Thinking Globally: How ISO 50001 – Energy Management Can Make Industrial Energy Efficiency Standard Practice

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ABSTRACT

Industry utilizes very complex systems, consisting of equipment and their human interface, which are organized to meet the production needs of the business. Effective and sustainable energy efficiency programs in an industrial setting require a systems approach to optimize the integrated whole while meeting primary business requirements. Companies that treat energy as a manageable resource and integrate their energy program into their management practices have an organizational context to continually seek opportunities for optimizing their energy use.

The purpose of an energy management system standard is to provide guidance for 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. The International Organization for Standardization (ISO) has identified energy management as one of its top five priorities for standards development. The new ISO 50001 will establish an international framework for industrial, commercial, or institutional facilities, or entire companies, to manage their energy, including procurement and use. This standard is expected to achieve major, long-term increases in energy efficiency (20% or more) in industrial, commercial, and institutional facilities and to reduce greenhouse gas (GHG) emissions worldwide.

This paper describes the impetus for the international standard, its purpose, scope and significance, and development progress to date. A comparative overview of existing energy management standards is provided, as well as a discussion of capacity-building needs for skilled individuals to assist organizations in adopting the standard. Finally, opportunities and challenges are presented for implementing ISO 50001 in emerging economies and developing countries.

ISO 50001: Energy Management and Industrial Energy Efficiency

The principal business of an industrial facility is making a profit through production of goods and services, not energy efficiency. While there has been movement in industrial markets over the past few years to attribute a higher value to energy efficiency as a pathway for addressing climate change, typically in response to emissions trading schemes or shareholder activism, the fact remains that the first priority of industry is to remain profitable. Recent revival of arguments about how industry cannot afford to deal with climate change during the current economic downturn brings this duality sharply into focus. Energy efficiency has demonstrated, time and again, that it saves industrial firms money while having a positive effect on productivity.

Despite this, energy efficiency is still viewed during hard times as a luxury that industry can't afford, rather than a strategic investment in future profitability.

This phenomenon cannot be understood in purely economic terms because it is largely a function of institutional behavior. High energy prices or constrained energy supply will motivate industrial facilities to try to secure the amount of energy required for operations at the lowest possible price. But price alone will not build *awareness* within the corporate management culture of the potential for energy reduction and cost savings, maintenance savings, and production benefits that can be realized from the systematic pursuit of industrial energy efficiency. Managers, whether at the C-level or plant level, are not typically drawn from the ranks of facility engineering and often have little context for understanding the economic consequences of energy-inefficient operations and practices. It is this lack of awareness and the corresponding failure to manage energy use with the same attention that is routinely afforded production quality, waste reduction, and labor costs that is at the root of the opportunity.

To be effective, energy efficiency programs need to engage industry at the management level as well as facilities engineering. Because industrial decision making is largely driven from the top, failure to engage management results in missed opportunities for energy efficiency improvement, even when technical staff is educated and aware of the opportunities. This paper offers up a potential solution, an international energy management standard, *ISO 50001: Energy management and guidance for use*, suitable for any organization, whether industrial, commercial, or institutional.

To build context, an overview will be provided of the current status of energy management standards, regulations, and specifications in a number of countries as well as examples of enabling policies and programs used to promote adoption of these standards by industry. Because of its importance to future climate change mitigation efforts, particular attention will be given to existing and planned efforts to address barriers to future adoption of ISO 50001 by industries in developing countries.

The process of developing ISO 50001 will also be described, including international participation and a discussion of some of the core issues under consideration by the ISO committee responsible for this work, Project Committee 242 (ISO PC 242). The paper will conclude with a discussion of the anticipated impact of the standard in international markets, industrial decision making, and industrial energy policy.

An Overview of Energy Management Standards

The barriers to improving industrial energy efficiency have been well-documented and include:

- Lack of information regarding energy efficiency;
- Limited awareness of the financial or qualitative benefits arising from energy-efficiency measures;
- Inadequate skills to implement such measures;
- Capital constraints and corporate culture leading to more investment in new production capacities rather than energy efficiency; and
- Greater weight given to addressing upfront (first) costs compared to recurring energy costs, especially if these costs are a small proportion of production costs (Monari, 2008).

