Implementing Standardized Energy Management Systems, compatible with ISO 50001: case study of UNIDO’s EnMS Program in Latin America

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Abstract

The purpose of ISO 50001 Energy management systems (EnMS) standard is to enable organizations establishing systems and processes to improve energy performance. This standard is expected to achieve long-term increases in energy efficiency (20% or more) in several sectors and to reduce greenhouse gas (GHG) emissions worldwide. The United Nations Industrial Development Organization (UNIDO) has developed a program for the promotion of EnMS in 12 developing countries to support national institutions in adopting an integrated approach for industrial energy efficiency measures, including the adoption of standards. Despite the increasing use of standardized EnMS (mainly in Europe) and the certified organizations in several countries, the number is still very timid.

The paper first presents a review of the literature which establishes the major reasons for, and the benefits of, the introduction of ISO 50001. It also details the principles of the UNIDO’s program for implementation of EnMS. The purpose of this empirical study is to examine the various barriers and misconceptions that impede ISO 50001 implementation in the industrial sectors, using a sample of organizations participating of UNIDO’s EnMS program in Ecuador. The study suggests the need to formulate local strategies to meet the emerging ISO requirements which will enable industry organizations to achieve benefits by maximizing the use of its energy sources and assets, thus reducing energy cost and consumption. This study contributes to the knowledge in the area of EnMS, promoting the development of policies for increasing the energy efficiency of systems (including motors) and their uptake in industry. The findings of this work are limited to the sample surveyed and its geographical limits, however, they draw important conclusions for policy-makers around world.

Introduction

Energy is critical to the operation of enterprises or organization and can represent a significant operational, whatever their economic or activity sector is. An idea can be gained by considering the use of energy through the supply chain of a business, from raw materials through to recycling. In addition to the economic costs of energy to an enterprise, energy has associated environmental and societal costs by depleting resources and contributing to climate change. Improved energy performance can provide rapid benefits for an enterprise by maximizing the use of its energy sources and energy-related assets, thus reducing both energy cost and consumption [1].

The ISO 50001 Energy Management System is based on the management system model that is already understood and implemented by enterprises worldwide. It can make a positive difference for enterprises of all types, while supporting longer term efforts for improved energy technologies and providing strategies to increase energy efficiency, reduce costs and improve energy performance. The standard is intended to accomplish the following:

- Assist organizations in making better use of their existing energy consuming assets;
- Create transparency and facilitate communication on the management of energy resources;
- Promote energy management best practices and reinforce good energy management behaviors;
- Assist facilities in evaluating and prioritizing the implementation of new energy-efficient technologies;
- Provide a framework for promoting energy efficiency throughout the supply chain;
- Facilitate energy management improvements for greenhouse gas emission reduction projects;
- Allow integration with other organizational management systems such as environmental, and health and safety.

ISO 50001 is based on the ISO management system model familiar to more than a million organizations worldwide who implement standards such as ISO 9001 (quality management), ISO 14001 (environmental management), ISO 22000 (food safety), ISO/IEC 27001 (information security).
In particular, ISO 50001 follows the Plan-Do-Check-Act process for continual improvement of the energy management system and the energy performance. Figure 1 presents an EnMS model.

These characteristics enable organizations to integrate energy management with their overall efforts to improve quality, environmental management and other challenges addressed by their management systems. ISO 50001 provides a framework of requirements enabling organizations to:

- Develop a policy for more efficient use of energy;
- Fix targets and objectives to meet the policy;
- Use data to better understand and make decisions concerning energy use, efficiency and consumption;
- Measure the energy results and review the effectiveness of the policy;
- Continually improve energy management and energy performance.

ISO 50001 does not fix targets for improving energy performance [2]. Target setting is up to the user organization, or to regulatory authorities. This means than any organization, regardless of its current mastery of energy management, can implement ISO 50001 to establish a baseline and then improve on this at a rhythm appropriate to its context and capacities.

Since its introduction in 2011, the ISO 50001 standards have received wide acceptance; the number of organizations certified has grown. According to a survey [3] conducted by ISO in 2011, the total number of certifications at the end of 2011 exceeded 450. Table (1) presents the worldwide total of ISO 50001:2011 certification and other management systems.

