REVIEW OF EXISTING ENERGY MANAGEMENT STANDARDS AND POSSIBILITIES FOR ITS INTRODUCTION IN SERBIA

by

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Until recent times, energy management practices primarily consisted in replacing inefficient equipment and then using any number of methods to estimate obtained savings. Experience shows that positive effects of energy efficient improvements were decreased over time. There have been significant efforts over the last decade to define appropriate standards and best practices and implement the consistent energy management system to increase and maintain the energy savings. The knowledge gained from thousands of energy efficient projects is driving a transition from traditional tactical practice (one-time "build and forget" projects) to energy management strategies proposed and endorsed by a number of international organizations. The current status of internationally developed energy management standards, including an analysis of their shared features and differences is presented in this paper. The purpose of the analysis is to describe the current state of "best practices" for this emerging area of energy efficiency policymaking in order to study the possibility of implementation of energy management standards in Serbia and to estimate the effects and the potential for energy saving that would be made by its implementation.

Key words: *energy management, energy management standard, energy efficiency in industry*

Introduction

The concept of energy flow parameters includes various quantitative and qualitative parameters that can be used to describe energy processes from the technical, economical, and social aspects as well as environmental aspects. Energy management in the basic sense is the management of energy flow parameters within an organization (facility). Its focus is on supply of energy sources through the process of their transformation and all the way to the final use of energy. If energy management defined in this way is performed as an organized, structured, systematic, and permanent, then the organization established an energy management system [1].

Energy management is a continuous process that includes monitoring of the energy performance. It constantly finds ways to maintain and improve the performance of an organisa-

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tion. Modern equipment supports the efforts of all participants in this process with automatic systems for measurement, monitoring, and control of key energy performance parameters. But since the efforts of individuals are the most important: energy management should be oriented towards people. [2]

Beside influence on energy consumption, the operation of an industrial system can also have a significant environmental impact. Inefficient systems do not only use up to twice energy required for optimized systems, but they are also responsible for off-quality products and bigger waste production. Organizations are not often aware of this impact [3]. And those who consider the impact usually think only of the initial energy impact and neglect the energy used for the rework of off-quality products. After energy audits of such systems have been done, the recommendations have been implemented and the auditor has gone, there is no procedure in place to ensure continued proper operation of the system.

In order to ensure preservation of energy efficiency savings from implemented projects, a method of confirming further energy savings under different operating conditions must be developed. The answer to these issues can be found in one of the most tested mechanisms – energy efficiency standards.

Energy management standards

The knowledge gained from a numerous energy efficiency projects makes a transition from traditional tactical practices to strategic energy management practices possible. This strategic approach to energy management is accepted by international organizations, including Energy Star (USA), Natural Resources Canada (Canada), and Action Energy (UK). Energy management practice has traditionally focused exclusively on technologies that increase the energy efficiency of key energy-consuming processes and equipment [4]. It means that focus is exclusively on individual system components, such as motors, pumps, compressors, boilers, steam traps, *etc*. Equipment manufacturers have improved the performance of individual system components but these components are operating as a part of a system which overall efficiency can be quite low. Motor systems, on average, lose 55% of their input energy before reaching the process or end use. Some of these losses are inevitable during the energy conversion process (for example, a compressor typically loses 80% of its input energy to low grade waste heat). Many losses can be avoided through the application of commercially available technologies and good engineering practices. The potential for motor system energy efficiency improvement has been well documented at 20% or more by program experiences in the USA, UK, China, and elsewhere [5]. System optimization cannot be achieved through universal "one size fits all" approach or standards for components. Experience has shown that even optimized systems lose their initial efficiency gain over time due to personnel and production changes, so the purpose of an energy management standard should be to provide guidance for industrial facilities to integrate energy efficiency into their management practices.

There is no doubt that upgrading equipment and processes is one of the key elements to increased energy efficiency, but a traditional operation practice does not record consistent and long-term energy savings. There has been considerable effort over the last several years to define standards and best practices that increase the performance of energy efficiency projects and make the savings realized more predictable and repeatable. These standards move beyond traditional energy efficiency practices into more comprehensive strategic energy management practices that resemble the structure and discipline found in best-practice management systems like quality ISO 9000 and environmental ISO 14000 [4].