The purpose of an energy management standard is to provide an organizational framework for industrial facilities to integrate energy efficiency into their management practices, including fine-tuning production processes and improving the energy efficiency of industrial systems. Energy management seeks to apply to energy use the same culture of continual improvement that has been successfully used by industrial firms to improve quality and safety practices. An energy management standard is needed to influence how energy is managed in an industrial facility, thus realizing immediate energy use reduction through changes in operational practices, as well creating a favorable environment for adoption of more capital-intensive energy-efficiency measures and technologies.

An energy management standard requires a facility to develop an energy management plan. In organizations without a plan in place, opportunities for improvement may be known but may not be promoted or implemented because energy management is not part of the organizational culture and the normal planning process. This failure to plan reinforces traditional barriers, which include lack of communication among sites, poor understanding of how to create support for an energy efficiency project, limited finances and financial data, poor accountability for measures and perceived risk from changing the status quo. In addition, business metrics such as energy performance indicators that relate energy use to production output are typically not utilized, thus making it difficult to document improvements in energy performance.

Companies who have voluntarily adopted an energy management plan have achieved major energy intensity improvements. Some examples include:

- Dow Chemical achieved 22% improvement ($4B savings) between 1994 and 2005, and is now seeking another 25% from 2005 to 2015
- United Technologies Corporation reduced global GHG emissions by 46% per revenue dollar from 2001 to 2006,: an additional 12% reduction is sought from 2006 to 2010
- Toyota's North American (NA) Energy Management Organization has reduced energy use per unit by 23% since 2002; company-wide energy efficiency improvements have saved $9.2 million in NA since 1999.
- InterfaceFLOR, a carpet manufacturer, is a world leader in sustainable manufacturing and has reduced its energy intensity for manufactured carpet by 35% from 1994 to 2004 through a systematic continual improvement program in energy efficiency.

Denmark, Sweden, Ireland, Korea, Spain, Thailand, and the U.S. have a national energy management standard. Japan has a legal requirement for its more energy intensive industrial facilities to have an energy manager and an energy management plan. These requirements also extend to large commercial facilities and parts of the transportation sector. The Netherlands has an energy management specification closely linked to long-term agreements. The European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) have developed a common standard for the European Union, to be published in mid-2009. China also has a draft national energy management standard expected to be published in 2009.

Table 1 compares the elements of the energy management standards in seven countries or regions with existing energy management standards (or specifications) plus two under development and Japan (energy management required by legislation). In all instances, the standard has been developed to be entirely compatible with the ISO quality (ISO 9001:2008) and environmental (ISO 14001:2004) management standards. A number of countries have enabling

programs, such as target-setting agreements and/or tax policies, which drive the use of their national energy management standard. The importance of enabling programs to accelerate uptake of the standard cannot be overstated. As indicated in Table 1, market penetration of the US energy management standard is less than 5%, although it has been in place since 2000. This can be largely attributed to the lack of enabling programs and policies. The first such program, *Superior Energy Performance*, is now in its pilot phase.

While the existing energy management standards and specifications have many features in common, they have subtle variations in language, content, and approach. The continued proliferation of national and regional energy management activities in a market that is increasingly global in scope creates the need for an international approach. ISO now identifies energy management as one of its the top five priorities based on its enormous potential to save energy, increase profitability, and reduce greenhouse gas (GHG) emissions worldwide.[1]

A successful program in energy management begins with a strong commitment to continual improvement of energy efficiency. A first step once the organizational structure (management representative and cross-divisional/functional team) has been established involves assessing the major energy uses in the facility to develop a baseline of energy use and set targets for improvement. The selection of energy performance indicators and objectives help to shape the development and implementation of an action plan. The effectiveness of an action plan depends on the involvement of personnel throughout the organization, who need to be aware of energy use and performance objectives. Staff and those who work on behalf of the organization need training in both skills and day-to-day practices to improve energy performance. The results should be regularly evaluated and communicated to all personnel, recognizing high achievement. The emergence over the past decade of better integrated and more robust control systems can play an important role in energy management and in reducing energy use. [2]

Experience in countries with energy management standards has shown that the appropriate application of these standards requires significant training and skill. Implementation of an energy management standard within an organization requires a change in existing institutional practices toward energy, a process that may benefit from technical assistance from experts outside the organization. There is a need to build not only internal capacity within the organizations seeking to apply the standard, but also external capacity from knowledgeable experts to help establish an effective implementation structure.