![Energy Management Systems Model for ISO 50001](image)

**Figure 1 – Energy Management Systems Model for ISO 50001**

<table>
<thead>
<tr>
<th>Name of standard</th>
<th>Number of certificates in 2011</th>
<th>Number of certificates in 2010</th>
<th>Evolution</th>
<th>Evolution in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 9001</td>
<td>1,111,698</td>
<td>1,118,510</td>
<td>-6,812</td>
<td>-1%</td>
</tr>
<tr>
<td>ISO 14001</td>
<td>267,457</td>
<td>251,548</td>
<td>15,909</td>
<td>6%</td>
</tr>
<tr>
<td>ISO 50001</td>
<td>461</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ISO/IEC 27001</td>
<td>17,509</td>
<td>15,626</td>
<td>1,883</td>
<td>12%</td>
</tr>
</tbody>
</table>
The number of ISO certificates in Latin America was 0 in 2011. Based on this fact and due to lack of research information about this field in Latin America, there is a strong need exists to conduct this proposed study to comprehend and explain the implementation issues and misconceptions about standardizes management systems at regional level. The purpose of this empirical study is to investigate the phenomenon pilot program to facilitate the adoption of standardized EnMS, and to report results to policy-makers in the Latin America organizations. It is expected that the findings of this work will help the non-ISO certified organization to consider investing resources in the adoption and the deployment of EnMS which will, finally, lead to certification under the ISO 50001 standard. With respect to theoretical contribution, this work shall augment the knowledge in the domain of energy management within the context of developing countries with particular focus on Latin America organizations. Although this study has a limited scope, it is the first one of its kind, by addressing energy management adoption in Latin America.

**Benefits of the adoption of standardized energy management systems**

**ISO 50001 standard background**

The United Nations Industrial Development Organization (UNIDO) initiated a dialogue on the development of an international energy management system standard at an expert group meeting (EGM) on industrial system optimization and energy management standards in industry, in March 2007. The meeting included representation from developing countries, the ISO Central Secretariat, and countries using national energy management standards. As a result, a request was submitted to the ISO Central Secretariat to work on an international energy management standard.

As of March 2007, four countries Denmark, Ireland, Sweden and United States had national energy management standards. In addition, China had a draft standard, the Netherlands had an energy management specification, and the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) had formed a task force to develop a common standard for the European Union. As of June 2008, Republic of Korea, Spain and Thailand completed work on a draft national standards; Brazil and South Africa initiated this process.

In view of international interest in the subject and its potential impact on industrial energy efficiency, UNIDO launched a new initiative to support the development of an international ISO energy management standard in July 2007. As part of the initiative, a regional workshop was held in Thailand, in September 2007, and an international working group meeting was held in China, in April 2008 discussing about concept of energy management.

In February 2008, the Technical Management Board of ISO approved the establishment of a new project committee, PC 242 – Energy Management (changed to technical committee TC242 in 2011), to develop the new ISO management system standard for energy, ISO 50001. The Secretariat of ISO/TC 242 is shared by the American National Standards Institute (ANSI), which chairs ISO/TC 242, and the Brazilian Association for Standardization (ABNT). The Standardization Administration of China (SAC) provides the Vice-Chairman. As of December 2008, UNIDO workshops and awareness-raising initiatives had been held for more than 30 developing countries and emerging economies, with many of them currently members of ISO TC 242.
Benefits of ISO 50001 implementation

The ISO 50001 was launched in 2011 [4]. Energy management seeks to apply to energy use the same culture of continual improvement that has been successfully used by organizations to improve quality, environmental and safety practices. An energy management standard can influence how energy is managed in an organization facility, thus realizing reductions in the energy use 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 [4]. 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;
- Interface FLOR, 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.