Energy management system standards provide practical tools and market-based mechanisms for supporting and effecting energy efficiency in industry. Their purpose is to provide guidance for industry to integrate energy efficiency into their management practices using the same "plan-do-check-act" approach of well-known and widely used quality and environment management systems (fig. 1).

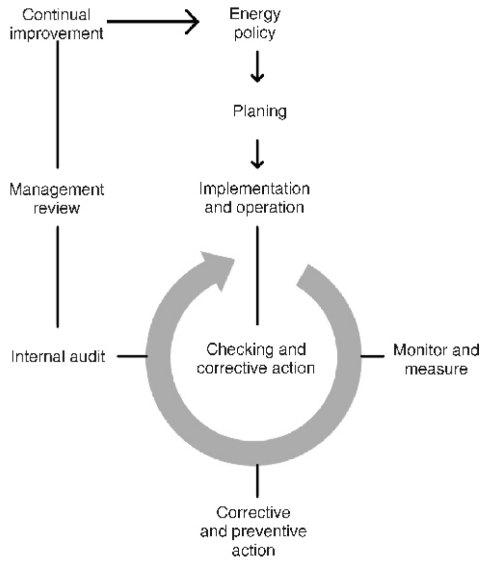

Figure 1 Plan-do-check-act approach of an energy management system standard

Typical features of an energy management system standard include:
- an energy policy (defines scope, objectives, and targets of the energy management system and addressing all significant energy use),
- a strategic plan (it requires measurement, management, and documentation for continuous improvement of energy performance and energy efficiency),
- a cross-divisional energy management team (this team is led by an energy co-ordinator (manager) who reports directly to management and is responsible for overseeing the implementation of the strategic plan),
- policies and procedures (which aim is to address all aspects of energy purchase, use, and disposal),
- the identification of key performance indicators (that are tracked to measure the progress of the system),
- projects (to demonstrate continuous improvement in energy efficiency), and
- periodic reporting of progress (presented to management) and continual improvement of the system [6].

Comparison of national energy management standards

Presently, several national energy management standards exist. The most prominent are: U.S. Standard ANSI/MSE2000:2005, Chinese Standard GB/T xxx-2000x ICS 03.120.10, European Union Standard CEN/CLC/TF 189 N. 030 2007-05-016, Swedish Standard SS 62 77 50: 2003, Irish Standard IS 393:2005, Danish Standard DS 2403 E:2001, The Netherlands Standard SenterNovem 2004, Korean Standard KSA 400:2007, United Kingdom Standard PAS 99:2006. [5, 6]. All this standards employ a plan-do-check-act continual improvement cycle to management system design. Some of them (European) used environmental ISO 14001 standard as a basis, while other used quality ISO 9001 standard. Therefore the most of the elements of national management standard that focus on management system best practices are very similar. But some technical elements of the standards have significant differences and they require considerable effort to achieve harmonization. Elements that have the lowest level of agreement are in the "PLAN" and "DO" phases of the cycle (tab. 1) [7].

Table 1. Level of agreement among standards

Categories	Elements	Level of agreement
Scope and definitions	Scope	Medium[1]
	Definitions	Medium
General requirements	General requirements	High[2]
	Documentation	High
PLAN	Records	High
	Management commitment	Low[3]
	Energy policy	High
	Responsibility and authority	Medium
	Strategic planning	Low
	Energy data management, energy profile	Low, Medium
	Legal and other	High
	Goals, targets, and projects	High
DO	Purchasing	Low
	Design	Low
	Communication	High
	Competency, training, and awareness	High
	Equipment, systems, and process control	Medium
	Energy project implementation	Low
	Calibration	Medium
	Contingency planning	Low
CHECK	Monitoring and measuring	Medium
	Evaluation of legal and other requirements	High
	Internal audit	Medium
	Non-conforming, corrective actions, preventive action	High
ACT	Management review	High

[1] Medium – six to eight of the twelve standards agreed, [2] High – strong agreement, eight or more of the twelve standards agreed, [3] Low – five or less of the twelve standards agreed

Since the differences between standards start from the basic definition of energy and continue in all aspects of plan-do-check-act approach short review of the cycle phases is given in the following text.