[1] http://www.iso.org/iso/energy_management_system_standard

[2] Related ACEEE 2009 Industrial Summer Study paper: *Automated Demand Response: The Missing Link in the Electricity Value Chain*

Table 1: Comparison of National and Regional Energy Management Standards

Participating Countries	Management Commitment Required	Develop energy management plan	Establish energy use baseline	Management Appointed Energy Representative	Establish Cross- Divisional Implementation Team	Emphasis on Continuous Improvement	Document Energy Savings	Establish Performance Indicators & Energy Saving Targets	Document & Train Employees on Procedural/Operational Changes	Specified Interval for Re-evaluating Performance Targets	Reporting to Public Entity Required (Policy Outside Standard)	Energy Savings Externally Validated or Certified (Outside Standard)	Year Initially Published	Approx Market Penetration by Industrial Energy Use
Existing														
Denmark	yes	yes	yes	yes	implied	yes	yes	yes	yes	suggests annual	yes	optional[1]	2001	60%[2]
Ireland	yes	yes	yes	yes	implied	yes	yes	yes	yes	industry sets own	yes	optional[1]	2005	25%
Japan[3]	yes	yes	yes	licensed	yes	yes	yes	yes	yes	yes, annually	yes	yes	1979	90%
Korea	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes, annually	optional	optional[4]	2007	data not yet avail
Netherlands[5]	yes	yes	yes	yes	implied	yes	yes	yes	yes	yes	yes	optional[1]	2000	20-90%[6]
Sweden	yes	yes	yes	yes	implied	yes	yes	yes	yes	yes[1]	yes	optional[1]	2003	50%elect
Thailand	yes	yes	yes	yes	implied	yes	yes	yes	yes	industry sets own	yes	evaluation plan	2004	not known[7]
United States	yes	yes	yes	yes	yes	yes	yes	yes	yes	annual recomm	no	no[8]	2000	<5%[8]
Under Development														
CEN (EU)	yes	yes	yes	yes	implied	yes	yes	yes	yes	industry sets own	national schemes	national schemes	2009 (planned)	
China	yes	yes	yes	yes	implied	yes	yes	yes	yes	industry sets own	likely	not avail	2009 (planned)	

1 Certification is required for companies participating in voluntary agreements (also specified interval in Sweden). In Denmark, Netherlands & Sweden linked to tax relief eligibility.

2 As of 2002, latest date for which data is available

3 Japan has the Act Concerning the Rational Use of Energy, which includes a requirement for energy management

4 Korea invites large companies that agree to share information to join a peer-to peer networking scheme and receive technical assistance and incentives

5 Netherlands has an Energy Management System, not a standard, per se, developed in 1998 and linked to Long Term Agreements in 2000.

6 800 companies representing 20% of energy use have LTAs and must use the Energy Management System. The 150 most energy intensive companies, representing 70% of the energy use, have a separate, more stringent, bench marking covenant and are typically ISO 14000 certified, but are not required to use the EM System.

7 Thailand has made the energy management standard is mandatory for large companies, linked it to exisitng ISO-related program activities, coupled with tax relief; program evaluation not yet available

8 To date, the US government has encouraged energy management practices, but not use of the standard. A program was initiated in 2008 to address this which also includes validation; program evaluation results anticipated in 2011.