Evidence of ISO 50001 implementation benefits were presented by ISO when discussing about five early adopters of the standard [5]. The organizations are power and thermal management solutions enterprises. They report numerous early gains from implementing ISO 50001, including significant reductions in power consumption, carbon emissions and energy costs, and benefits to manufacturing plants, communities and the environment. The following quotes are taken from the article:

- Delta Electronics (China) have reduced power consumption by 10.51 million kWh in 2011 as compared to the same period in 2010. This is equivalent to a reduction of 10.2 thousand tons of carbon emissions and a saving of CNY 8 million.
- Schneider Electric (France) is implementing ISO 50001 in all facilities around the world, integrating with other ISO standards such as ISO 14001. About 90% of facilities are ISO 14001 certified.
- Dahanu Power Station (India) has conducted a series of targeted investments since March 2010 which, aided by the organization’s new ISO 50001 based energy management system, are expected to yield annual savings of about INR 96.4 million form raised energy efficiency and management.
- AU Optronics (Taiwan) was expected to help achieve 10% energy conservation at the plan in 2011, save an estimated 55 million kWh of electricity and reduce carbon emissions by 35.000 tons.
- Municipality of Bad Eisenkappel (Austria) expected to decrease by nearly 25% whit the main savings achieved by updating the waste plant and reducing energy consumption by 86.000 kWh, equivalent to EUR 16.000.

ISO 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 [4].
The challenge in implementing EnMS

A successful program in energy management begins with a strong commitment to continual improvement of energy performance, related to energy use, efficiency and consumption. 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 consumption.

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.

Development of an internationally recognized energy management standard would be particularly helpful to developing countries and economies in transition that lack national EnMS as well as policies and mechanisms for improved efficiency in the industrial sector. Experience with environmental management standards shows that ISO standards have provided stimulus and a framework for development of national environmental standards, regulations and laws. The promotion of and support for the adoption and implementation of standardized energy management systems, compatible with ISO 50001, is a core element of UNIDO’s program to strengthen policy-making and technical capacities of developing countries and emerging economies to improve energy efficiency in industry.

UNIDO’s program in Ecuador to facilitate the implementation of Energy Management Systems

Ecuadorian context

According to reports by the Latin American Energy Organization (OLADE), the energy consumption in Ecuador in 2011 was of 81,389 Million barrels of oil equivalent (Mboe). The annual electricity consumption was of 15,248 GWh in 2011 and the sector with highest consumption were residential with 29.9% and industrial with 26.8% (CONELEC) [6]. The energy intensity in Ecuador is higher than in other Latin American countries; in 2009 it was 3.23 barrels of oil equivalent (boe) per USD 1,000, in two to three times higher than in Argentina (0.94 boe/USD 1000), Brazil (1.65) or Colombia (1.32).

The total consumption of fuels by the industry sector in 2009 was 233.5 million gallons of diesel (11.10 million GJ). Electricity demand in industry was of 4,798 GWh (6.8% of national consumption) and the average power price for the industrial sector was USD 0.0487 per kWh in 2011. The energy consumption resulted in greenhouse gas emissions of 7,009 KtCO2e in 2011.

Around 68% of industrial activity is located in only two provinces, namely Guayas (with capital Guayaquil, 35%) and Pichincha (with capital Quito, 33%) with minor activity in Manabí (9%) and Azuay (5%). SMEs (known as PyMES - pequeñas y medianas empresas in Ecuador) provide 15% of the manufacturing sector contribution to the GDP in Ecuador, but encompass 86% of the industrial
companies (13% are characterized as large companies), consisting of medium enterprises (20%), small enterprises (43%) and micro industries (24%).

In reality, energy efficiency has always been a low priority of the industry due to relative low energy prices (supported by subsidies), and preference for second-hand equipment. An local analysis concluded that the avoided electricity costs realized from the investment in energy efficiency and renewable energy technologies by 1% of the country GDP, amounting to over USD 5 billion by 2025, could contribute significantly to poverty alleviation, job creation and to the improvement of social services [7]. The Government of Ecuador is committed to increase energy efficiency (EE) in the country. Given this culture of lack of regard for energy conservation, there exist numerous related barriers that stand in the way of financing and implementing energy efficiency options.

