

INTRODUCTION OF THE ENERGY MANAGEMENT SYSTEM IN THE INDUSTRIAL SECTOR OF THE REPUBLIC OF SERBIA Achieved Results and Challenges

by

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The introduction of the Energy Management System into the industrial sector of the Republic of Serbia, as one of the sectors within the System, formally started on March 15, 2013, when the National Assembly of the Republic of Serbia adopted the Law on Efficient Use of Energy. This indigenous and legally established system of organized management of energy flows, from the processes of production through the processes of transmission, distribution, and ways of consumption of energy, for the purpose of optimization and rationalization of this processes, includes a wide range of regulatory, organizational, incentive, technical, and other measures and activities that within the scope of their powers are determined and implemented by the subjects of this system: the Government of the Republic of Serbia, the Ministry of Mining and Energy, designated organizations, energy managers, and authorized energy advisors. For the purpose informing the industrial sector, as one of legal obligors of the Energy Management System, the achieved results, next steps and future plans for the development of this System are present in this paper.

Key words: *energy efficiency, Energy Management System, designated organizations, regulatory measures*

Introduction

As with other energy, partly or totally, dependent countries, Serbia's energy policy is based on four strategic postulates: ensuring security and regularity of supplying the industry and the citizens with energy products, reducing the negative impact of the energy sector on the environment, reducing energy dependence, and the tendency towards making the energy sector more sustainable. In addition, since 2000, in order to realize the general goal of the Republic of Serbia to become one of the member states of the European Union, and especially since 2006, when the National Assembly of the Republic of Serbia ratified the Treaty establishing the Energy Community [1], or since 2008 when it ratified the Stabilization and Association Agreement of the Republic of Serbia with the European Union [2], an intensive process of adjustment of the energy sector and integration of the Republic of Serbia into the European Union's energy system is underway.

In the area of energy efficiency, following the Decision of the Energy Council of the Energy Community of 18 December 2009, the Republic of Serbia assumed the obligation to

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implement Directive 2006/32/EC on energy efficiency in end-users and energy services [3]. On the basis of this Decision, the Republic of Serbia undertook to reduce the final energy consumption by 9% in the period from 2010 to 2018 in relation to the final energy consumption in 2008, *i. e.* to achieve the final energy savings of 0.7524 Mtoe by 2018.

In order to realize its own strategic goals and fulfill the undertaken international commitments related to reduction of final energy consumption, the Ministry of Mining and Energy has prepared and the National Assembly of the Republic of Serbia on March 15, 2013 adopted the Law on Efficient Use of Energy [4]. In addition to transposing the provisions of Directive 2006/32/EC, the provisions of Directive 2010/30/EU [5] and in part the provisions of Directive 2010/31/EU [6] are fully transposed in the Law. It is of particular importance that this law envisaged and legalized the introduction of a completely new and indigenous Energy Management System (EMS) for the implementation of the provisions of these directives, as well as a whole range of other measures and activities for achieving energy savings in other energy sectors, and not only in the sector of final energy consumption.

The basic principles for the work of the EMS largely developed due to the realization of the project *Study for the introduction of the energy management system in the energy consumption sectors in the Republic of Serbia* [7]. This Project was implemented by the Ministry of Mining and Energy of the Republic of Serbia in the period 2009-2011 in co-operation with the Japan International Cooperation Agency (JICA). The applied model of organizing EMS in the industry is almost identical to the model that was established in Japan in the early eighties. However, unlike the Japanese model, in order to include as much as possible energy entities that use public funds for energy costs, the Serbian model of EMS has been extended to the sector of trade and services, the public sector, and especially the local self-government units. For the modeling of this new part of the EMS, the Ministry of Mining and Energy used experience from several previous projects related to energy planning at the municipal level, which were implemented in the period from 2005 to 2012 by means of donations from the Kingdom of Norway and the German Organization for Technical Cooperation (Deutsche Gesellschaft fuer Internationale Zusammenarbeit – GIZ) and the United Nations Development Program (UNDP).