NOTE: National standards and specifications were used as source documents to develop this table

Source: McKane, 2007 as updated by the author in 2009

Supporting the Transition to Energy Management in Industry

The core of any energy management standard involves the development of an energy management system. For organizations already familiar other management systems, such as ISO 90001 (quality) and ISO 14001 (environmental), implementation of a management system for energy includes many similar elements. For these organizations, the need for outside assistance may be limited to an orientation period and initial coaching, especially in some of the more technical aspects of managing energy data and measuring performance. For organizations without such experience, varying degrees of technical support will likely be required for several years until the energy management plan is well-established.

The suite of skills required to provide the technical assistance needed for energy management is unique, since it combines both management systems and energy efficiency. Individuals and firms familiar with management systems, for example - quality, safety, and environment, understand the dynamics of establishing a management system and its successful integration into the organization's corporate culture. These experts, however, typically have little or no expertise in energy efficiency. In contrast, industrial energy-efficiency experts are highly specialized in energy efficiency, but are trained and oriented toward the identification and execution of energy-efficiency projects without a management system context. Globally, the need for energy management experts is expected to increase exponentially once ISO 50001 is published in early 2011. Capacity-building is urgently needed now to meet this growing need.

Several countries have initiated training and support activities in an effort to create both internal capacity within implementing organizations as well as external capacity by creating a cadre of experts in energy management. For building internal capacity, SenterNovem in the Netherlands and the Carbon Trust in the UK offer a series of web-based tools to assist industrial facilities seeking to initiate an energy management plan. Ireland and Sweden both offer industrial facilities training in energy management; the Irish also have tools such as the Energy MAP[3]. In the U.S., the Georgia Institute of Technology has an extensive training program for industrial facilities implementing the U.S. national energy management standard; this program is currently being modified to allow industrial facilities to access tools and training remotely, as well as in a classroom.

A well-developed program for both internal and external capacity-building for energy management already exists in Japan. An extensive series of training courses are offered to prepare for a qualifying exam to become licensed as a Qualified Person in Energy Management. Demand for the course is driven by a legislative requirement for five energy-intensive industries to appoint a Registered Energy Manager or a qualified person for energy management. For many other industries, there is a requirement to appoint a qualified person for energy management. [4]

A program to certify individuals for energy management via a professional certification program is also part of the U.S. energy efficient manufacturing initiative, *Superior Energy Performance*. This initiative is developing an American National Standards Institute (ANSI) - accredited certification of industrial plants based on conformance with ISO 50001 and improved energy performance. [5] It is anticipated that the Certified Practitioners will draw potential candidates from both energy efficiency and management system backgrounds. Candidates must

[3] http://www.sei.ie/energymap/
[4] Ushio, Y., 2008. "The Energy Manager System in Japan" from the Energy Conservation Center, Japan, presented at the Enhanced Energy Efficiency by Management Seminar, September 18, 2008, Singapore.
[5] http://www.superiorenergyperformance.net/

demonstrate experience in management systems and will be subject to a rigorous qualification exam, certified by an independent third party organization and, once certified, be subject to periodic professional enrichment requirements.

The United Nations Industrial Development Organization (UNIDO) is continuing its interest and support for energy management through the inclusion of capacity-building as part of its regional and national programs in a number of countries in Southeast Asia, plus South Africa, Russia, and Turkey. Since system optimization is not taught in universities or technical colleges, these programs also include capacity-building for system optimization, based on a successful model developed for a pilot program in China.

Role of Emerging Economies and Developing Countries

While the industrial sector represents more than one third of both global primary energy use and energy-related carbon dioxide emissions (Price et al., 2006), it is frequently in excess of 50% in emerging economies and developing countries and can lead to conflicts with constraints on energy supply. Further, countries with an emerging and rapidly expanding industrial infrastructure have a particular opportunity to increase their competitiveness by applying energy-efficient best practices from the outset in new industrial facilities. For example, 80% of global industrial growth in over the past ten years has been in China (IEA 2007). Integrating energy efficiency into the initial design or substantial redesign is typically less expensive and allows for better overall results than retrofitting existing industrial facilities. Conversely, failure to integrate energy efficiency in new industrial facility design in emerging economies and developing countries represents a large and permanent loss in climate change mitigation potential that will persist for decades until these facilities are scheduled for major renovation. The current economic downturn provides a unique opportunity for industry, particularly rapidly growing industries in developing countries, to regroup and embed energy management practices in anticipation of the next cycle of economic growth.