An overview of these barriers, related to industrial energy management, are the following:

- Energy efficiency is not a core interest for most industries and company strategies tend to focus on output growth rather than cost management. Most industries have a budgetary disconnect between capital projects (equipment purchases) and operating expenses (energy and maintenance), therefore, purchasing decisions are based normally on initial capital investment consideration, rather than on operating costs;
- Technology aims to support production, and production practices can have a significant impact on operational efficiency. These practices, however, are usually outside the control of the facility engineers;
- Industries lacks a culture of energy and resource management.

Other barriers can be related to technical knowledge and dissemination, as following:

- Facility engineers tend to focus on components, not on systems. When processes and equipment change over time, inefficiencies in term of energy use compound and reoccur. Even were systems optimization is available, knowledge resides with the individual who has been trained and is often not institutionalized;
- SMEs are not familiar with system optimization and energy efficient;

UNIDO’s project seeks to address some of the existing barriers to industrial energy efficiency in the Ecuadorian industrial sector, to deliver measurable results and to make an impact on how Ecuadorian industries manage energy through an integrated approach that combines capacity building and technical assistance interventions at the policy and energy efficiency project level. Primary target groups of the project are industrial decision-makers (managers), engineers, vendors and other professionals and industrial energy efficiency (IEE) policy-making and/or implementing institutions. With regard to social beneficiaries, the project includes the improvement of industrial competitiveness and the development of national technical capabilities. The main aspect for the improvement of technological knowledge will take place during the training and accreditation of 75 national experts (25 in energy management and 50 in systems optimization).

Latin America EnMS program

The proposed project in Ecuador focuses on building national capacities in two technical fields: Systems Optimization and Energy Management Systems.

The reason to integrate these two ethnical measures is related to the benefits archived, by addressing the software (managerial) and hardware (equipment replacement) actions. The presence of energy-efficient components in industrial systems, while important, provides no assurance that energy savings will be attained if the system of which the components are part is not properly designed and operated. Evidence from implemented national and international programs shows that, while efficient components may bring about gains in the range of 2 to 5 percent, systems optimization measures can attain average efficiency gains of 20 to 30 percent with a payback period of less than 2 years. The implementation of system optimization measures requires specific technical knowledge and consistent monitoring and remedy action by the industry.

The program focuses on four main areas of actions:

- Analysis of industrial EE institutional and regulatory arrangements and development of tools to facilitate EE measures adoption
• National program to implement ISO-compatible energy management standard

• Capacity building for personnel involved in EE from the public and private sectors in the areas of energy management and system optimization and energy efficiency promotion. UNIDO’s has developed targeted programs to train different stakeholders at different levels or tiers of training for both technical fields. National programs include an awareness raising training for enterprise manager, an introductory training for plant staff, technical training for equipment vendors and extensive expert for national training

• Demonstrated and measured energy savings in industrial entities through application of system assessment techniques by trained experts, leveraging additional energy savings as more industrial facilities will seek the implementation of systems optimization

The adoption and promotion of national energy management standards, along with capacity building of enterprises and institutions intends to be effective in transforming the national industrial energy efficiency market condition. Experiences in national and international Industrial Energy Efficiency projects have shown that maintaining energy efficient practices is a challenge in industry: most optimized systems lose their initial efficiency gains over time due to personnel and production changes.

**The research problem**

The first review of companies who have voluntarily adopted an energy management and expected results from early adopters of the standard provides opinions about the benefits in adopting and implementing standardized EnMS. The literature revision presents some barriers in adopting and working with the concept of energy efficiency, mainly in industry sectors. Although the developing countries have attempted, for long time, to implement other management systems (ISO 9001, ISO 14001) to compete in domestic and international markets, we observed that the ISO 50001 implementation in developing countries is still very limited. The implementation issues standardized EnMS has been explored in some developed countries, but no research work has been conducted on Latin America in this field.

**The importance of combining technical and managerial measures**

**Implementation activities of EnMS Program in Ecuador**

Since May 2012, the project has focused on the development of key activities, sustained in:

• User training for national Industry staff through introductory (user training) workshops;

• Awareness seminar for top management;

• Expert training for Industrial companies in order to promote implementation of EnMS.