Organizational structure of EMS in Serbia

The EMS includes a wide range of regulatory, organizational measures and activities that are determined and implemented by the entities of this system within the framework of their powers: the Government, the Ministry of Mining and Energy, the designated organizations of EMS, energy managers and authorized energy auditors, fig. 1. With this System, through organized monitoring of all processes in the energy transformation chain, their observation and analysis from the aspect of different quantitative and qualitative parameters, conditions are created for identifying the weakest energy links and for taking appropriate measures and activities for their elimination.

Government of the Republic of Serbia. Although hierarchically, the highest position in this system belongs to the Government of Republic of Serbia, the main operational role in the functioning of the EMS is given to the Ministry of Mining and Energy, regarding the part of the state. The reason for this lies in the fact that the Government, as a subject of the energy management system only on the proposal of the Ministry, issues regulations in the area of efficient use of energy.

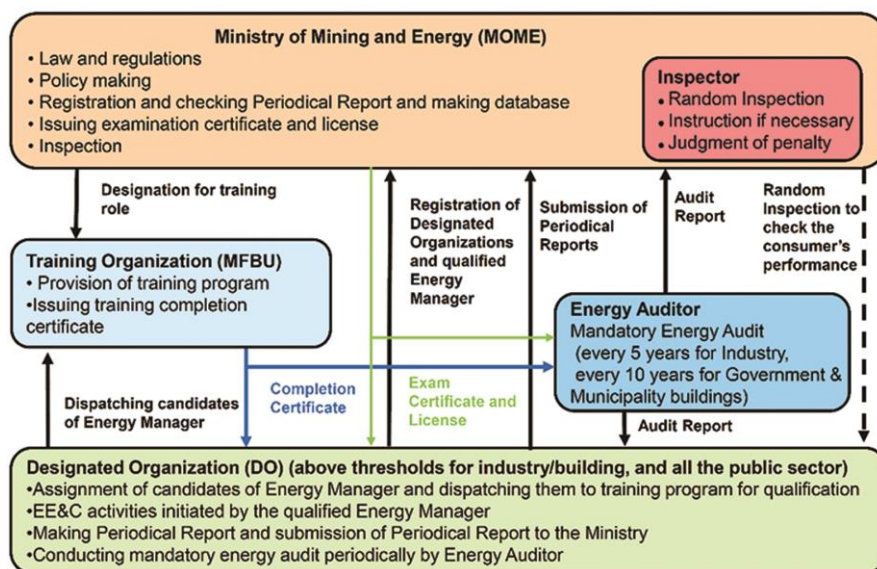


Figure 1. Organizational chart of the Energy Management System

Ministry of Mining and Energy (MoME). At the same time with the role of preparing laws and by-laws for the purpose of establishing the EMS, the MoME monitors and manages its functioning and works on further development and improvement of the entire EMS.

The MoME evaluates the process of monitoring the EMS by collecting the so-called periodical reports of the designated organizations. In this way, designated organizations inform the MoME of energy consumption, plans and results of implemented energy efficiency measures. On the other hand, through the established information system for collecting and analyzing periodical reports, the MoME observes and analyzes the collected data by calculating different quantitative and qualitative energy efficiency indicators, fig. 2. Thus, the MoME is able to identify the weakest energy places in the processes of energy transformation and instruct the designated organizations to take appropriate measures and activities for their elimination. Also, by analyzing the report and monitoring data on energy consumption, the MoME receives the necessary information that can serve to improve the work and create further development of the EMS.

The MoME performs control over the work of energy managers and fulfillment of obligations of the designated organizations of EMS by the energy inspectors who perform inspection checks of data from the Periodical Reports of the designated organizations.

Designated organization of EMS have got the main role in the EMS, as the main bearers and implementers of the measures and activities that will contribute to energy saving.

Basically, the designated organizations of EMS come from three sectors: industrial, trade sector and services (buildings) and the public sector (state administration and local self-government). However, in accordance with the division by way of business and the purpose of establishing companies, which are recognized by the legal system of Serbia, the division of the designated organizations of EMS must have been carried out in a slightly different way, as shown in tab. 1. Therefore, companies, public or public utility enterprises (PE and PUE) are classified in the group of designated organizations of EMS from the industrial sector, according to the criterion of activity and realized annual consumption of primary energy exceeding 2500 toe.