The basic definition of energy is significantly different between the standards. The USA standard defines energy as primary and secondary energy and it is the most inclusive definition. Also only the US standard addresses water as a part of the energy system. Secondary energy is not addressed by the CEN, Swedish, Irish or Danish standards.

Continual improvement is a term that has several different definitions. The CEN, Irish, and Danish standards use the same definition and indicate that the activity that provides greater efficiency should be performed continuously by the organization. The USA, Swedish, and Korean standards refer to continual improvement in terms of improvement in overall energy performance. This definition is more in alignment with the current definition in management system standards.

In PLAN phase of the cycle one issue is whether to include management commitment in section on roles, responsibilities, and authorities or it should be identified as a separate requirement. The other topic with limited agreement is what should be included in energy profile/review. The main reason for difference in the topic of energy data management is presence of two basic approaches. One is data driven, based on the energy profile – from which projects are chosen and implemented. The other addresses the operational controls for the significant energy aspects and programs chosen that consider significant energy users.

The technical elements of the standards are mostly enclosed in DO phase and subjects with the least level of agreement are topics of purchasing, design, energy project implementation, and contingency planning. It is not clear that the full nature of purchasing is addressed in the standards other than the USA and China. On the other hand the concept of design is present in the most of the standards at some level. Five standards (US draft, Chinese, CEN, Swedish, and Korean) address the need for energy efficiency in the design process but there is not agreement on the items that should be included in the design consideration.

In CHECK phase, in particular in the topic monitoring and measurement is a significant amount of variation in what information should be measured and monitored to demonstrate an effective system or effective process. This phase is also referring to internal audits as a separate topic. Audit as a term is only defined in the CEN standard. The definition does specifically use the term independent which is not compatible with the current versions of the other management system standards. The current definitions in the other management system standards allow for audits as long as the auditor is objective. The term independent could introduce the concept of "certification/verification" audits – beyond the management system requirements. Although the standards agree that audits should be based on importance and previous results, they do not agree on the focus for importance. The US Standard uses energy status as the focus, the Chinese uses the influence of energy efficiency, the CEN, Irish, and Danish use importance of the processes and areas, the Swedish use the significant energy aspects, and the Koreans use the impact of energy [7].

The only topic of the ACT phase is a management review and the standards have a high level of agreement on this issue. The US, Swedish, and Korean standards require that the necessary information for the management review be collected and presented. The US standard assigns the responsibility for this to the energy co-ordinator. It is interesting to note that only three standards (China, CEN, and Irish) include compliance audits or legal information as inputs into management review.

In February 2008, the Technical Management Board of the Geneva-based International Standards Organization (ISO) approved the establishment of a new project committee (PC 242 – Energy Management) appointed to develop the new international energy system standard. The task of the committee is to internationally harmonize the existing national management standards and adopt new Management System Standard for Energy – ISO 50001.

Policies and programs that support energy management standards initiation

The energy management standards are designed to be applicable to all types and sizes of companies but the largest most energy intensive industries are the focus of additional programs and initiatives that support energy management standards initiation. Focusing efforts on these large energy users, policy makers seek the greatest reduction in industrial energy consumption and overall GHG emissions.

The biggest impact on energy consumption in industry has been in Denmark. They had financial incentives since 1992 in the form of a CO_2-tax rebate together with voluntary agreements and as of 2001 energy management standard. Danish government had concern that the CO_2 tax would make Danish industries non-competitive so they offered a CO_2-tax rebate to energy-intensive companies for adopting energy management practices and undertaking energy efficiency measures. Energy-intensive companies that entered into agreements for tax benefits must have implemented all energy-efficiency measures related to heavy processes with a payback period of four years or less [5]. The Danish Energy Authority found that half of the companies involved in the program had reduced their energy consumption by 20% in 2002. The motives of the companies to work with energy efficiency were: reduction of costs (76%), the environment protection (26%), and image of a green firm (16%) [8]. These agreements and their results have become powerful tool in encouraging the use of energy management standard in Denmark.