The user training has been designed with the aim of raising awareness of the energy efficiency benefits. This training aims to present the global reality on the energy issues, the sources and their energy trends for reducing consumption and environmental impacts, including a complete revision of the standardized EnMS, implications, requirements, results and experiences of implementation in other countries.

Four user training rounds have been implemented to date at national level in relevant locations in which industry is concentrated: two in Quito, one in Guayaquil and other in Cuenca. More than 200 experts and private consultants attended the meetings.

The awareness workshops for managers and executives of the industries were made, one in each city, Quito, Guayaquil and Cuenca. Almost 150 people have been registered representing 85 industries nationwide. These events have allowed to define the interest of industrial companies that currently implement the EnMS.
The development of training of experts is being accomplished through the following activities:

- Selecting 25 national technical professionals from industrial plants and consultants, which are being trained as national EnMS (ISO 50001) experts;

- Identifying related industries in order to facilitate the training of the 25 technicians in implementing ISO 50001. These industries are from the following sectors: metals, textiles, finishes and home accessories, automotive accessories, cosmetics, timber and food. Figure 1 shows the distribution of these companies.

- Conducting the “train-the-trainers” program with theoretical and practical training, undertaken international experts selected by UNIDO.

![Figure 1 – Distribution of industrial sub sectors in the industries implementing EnMS](image)

**Implementation activities of System Optimization Program in Ecuador**

Electric motors are responsible for 73% of all electricity consumed in the industry. This consumption was 22% distributed in pumping systems, 18% in compression systems and 16% related to ventilation systems. These are precisely the objectives in the field of System Optimization training program in Ecuador.

In Ecuador, the initial step to build national technical capacities have been taken forward.

The experience gained so far in the early stage of the Motor System Optimization Programme implemented by UNIDO in Ecuador, highlighted the importance of combining both technical and managerial measures to achieve greater energy, carbon and economic savings.

Motor systems are often very complex systems and its efficiency depends on various factors which include: motor efficiency; motor controls (such as soft-starters and variable speed drives); the distribution network that feeds the motor (attention to power factor and distribution losses); power supply quality (high-quality power supply), with careful attention to harmonics; system oversizing (proper equipment sizing); the transmission and mechanical components (optimized transmission systems); maintenance practices (careful maintenance of the entire drive power system) and the match between the load and the motor (good load management practice). Figure 2 present a general motor system highlighting the relevant components which may influence the system performance and efficiency.
It must be emphasized that the design of the process itself can also influence to a large extent the global efficiency (units produced/kWh). However, technical solutions alone are not able to realize the full savings potential available. An organization that has a right approach towards energy-efficiency, both by having the technical expertise and by having an energy management system that works, is in a much better position to implement a successful energy saving campaign, and the created synergies potentiate the obtained environmental and economic saving. Furthermore, the combination between managerial and technical solutions increases the reliability of the equipment and processes, reducing maintenance and costly plant downtime.

Therefore, technical solutions should not be considered as circumstantial measures but included in a broader management plan that takes into account operational and maintenance practices, also in the long-term. Talking to other staff, such as maintenance and production personnel, who are also familiar with the items of the plant, is a very good way of identifying other benefits. Additionally, by making them feel involved and being able to identify the different type of benefits, they will be more likely to support actions towards energy-efficiency.

The integration between the production and maintenance teams, and the energy manager is key to optimizing resources and achieving sustainable, long term goals. For example, a list of all key equipment should be at the heart of a maintenance management program, and is an excellent basis for the development of an energy management program; routine checks on equipment such as checking for leaks, verifying lubrication, monitoring bearing vibration, temperatures/pressures etc. are core elements of both maintenance and energy saving campaigns. The implication is that the person doing these measurements should be aware of both reasons for undertaking them, and where appropriate modify the details of the procedure to maximize all energy saving and maintenance benefits; on equipment that runs for weeks or months between scheduled stoppages, the cost in lost production means that shutting down plant to fit and commission energy saving equipment can only be done if planned ahead as part of a scheduled shutdown; expansion or contraction of plant output can quickly lead to a mismatch between the provision of site services and the actual demand, and is a common cause of inefficiency. A better match of those services minimizes the costs of maintenance both through better use of existing plant resources, and through the avoided costs of plant maintenance to supply capacity that is no longer needed. The periodic re-appraisal of what site services are actually needed should therefore be part of maintenance and energy saving best practice.