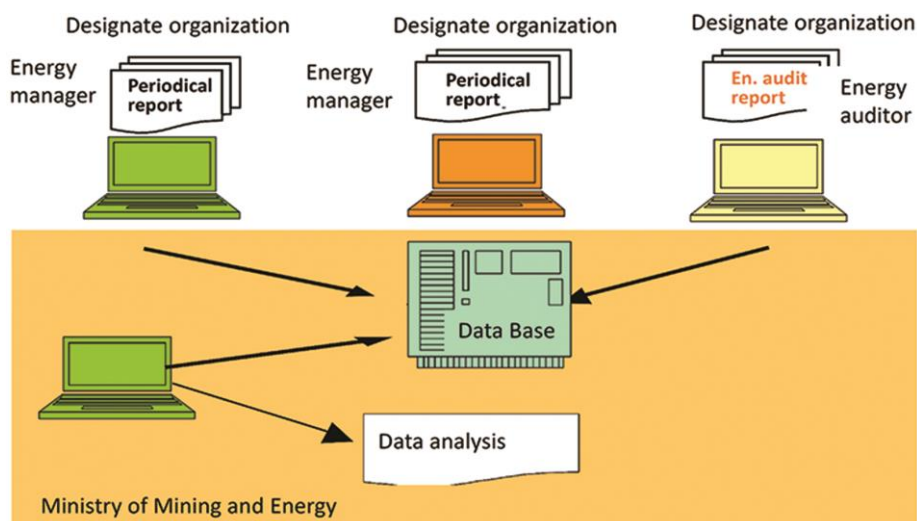


Figure 2. Structure of the information system for the collection and analysis of periodical reports

Table 1. Designated organization of the EMS

Category	More precise definition	Criterion
Companies	Production sector – industrial plants	2 500 toe/year per location *
	Trade and services sector – buildings	1 000 toe/year per location
	Production sector – buildings	1 000 toe/year per location
Local self-government body units (LSGU)	All facilities for which LSGU are paying energy costs, as well as facilities using public services (institutions and enterprises) established by LSGU that do not exceed the limit energy consumption	Municipalities, cities with more than 20000 inhabitants
State administration bodies and other Republic of Serbia and Autonomous Province bodies	All buildings used by the authorities and for which they pay energy costs	Official buildings, business premises with an area of over 2000 m ²
Public services **	Facilities that perform activities in the field of education, science, culture, health care, <i>etc.</i>	Public property facilities that consume more than 1000 toe/year on at least one location
	Enterprises: Public and public utility enterprises (PE and PUE) in the field of energy, roads, utilities and others.	Energy consumption is greater than 2500 toe/year per location

* The location consists of all facilities for performing the activities of the designated organizations of EMS located at the same address, whose annual primary energy consumption in the sum exceeds the limit values of the prescribed energy consumption

** Public services are institutions, enterprises and other forms of organization regulated by law that perform activities or jobs that ensure the exercise of citizens' rights, ie meeting the needs of citizens and other organizations, as well as the realization of other legally determined interests in certain areas. Public services are represented in different fields, and within the public services, institutions are formed to perform tasks in the fields of education, science, culture, health and social protection, and enterprises are established to perform tasks envisaged by law in the field of public information, energy, utilities and other tasks.

Energy managers. Although companies, local self-government units, state administration bodies and other bodies, institutions and enterprises as public services are designated organizations of EMS, the persons appointed to perform these tasks, energy managers, are the real bearers of the activities that will implement these obligations of the designated organizations. The activities of energy managers refer to the collection and analysis of data on energy use, the production of a periodical report on energy consumption and the achieved goals of energy savings, the preparation of planning documents related to the improvement of energy efficiency: programs and plan of energy efficiency, proposing, implementation and supervision over the implementation of energy efficiency.








Due to the diversity of energy infrastructure, the organizational structure of the energy systems of the designated organizations of EMS, in which energy managers need to carry out these activities, the EMS envisages that there are three types of energy managers:

- energy manager for the field of industrial energy – industrial energy manager,
- energy manager for the field of building energy – building energy manager, and
- energy manager for the field of municipal energy – municipal energy manager.

The engagement of energy managers, depending on the type of designated organizations of EMS, is shown in tab. 2.