UNIDO recognized the industry's need to enhance competitiveness while responding effectively to climate change and to the proliferation of national energy management standards. In March 2007, UNIDO hosted a meeting of experts from developing countries and emerging economies, nations that had adopted or were developing national energy management standards and representatives from the ISO Central Secretariat. That meeting led to submission of a formal recommendation to the ISO Central Secretariat to consider undertaking work on an international energy management standard.

UNIDO has been supporting the development process of ISO 50001 by facilitating the participation of developing countries and emerging economies in the process through international and regional workshops, and a survey on energy management in industry.

A key objective of the UNIDO survey is to better understand the potential opportunities, barriers and challenges for industry in adopting and implementing energy management standards. In partnership with the Standards, Productivity and Innovation Board (SPRING) and the National Environment Agency (NEA) of

Table 2: Distribution of Survey Respondents

	Size			
Sector	Small	Medium	Large	**Tot**
Chemical	0	1	3	**4**
Electronic	1	0	6	**7**
Food & Beverage	0	2	1	**3**
Textile	0	0	1	**1**
Pharmaceutical	0	3	5	**8**
Wafer fabrication	0	1	3	**4**

Singapore, UNIDO piloted the survey in July 2008. The Survey was sent to 47 enterprises of six different sectors, with 27 enterprises completing and returning the survey. Table 2 shows the sectors and distribution of respondents by company size. Below is a summary of the results.

The Catalytic Role of ISO9000/ISO14000

The majority of enterprises using management system standards such as ISO 9001 and ISO 14001 have some elements of an energy management system in place. Most of these ISO certified organizations have an energy policy (Fig 1) and most organizations with such a policy have energy efficiency and performance goals (Fig 2) and management- appointed responsible persons. However, at the level of implementation and performance/management review, signs of inconsistency and weak methodologies appear together with limited use of systemic approaches (Figs 3 and 4).

Fig. 1: Enterprises ISO 9001/14001 Certified

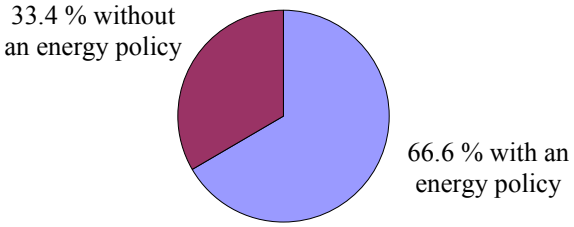


Fig. 2: Enterprises with Energy Policy

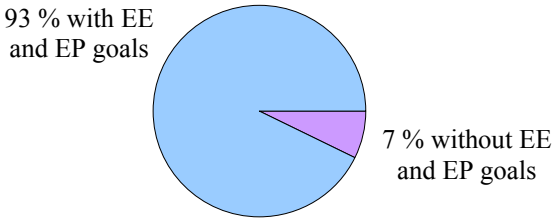


Fig. 3. Enterprises with Energy Policy — Energy Audits

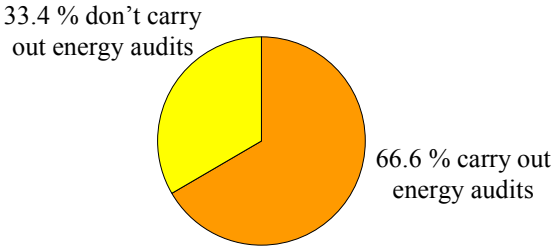
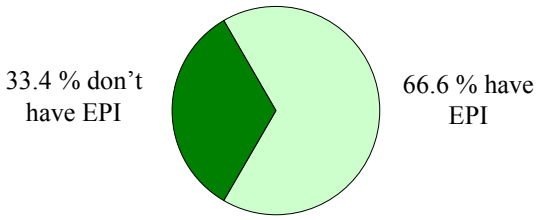


Fig. 4. Enterprises with Energy Policy — Energy Performance Indicators (EPI)