The support of the plant management is also of fundamental importance, particularly of the energy management plan which will often determine its success or failure. Therefore, the clear definition of goals, assignments, training needs; an assessment of the costs and benefits (energy savings, demand reduction, productivity gains) associated with conservation opportunities; the implementation of time-lines, and a description of feedback and reporting mechanisms is essential to secure the management commitment to energy-efficiency which will, in turn, help secure the involvement of all plant staff.
Research design and data collection

The present study is similar to other studies conducted in foreign several countries, mainly related to implementing management systems. Although the similarity is found in the objective of determining the important factors which impede the adoption and implementation of management systems and other related activities. The difference between this study and the prior research work reviewed is found in investigating the misconceptions about ISO standards which could reveal some possible indicators for factors behind the adoption of ISO 50001. No attempt is made here to test any hypothesis or to verify any relationships between variables. Our interest in this work is pure explorative. To achieve the objective of this research, an instrument was designed to obtain evidence about the barriers and the misconceptions of adopting ISO 50001. The instrument was derived from the research literature and was adjusted to add more clarity to the questions. The research instrument included a data collection during user and experts training activities. The direct interviews with experts during training were intended to investigate the barriers of ISO 50001 adoption, while the analyses of EnMS implementation procedures were concerned with exploring the misconceptions about ISO 50001. The group analyses comprises the observations from the 25 national trainees who aspire to become experts participating of the EnMS program in Ecuador.

Barriers which prevent the industry from becoming more energy efficient

Barriers to ISO 50001 implementation

According to research performed the most important barriers to ISO 50001 implementation are:

- Absence or difficult of measuring gains;
- Absence of government incentives;
- Insufficient knowledge about energy systems and programs;
- Employee resistance;
- Lack of human resources;
- Absence or difficult of consulting energy data;
- Difficulty of performing energy measurements;
- Difficulty of defining energy baselines and performance indicators;
- Financial resources.

The major quoted factors that impedes the standardized EnMS implementation are absence or difficult of measuring gains and absence of government incentives. In fact, all of barriers are strong related. Insufficient knowledge about energy systems, absence of energy data and difficult of performing energy measurements contribute to define a clear figure for energy performance target. Also the difficulty of defining energy baselines and energy performance indicators can influence any construction of energy performance situation.

Lack of staff dedicated to managing energy performance is common in industrial organizations. The implementation of a standardized EnMS can affect the whole organization, and if technical management is able to shows total dedication to energy programs, it leads to an atmosphere of continuous improvement. If not, it is almost impossible to implement an EnMS. Top management must be convinced that the implementation shall enable the organization to obtain advantages like energy savings, improvement in efficiency or reduction in energy consumption. It should understand that an EnMS shall improve the business efficiency by optimizing energy systems improving energy performance of processes. Some suggested actions that may be taken by organization are:
participating in energy improvement projects creating an atmosphere to encourage people participation in energy management initiatives. The employee resistance is always founded in energy management research. The employee resistance may come from the fear caused by a lack of information about standardized EnMS requirements, and from the belief that it will be difficult to change the mindset of employee regarding energy programs. Therefore, employee understanding and support to standardized EnMS are critical to its success. Another important barrier reported by the sample surveyed is the difficulty of performing energy measurement. Measurement procedures are as a mean of improvement energy performance and to confirm compliance with other requirements of the standards. Lack of equipment is attributed to lack of understanding the importance of monitoring energy aspects inside processes. Funds are needed to institute training programs, provide quality resources, payments for external consultants, payment for auditors, and payment for certification. With respect to human resources, the experts thought that lack of human resources was essential factor acting against the implementation of ISO 50001. A range of issues may comprise this factor such as: inadequate level of education, misinterpretation of the standards, low worker moral, and high worker turnover.