Authorized Energy Auditor. The role of additional expert assistance to energy managers and assessment of the status of designated organization, in terms of fulfillment of energy efficiency obligations, is entrusted to authorized energy auditors. Energy auditors perform this role by implementing, according to the prescribed methodology, periodic energy audits of the designated organizations. Designated organizations from the industrial sector and public and utility enterprises are obligated to periodically carry out energy audits of the locations every five years, and the designated organizations of the commercial public sector system for buildings covered by the EMS, every ten years.

Table 2. Engagement of energy managers depending on the type of designated organizations of EMS

Energy manager type	Companies		Administration bodies and public services				
	Production sector	Trade and services sector	LSGU bodies	RS and AP bodies	Public services		
					Institutions	PC and PUC	
Industrial energy manager	Location 						Location 
Building energy manager		Location 	Location 		Building 	Building 	
Municipal energy manager							

Training organization for energy managers and authorized energy auditors. In order for energy managers and energy auditors to be able to implement the prescribed activities of the EMS, they need to possess appropriate expertise. For the purpose of their training and preparation for the implementation of these activities for the needs of the EMS, a training organization for energy managers and authorized energy auditors was established. This organization works within the Faculty of Mechanical Engineering of the University of Belgrade, and

a Laboratory for practical training of energy managers was created within its premises, shown in fig. 3 for the purpose of quality implementation of the practical part of the training for energy managers.



Figure 3. Laboratory for practical training of energy managers

Due to the aforementioned important organizational and structural and energy differences of the EMS system, the need for various necessary knowledge of energy managers emerged. Therefore, in accordance with the foreseen types of energy managers, three different trainings for energy managers are conducted.

- For the needs of business entities (companies and enterprises as public services) whose main activity is in the production sector (industry), as well as public enterprises and public utility enterprises, training for energy managers in the field of industrial energy is foreseen.
- For the LSGU administration bodies as designated organizations, public administration bodies and public services from the public sector as designated organizations (state bodies, other bodies of the Republic of Serbia, autonomous province bodies), training for energy managers in the field of municipal energy is foreseen.
- For the designated organizations in the commercial sector (business buildings, shopping centers) and public sector system designated organizations as individual designated organizations of the EMS – institutions using publicly owned facilities (schools, hospitals, sports centers, *etc.*), training for energy managers in the field of buildings energy is foreseen.

Industrial sector obligations

Designated organizations of EMS from the industrial sector, which, according to the criterion of activity, include companies or public or public utility enterprises, are obliged to:

- *Save 1% of primary energy in each of the next 5 years.* This obligation of the designated organizations is called the *annual energy savings target* and refers to each location separately.

- Compose and submit, in the prescribed format, to the MoME an annual periodical report on Achieved Energy Savings (periodical report). The format of this periodical report, to which the EMS obliges the MoME to report on the implemented measures and activities and the degree of realization of the objectives defined by the Program and the Energy efficiency plan, is also prescribed for the designated organizations from the industrial sector and must contain [8]:
 - basic information about the EMS designated organization,
 - basic information on all locations and in particular the location for which the report is submitted,
 - annual energy and water consumption at the site, per each energy product,
 - list of equipment/devices of the largest energy consumers (> 80%), which contains:
 - name of equipment/device,
 - brief description of equipment/device (nominal parameters – *e. g.* power, pressure, temperature, flow, effort ...),
 - average level of workload, and
 - equipment/device status (new, repaired or disassembled),
 - tabular overview of annual primary energy consumption in the period from the introduction of the EMS,
 - tabular overview of energy indicators by years in the period since the introduction of the EMS,
 - self-assessment table for the achieved level of EMS,
 - brief information on the most important measures and activities envisaged in the medium and long-term plan (measures that do not require financial investments and measures that require financial investments with the expected investment value and the expected effect of saving primary energy), and
 - information on changing the previous annual plan (process/equipment, measures planned and not implemented, measures implemented and not planned with explanation).

The very procedure for submitting the periodical report to the MoME is fully automated and carried out through the appropriate web application, *i. e.* a specially developed information system for the collection and analysis of periodical reports, fig. 2.