The Information and Technical Capacity Gap Challenge

As previously mentioned, experience with national energy management standards has demonstrated that the adoption of voluntary standards is heavily dependent on the existence of supporting programs and incentives. Responses to the pilot survey appear to reinforce the need for articulated programs targeted to intervene at all levels of the energy management decision-making, development, financing, and implementation process. The lack of information at the plant level remains a key barrier to improved energy management and energy efficiency in industry. This sample indicates a high level of interest in access to expert networks, sector-specific energy efficiency expertise, and technical tools (Figs 5 and 6). Energy benchmarks are seen as highly useful, yet remain largely unavailable (Fig 7).

While the small sample of respondent enterprises (27 out of 47) does not allow extrapolation of results to Singapore industry as a whole, the data has provided useful insight and hints for further analysis. The survey is currently being replicated in Brazilian enterprises in collaboration with the Brazilian National Confederation of Industry and will be implemented in a modified form in Southeast Asia. It is important to note that Singaporean industries are better aligned with developed, rather than developing economies relative to the integration of energy management into business practices. It is reasonable to assume that the need for access to energy efficiency information and skills will be even greater in developing countries

Fig. 5: Access to Relevant Industrial EE Networks of Experts

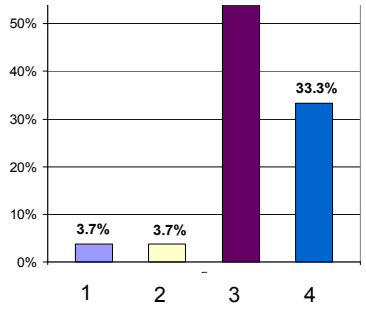


Fig. 6: Availability of Detailed EE Implementation Toolboxes Tailored to Specific Sectors

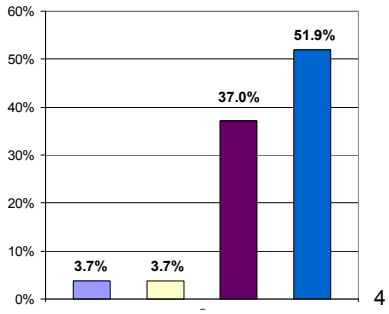
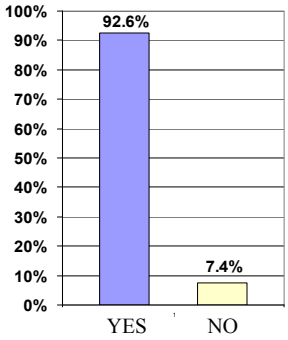


Fig. 7: Would Energy Benchmarks Help your Company in Being more EE?



Scoring legend: 1 = Not useful 2 = Quite useful 3 = Useful 4 = Very useful

Framework for Success

A successful program in energy management provides an organizational framework for a company to respond effectively through a program of continuous improvement to a national program that establishes energy intensity improvement and/or GHG reduction targets. UNIDO has identified a package of policies described as the "Industrial Standards Framework" that outlines the policy relationships among target-setting agreements, energy management standards, and system optimization and their intended impact on industrial markets.

Table 2: Industrial Standards Framework

Policy Objective	*Policy Response*	*Market Response*
Establishing National Goals for GHG Reduction	Voluntary or Target-setting Agreements; Tax incentives	Companies commit to energy intensity reduction targets
Integrating Energy Efficient Practices	Energy Management Standard, Guidance, Training	Plants actively manage energy like other resources
Capacity Building	System Optimization Training of plant engineers/consultants/ suppliers/ ESCOs	Trained experts conduct plant assessments, sell system services
Identifying Energy Saving Projects	-Trained System Experts -System Optimization Library -Standardized Assessments	Plant managers use trained experts to identify projects
Implementing Energy Efficiency Projects	Financial incentives, loan guarantees & subsidies, energy efficiency credits, ESCOs	Plants implement more projects, buy system services, accrue credits
Documenting for Sustainability	-Energy Management Plan -System Optimization Library -Measurement & Verification	Energy savings continue through project lifetime & are tradable as credits
Market Recognition	Recognition Programs, Energy Efficiency Credits, Certification	Companies & financial institutions value energy efficiency

UNIDO is currently engaged with 10 countries in the development of industrial energy efficiency programs based on the framework described above.