Both Ireland and The Netherlands have developed national energy management standards and targeted the standards to energy intensive users, particularly those subjected to the requirements of the EU Emission Trading Scheme. Companies that agree to implement energy management are eligible for an array of services to assist them in setting and meeting their energy management goals such as: training session that addresses topics such as energy management goals, bench marking, establishing energy performance indicators, and an overview of energy improvement opportunities with a focus on motor driven systems.

Sweden has added an energy management standard to voluntary agreement program that exists since 1994 as a program requirement in 2003. After Swedish government imposed a tax on industrial process-related electricity in 2005, the Program for Improving Energy Efficiency in Energy-Intensive Industries was launched. The program offers reduced taxation for companies that introduce and obtain certification for a standardized energy management system and undertake electrical energy efficiency improvements. To assist companies that signed up to participate in the program (126 companies had signed in 2007, representing approximately 50% of all industrial electricity use) the government has published handbooks on energy management, energy audits and analysis, routines for purchasing and planning, and a template for calculating life cycle cost in accordance with program requirements [5].

An entirely different approach has been taken in the USA, which has not explicitly promoted the use of its energy management standard nor offered financial incentives for meeting energy reduction targets. They have been concentrated on educating industry on system energy efficiency opportunities. One example of such educational program is initiative of the US Department of Energy (USDOE) for developing and offering technical trainings and publications to assist industrial facilities in becoming more energy efficient through its Best Practices program that exist since 1993. Also in 2003, the US Environmental Protection Agency (USEPA) began offering information on energy management guidelines and benchmarking as part of its ENERGY STAR for Industry program. These two examples and other similar activities encourage companies to manage energy, but do not explicitly encourage them to implement an energy management standard. This is the reason why relatively small number of plants are using energy management standard developed by Georgia Institute of Technology (Georgia Tech) in 2000. This standard was developed as a comprehensive energy management standard for industry and has served as a model for several subsequent national standards. However, recently USDOE and USEPA have joined together to develop a collaborative program to certify plants for energy efficiency that implement energy management standards, based on an updated version of the Georgia Tech/ANSI energy management standard. This program is expected to greatly increase use of the standard by US industries. Companies that have met the requirements of an energy management standard reported and documented the results of company-level target-setting programs and energy management programs which are impressive.

Examples of successful target-setting agreement programs

The purpose of an energy management standard is to integrate energy efficiency into their management practices, but because energy management standards have been in force since 2000 or later, the most of energy efficiency voluntary agreement programs have not yet been subject to an independent evaluation. Their effectiveness can be indirectly evaluated by the number of companies that look for membership within the programs even when there is no penalty for non-participation. Target-setting agreements (also known as voluntary or negotiated agreements) have been used by a number of governments as a mechanism for promoting energy efficiency within the industrial sector. A recent survey of such target-setting agreement programs identified 23 programs in 18 countries, including countries in Europe, USA, Canada, Australia, New Zealand, Japan, and South Korea [9]. Companies that have met the requirements of an energy management standard reported and documented high results of company-level target-setting programs and energy management programs.

Example 1: Industrial system energy efficiency in the USA

A study of 41 energy efficiency improvement projects implemented in industry in USA between 1995 and 2001 documented an average 22% reduction in energy use. In total, these projects cost $16.8 million and saved $7.4 million and 106 million kWh, recovering the cost of implementation in slightly more than two years [10].

Example 2: Energy efficiency agreements in Denmark

The Energy Efficiency Agreements led to a reduction in energy consumption of 9%, reduced energy consumption by 2 to 4% of total energy consumption per agreement after three years (thereby exceeding business-as-usual by about 1% per year) sped up the process of adopting energy-efficiency measures, and led companies to take energy management more seriously [11].

