's operation and that are objective measures of the organization's progress at meeting defined objectives for improved energy performance every year.

The standard does not require the use of any particular form or structure of EnPI, leaving such decisions to the organization that is demonstrating conformance. This paper offers suggestions on a structure of EnPIs that allow an organization to distinguish between improvements in technology and improvements in operations, enhancing its ability to rate its performance in both arenas, and allowing it to control more precisely for variations in external conditions that affect its energy use and consumption.

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