Developing ISO 50001: Energy Management

In February 2008, the Technical Management Board of ISO approved the establishment of a new project committee (PC 242 – Energy Management) to develop the new ISO Management System Standard for Energy.[6]

ANSI and the Associação Brasileira de Normas Técnicas (ABNT) jointly serve as the Secretariat to PC 242 to lead development of ISO 50001. This standard will establish an international framework for industrial, commercial, or institutional facilities, or entire companies, to manage their energy, including procurement and use. The standard will provide organizations and companies with technical and management strategies to increase energy efficiency, reduce costs, and improve environmental performance. Corporations, supply chain partnerships, utilities, energy service companies, and others are expected to use ISO 50001 as a tool to reduce energy intensity and carbon emissions in their own facilities (as well as those belonging to their customers or suppliers) and to benchmark their achievements.

To foster development of the standard, UNIDO and the Standardization Administration of China (SAC) jointly hosted an international meeting in Beijing in April 2008 to initiate a dialogue on harmonization of national and regional standards in preparation for the first meeting of ISO PC 242.

[6] http://www.iso.org/iso/energy_management_system_standard

The first meeting of ISO PC 242 was held in September 2008 in Washington, DC with participation by delegates from 25 countries from all regions of the world, as well as representation from UNIDO, which has liaison status. The goal of ISO PC 242 is to develop the new management system ISO 50001 on an accelerated schedule. Between the first meeting in September and the second meeting in March 2009 in Rio de Janeiro, Brazil, ISO PC 242 produced two working drafts for expert review and comment by member countries (35 as of March 2009). At the March meeting, a decision was made to go to Committee Draft (CD) in June 2009, following additional expert review and input. This puts development of ISO 50001 on track for publication in early 2011.

Some of the major issues being addressed by ISO PC 242 include:

- The definition of energy and energy performance, with the term "energy performance" encompassing energy efficiency, energy conservation, and increased use of renewable energy, as determined by the implementing organization in their policy, targets, and objectives;
- The role of top management in setting policy and empowering staff to implement it;
- The term "team" as applied to persons responsible for carrying out the energy management policy. Team describes the personnel resources necessary to implement and maintain the action plans and objectives of the organization and could be one person;
- An approach for energy planning that focuses on the process an organization would use both to implement and to maintain their management system;
- The appropriate role of purchasing for energy efficient supply, equipment, products, and services in a globally relevant standard;
- The role of renewable energy in energy management and energy performance, and
- The need for an annex that helps small and mid-size organization.

Potential Impact

Existing ISO standards for quality management practices (ISO 9001) and environmental management systems (ISO 14001) have successfully stimulated substantial, continual efficiency improvements around the globe. The emergence of ISO 50001, the international energy management standard is anticipated to have far-reaching effects on the energy efficiency of industry when it is published in early 2011.

This will be especially true in developing countries and emerging economies that still lack national energy management standards as well as policies and mechanisms to achieve improved efficiency in the industrial sector. Past experience with environmental management standards shows that the ISO standards have provided stimulus and a framework for the development of national standards, policies, laws and regulation. In addition, all indications are that ISO 50001 will become a significant factor in international trade, as ISO 9001 has been.

ISO 50001 has the potential to impact 60% of the world's energy use, including not only industry, but also the commercial and institutional sectors. Based on demonstrated savings that have been achieved by organizations that have implemented energy management plans and a continual improvement framework, energy intensity improvements of greater than 2.5% per year are achievable and can be sustained for the next decade. The International Energy Agency has stated that

*(*the*) manufacturing industry can improve its energy efficiency by an impressive 18 to 26%, while reducing the sector's CO2 emissions by 19 to 32%, based on proven technology. Identified improvement options can contribute7 to 12% reduction in global energy and process-related CO2 emissions* (IEA 2007).

The emergence of ISO 50001 will be an important link in realizing these impacts.

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