Example 3: Long-term agreement in The Netherlands

In the Long-Term Agreements (LTAs) in The Netherlands, voluntary agreements between the Dutch ministries and industrial sectors consuming more than 1 petajoule (PJ) per year were established. The goal of LTA was to support industry in achieving overall national energy-efficiency improvement target of 20% reduction in energy efficiency between 1989 and 2000. In total, 29 agreements were signed involving around 1000 industrial companies that represent about 90% of industrial primary energy consumption in The Netherlands. The overall LTA program ended in 2000 with an average improvement in energy efficiency of 22.3% over the program period [11].

Example 4: Results of multi-national companies with company-level target-saving programs

In addition to national programs, a number of multi-national companies have developed company-level target-setting programs and energy management programs with impressive results. Dow Chemical set a target to reduce energy intensity from 1994- 2005 by 20% and actually achieved 22% ($ 4 billions in savings). 3M Corporation has reduced its corporate energy consumption by 30% since 2000 through its global energy management program. DuPont has accomplished $ 2 billions in energy savings since 1990 as a part of a corporate goal to achieve a 65% reduction in GHG emissions below 1990 level by 2020.

Possibilities of employing energy management standard in Serbia

According to the energy balance of the Republic of Serbia for 2008, the final energy consumption in Serbia in 2006 was 7.36 Mtoe [12]. The participation of industry in the overall final energy consumption was 2.586 Mtoe (34%). Industrial sector consumed 6336 GWh of electricity in 2006 which is 24.1% of total electricity consumption in Serbia [13]. In Serbian industry, heat sources of 6300 MW of thermal power are installed in several hundred industrial companies. They are used for the production of heat energy for the needs of production processes and for heating of workspace. About 30 industrial companies could have both the production of thermal and electric energy. Their installed capacity is about 250 MW but the largest number of these combined heat and power plants is not operational [14].

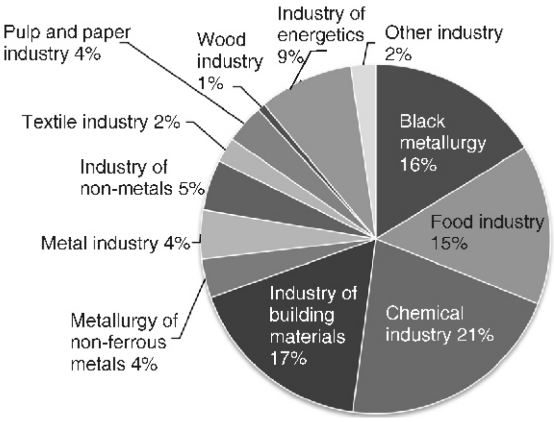

Figure 2. Final energy consumption in Serbia by industrial sectors

The share of industrial sectors in energy consumption in Serbian industry is shown in fig. 2 [15]. The most energy intensive industries are: chemical, industry of building materials, black metallurgy, and food industry that share approximately 70% of total final energy consumption in industrial sector.

The current status of energy efficiency in Serbian industrial sector is characterised by:
– unfinished proprietary transformation especially distinct in some industries,
– decline of Serbian GDP by about 50% in 1990s while the industrial energy consumption was reduced by about 30%,

– technical, technological, and organizational obsolescence, low efficiency and poor environmental conditions, as well as import dependency on liquid and gas fuels for industry, which is about 80%. An example of the technological obsolescence and inefficiency is the fact that about 74% of installed boilers in the industry are over 20 years old and even 30% are older than 30 years [14], and
– differences in the energy intensity and specific energy consumption in relation to the developed countries, *etc*.

To eliminate the above-mentioned technical and economic barriers appropriate energy policy should be envisaged. The most effective way to improve industrial energy efficiency is through an integrated approach, where a number of policies and programs should be combined to create a strong overall industrial energy efficiency policy that addresses a variety of needs in many industrial sectors [16]. Beside research and development program concerned for energy efficiency in industry, well established and supported by Serbian Ministry of Science [17, 18] and some sporadic educational, promotional, and demonstrational programs of Serbian Energy Efficiency Agency (SEEA) and Ministry of Energy, the introduction of energy management system standard in industrial companies with appropriate governmental fiscal support should be used.