- *Develop and submit to the MoME the Energy Efficiency Plan and Program.* The Energy Efficiency Program is a planning document issued by the designated organizations on the planned method of realization and the size of the planned energy savings target for a period of at least three years. The format of this program is prescribed and it must contain the following [4]:
 - planned goal of energy savings,
 - reviewing and evaluation of annual energy needs and analysis of the existing energy situation,
 - proposal of measures and activities that will ensure efficient use of energy,
 - holders and deadlines for implementation of proposed measure,
 - deadlines and assessment of the expected results of each of the measures envisaged to achieve the planned objective, and
 - financial instruments (sources and means of provision of funds) envisaged for the implementation of the planned measures and activities.

The energy efficiency plan of the designated organizations is a planning document with the measures and activities through which designated organizations plan to implement an

energy efficiency program. This plan, which elaborates in more detail the measures and activities from the energy efficiency program, is adopted for a period of one year. The format of this plan is prescribed and it must contain the following [4]:

- measures and activities that provide for the efficient use of energy,
 - holders and deadlines for the implementation of the planned activities, and
 - the expected results for each of the measures, that is, activities, financial instruments (sources and manner of provision) intended for the implementation of the planned measures.
- *Appoint the required number of energy managers.* During this, only the person who has the license to perform the tasks of the energy manager issued by the MoME can be appointed for the energy manager. The conditions for issuing a license are that a person should have at least higher education of the first degree of academic studies in the field of technical and technological sciences in the scope of 180 European Credit Transfer System (ECTS) passed examination for an energy manager at the Training organization for energy managers and authorized energy auditors and three years of working experience in the field. The procedure for obtaining a license is shown in fig. 4.
 - *Engage energy auditors to conduct energy audits of the location (once in five years).* These energy audits can be performed exclusively by an authorized energy auditor as a legal entity, as licensed to carry out these tasks. After the energy audit, the authorized energy auditor submits an appropriate report to the EMS and the MoME.
 - *Implement measures for the efficient use of energy listed in the Energy Efficiency Program and the Energy Efficiency Plan.*

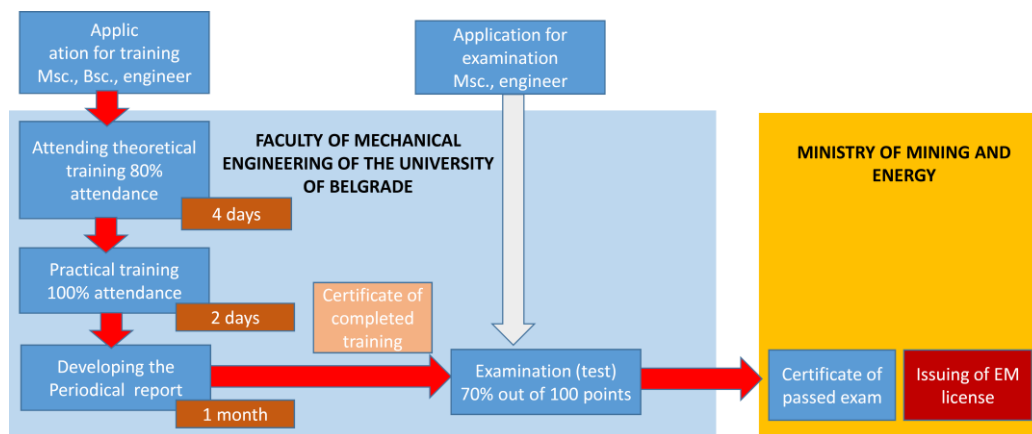


Figure 4. Procedure for obtaining a license for an energy manager

Energy managers in the field of industrial energy

Trainings for energy managers are carried out within the Training organization for energy managers and authorized energy auditors (the Faculty of Mechanical Engineering of the University of Belgrade). The aim of these trainings is to enable trainees to learn how to perform tasks of energy managers, *i. e.* to learn how to fulfill the obligations of the designated organizations.