Misconceptions about standardized EnMS

Since the adoption of standardized EnMS is voluntary in most important countries, and the limited dissemination of the ISO standard to date, it is expected that many misconception exist about such systems. The most important misconceptions are:

- Standardized EnMS requires to measurement of all equipment and processes of organization;
- Standardized EnMS requires great financial resources in order to control energy processes;
- Standardized EnMS define values for energy performance to be attended;
- All activities of organization must be certified for ISO 50001;
- Standardized EnMS is not simple in mixing with existent management systems;
- The certificate is awarded to industrial sector only;
- Standardized EnMS decreases productivity;
- ISO 50001 certification requires a long time.

The first and second misconception delineated by respondents was related to the great funds required for equipment and/or control of energy processes. It is true that implementation can requires financial resources, but these resources are not inhibitive. There are cases where no investments are necessary in implementation activities. A significant part of sample believe that EnMS establish values for energy performance. The intention of Standardized EnMS, particularly ISO 50001, is to lead the organization in defining own objectives and targets, according to own intention. Part of the respondents believed that all the levels in the organization must be certified. This belief comes from little education on Management Systems. In fact, the whole organization, or one of its departments, or one process can be qualified to obtain the ISO 50001 certification. This is one important misconception of why organizations hesitate in taking the initiative to qualify for the Standardized EnMS. The ISO 50001 was designed to be align with other management systems in order to promote adoption in case of existent system in the organization. Many respondents agreed that ISO 50001 is awarded to private organizations only. Actually, any organization (manufacturing or service) public, private, mixed, for profit, and non-profit can be ISO certified upon compliance with the requirements. In addition, part of the sample surveyed believed that ISO 50001 results in decreased productivity. Many companies that have implemented an energy management system reported cost savings through improved process, effectiveness, and efficiency. Standardized EnMS like ISO 50001 can lead to improved management and operational processes related to energy, resulting in less waste in energy, increased energy efficiency, and cost saving. The last misconception about ISO 50001 is that the certification process takes long time. Depending on the size of the organization, the nature of its operations, and the maturity of its energy system, the certification process may take between 6 months to two years.
Conclusions and recommendations

Interested countries in implementing EnMS, mainly developing countries, are facing a shortage of formal researches to reflect the barriers and misconceptions about Standardized EnMS. To enable the Ecuador’s organizations in competing locally and abroad, the Government of Ecuador are encouraging local organizations to adopt EnMS as a way to achieve efficiency in using energy, but so far none organizations are ISO 50001 certified.

The observations made are qualitative, due to the fact that the adoption of ISO 50001 in the case study is still ongoing. Further investigations shall be made when the implementation of the national program is completed and evaluated. This explorative study has attempted to uncover the barriers and misconceptions surrounding the implementation of ISO 50001 through a sample of 25 organizations at the cities of Quito and Guayaquil.

This study recognizes the importance of combining both technical and managerial measures to achieve greater energy, carbon and economic savings. The present research identified nine important barriers which impede the adoption of ISO 50001: absence of measuring gains and government incentives comes at the head of the list. This study has also addressed the misconceptions about ISO 50001 and has evidenced eight misconceptions; the belief that ISO 50001 requires great financial resources was top ranked. Combining the barriers with the misconceptions leads us to conclude that ISO 50001 is not a subject of significant interest in the Ecuador organizations, and its implementation is still very limited.

To meet the growing demand for compliance with the Standardized EnMS like ISO 50001, the Government of Ecuador should formulate national strategies to comply with these emerging requirements. These strategies should include the creation of agencies to register organizations complying with ISO 50001, encourage certifying bodies to work in Ecuador, lay down guidelines for training and registering auditors, educate top management and employees about ISO 50001 benefits and requirements, encourage teamwork and continuous energy performance improvement, and push towards integrated coordination within the organization. National standards board, trade and industry associations, and universities have an important role in establishing viable, independent, and credible national systems that will be recognized worldwide. Certain countries do not have a culture of certification. Nevertheless, adopting the principles of a standardized EnMS provided equivalent benefits. We stress again that top management and competent leadership are the backbone for implementing ISO 50001.

References