Considering the economic conditions of the industry, the establishment of Energy Efficiency Fund is of great importance for the introduction of energy management standard. Serbia is planning to establish the Fund in order to encourage and co-finance activities aimed at improving energy efficiency in the sectors of production and consumption of energy, and increase the use of renewable energy sources.

Energy efficiency law should regulate the use of energy and it is important to define the obligations of energy entities (users and consumers of energy) to establish appropriate services for energy management. According to presented standards, energy management includes different activities and therefore minimum requirements are needed to describe whether a company practices energy management. The minimum requirements for Serbian companies should be: adoption of energy policy, appointment of designated energy manager, adoption of quantitative goals for energy savings, establishment of energy parameters monitoring system, implementation of specific energy saving projects originating from the energy management and periodic reports about the current energy parameters and realized projects to appropriate state institution (SEEA) respecting the prescribed procedure.

In order to make this program more effective it should be complemented with financial incentives, technical assistance where needed, and the threat of taxes or regulation if companies fail to meet their obligations [19]. Special attention should be paid to the four mentioned most energy intensive industrial sectors that consume approximately 70% of final energy consumption. Energy management standard implementation should be prioritised in large and medium companies of these sectors. Companies that have already introduced ISO 9000 and ISO 14000 should have an advantage in obtaining the financial incentives.

Calculation of expected benefit of the energy management standard implementation program in practice requires more valuable input data from Serbian industrial sector. It should be emphasised that reliable data of final energy consumption by fuels and energy indicators by industrial branches are not systematised. If one, for instance, assume that subsidies are provided for up to 30% of the investment costs in energy-efficient projects with pay back time less than 4 years, for companies (of the four most intensive industries) that impose energy management standard into practice, then for the actual price of electricity (average 4,8 €c/kWh for industry –

2008) governmental support of 10 M€ will contribute to 190 GWh (4%) of annual decrease of electricity consumption in Serbian industry (fig. 3).

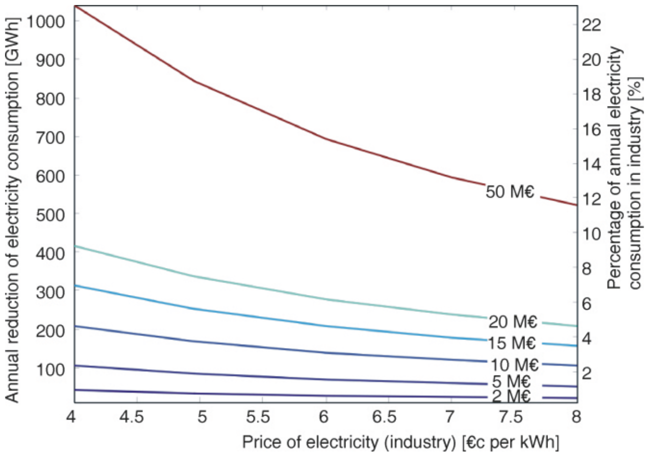

Figure 3. Influence of price of electricity and governmental financial support on reduction of annual electricity consumption in Serbian companies that implement energy management

Conclusions

The goal of energy management standard is to provide a mechanism that helps each company to maintain its focus on energy efficiency commitments, provide visibility for achievements and provide verification of results to help stimulate much bigger industrial energy efficiency.

Industrial energy efficiency is frequently overlooked by policy makers concerned about energy supply and use. The common perception is that energy efficiency of the industrial sector is too complex to be addressed through public policy and that industrial facilities will achieve energy efficiency through the competitive pressures of the marketplace alone. Neither premise is supported by the evidence from countries that have implemented industrial energy efficiency programs. It has to be highlighted that in each country the largest, most energy intensive industries should be in the focus of supporting programs and initiatives. Concentrating efforts on these energy intensive users is the way to achieve the greatest reduction in industrial energy consumption and overall GHG emissions.

In the next period a detailed analysis of studies and practice of the EU, and other directives in this area should be carried out by the Serbian relevant authorities supported by SEEA and its Regional Energy Efficiency Centres. Also, these centres should make strong educational and promotional campaigns to promote energy efficiency and energy management standard implementation. Both these actions would aid the government to identify and prepare measures and activities that could give good results for standard implementation.

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