In order for the energy manager for the field of industrial energy to be able to realize the obligations of companies or public or public utility enterprises, as designated organiza-

tions, and more importantly, to identify and implement measures that ultimately reduce unnecessary energy consumption, he needs to have the following knowledge:

- collect and carry out an analysis of energy data on the industrial or technological process, characteristics and condition of devices and equipment and other energy consumers, physical facilities and production capacities, produce an energy balance of a business company or public or public utility enterprises, and based on the performed survey of the state and collected data on energy consumption,
- identify measures that allow for energy savings and carry out their economic analysis,
- participates in energy procurement procedures,
- in accordance with the prescribed format, prepare an periodical report on the achievement of the goals of energy savings,
- develop and implement projects and measures for energy savings, as well as carry out appropriate technical and economic assessments of the impact of these measures, and
- develop an energy efficiency plan program and plan.

In accordance with these requirements, a training program is prescribed [9], according to which six-day trainings for energy managers for the field of industrial energy are held several times during a year in the training organization. In the first four days, this training includes 18 interrelated theoretical lessons, while the fifth and sixth day of training are devoted to carrying out three groups of practical exercises. Each group of practical exercises is performed on a special laboratory facility: boiler plant with a condensate separation system, a pump plant or a compressed air unit. Figure 5 shows practical exercises on installations in the laboratory for practical training of energy managers.



Figure 5. Implementation of exercises boiler plant with condensate drainage system and pump plant in the Laboratory for practical training of energy managers

Achieved results and future steps

In addition to the adopted Law on Efficient Use of Energy and the adoption of eight bylaws [4, 8-12], which in formal legal terms were necessary for establishing the EMS, in the period from 2013 to 2017, and in 2015, by the decision of the Minister of Mining and Energy, the Organization for Training of Energy Managers and Energy Auditors was established at the Faculty of Mechanical Engineering of the University of Belgrade. In the same year, a fully equipped Laboratory for practical training of energy managers was established. For the sake of quality training, by the end of 2016, three textbooks for each type of energy manager were

prepared and published, [13-15] and a website of the Training Organization was created [16]. In 2016, within the MoME, an information system was created for collecting periodical reports and processing of collected data [16, 17].

In the established Training Organization for Energy Managers and Energy Auditors, in the period from 2016 to the end of 2017, 9 trainings for energy managers were conducted, attended by 282 candidates, out of which 215 candidates passed the exam. Out of that number, four trainings were conducted for energy managers in the field of industrial energy. They were attended by 131 candidates, 101 of whom passed the exam and thus gained the right to a license for an energy manager in the field of industrial energy. Designated organizations from the industry sector, have appointed 37 energy managers so far.

By introducing EMS in Serbia, it is expected that in the first year of establishment, that is, in 2018, the primary energy savings in the public and commercial sector will be 13 ktoe, and in the industrial sector 36.9 ktoe [18]. After fully establishing this system, due to the high initial potential, it is expected that primary energy savings in the industrial sector will amount to 1.36%.

The most important future steps that will be undertaken in order to increase the quality and sustainability of this EMS in the legislative part will refer to the adoption of bylaws related to training for authorized energy auditors, the implementation of energy audits and the content and format of the report on the conducted energy audit. Also, in this part, further work is planned to improve the format of periodical reports for particular specific groups of designated organizations, such as thermal power plants, hydroelectric power plants, district heating systems, *etc.* At the same time, it is planned to increase the energy coverage of the EMS and the number of its designated organizations by lowering the energy consumption limit from 2500 tonne per year to 1500 tonne per year.

In the work of the information system for collecting and analyzing periodical reports, further development of analytical modules for data analysis, development of new types of analytical reports and development of a special database of energy indicators is planned.

Conclusions

The energy management system is a key mechanism which it is expected to enable the realization of the planned goals of energy savings, *i. e.* its more efficient use in Serbia. Although simple, this autochthonous and legally established system of organized management of energy flows required the adoption of a whole set of regulatory, organizational measures and activities of rules that within the framework of their competencies are determined and implemented by the subjects of this system: the Government, the MoME, designated organizations, energy managers and authorized energy auditors.

Good starting results for all designated organizations, which exceed the planned energy savings targets of 1% per year, provide a confirmation of the correctness of the establishment of the EMS, *i. e.* the correctness of the approach that the problems of more efficient use of energy should be solved systematically and in an organized way. The efforts of countries in the region which are trying to introduce almost identical systems of monitoring and energy management in their countries speak in favour of confirming the justification of the EMS establishment.

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