FACTA UNIVERSITATIS
Series: **Working and Living Environmental Protection** Vol. 10, N° 2, 2013, pp. 99 - 109

ENERGY MANAGEMENT INTEGRATED IN THE MANAGEMENT SYSTEM OF COMPANIES IN THE FUNCTION OF ENVIRONMENTAL PROTECTION - A CASE STUDY

UDC 005.6:620.9

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Abstract. *Energy efficiency and better energy management are increasingly the focus of attention in the world and in our country. The reasons are that there is significant potential in terms of energy savings, reduction of related costs and decrease of greenhouse gas emissions.*
The establishment of an energy management system in Serbian organizations is more than necessary. The reason is that we are among the countries with the worst results in terms of energy efficiency and such a treatment of energy directly affects the cost of our products and reduces the competitiveness of our companies on the global market. Also, one should not ignore the importance of the impact on the environment.
As a model of an efficient energy management system in the framework of the existing integrated management system, the example of the energy process in the Oil Refinery Belgrade is presented in this paper.

Key words: *energy management systems, energy efficiency, integrated management systems, EN 16001, ISO 50001, ISO 14001*

1. INTRODUCTION

Energy efficiency and better energy management are increasingly in the focus of attention in the world. The reasons are the significant potential for energy savings and reduction of associated costs, and a decrease of negative impacts on the environment (reduction of greenhouse gas emissions).

In our country, which currently ranks among the countries with the worst results in terms of energy efficiency, it is essential for organizations to realize that the potential

Received September 5, 2013
* **Acknowledgement**: The research presented in this paper was financed by the Ministry of Science and Technological Development of Republic of Serbia under the project III 43014 and III 42006

savings can achieve better energy management, thereby achieving significant cost savings and a better financial performance in terms of environmental protection, and with that improved competitiveness on the market. In doing so, it should be borne in mind that much of the savings can be achieved with relatively modest financial investment: through the host business, better planning and organization, as well as activities that include routine maintenance of equipment.

New standards for energy management systems EN 16001:2009 and ISO 50001 have the overall goal to help organizations establish the systems and processes necessary to improve energy efficiency. Both of these standards largely follow the structure of ISO 14001:2004 [3], thereby facilitating their integration, although they can be applied independently.

2. BASIC CHARACTERISTICS OF STANDARD EN 16001 AND ISO/CD 50001

Standard EN 16001:2009 Energy management system and requirements with guidance for use is a European standard that was officially released in July 2009 by the CEN - the European Committee for Standardization. The basic idea was to develop a standard that will provide the basic requirements for energy management systems, which will enable organizations to establish the systems and processes necessary to improve energy efficiency and to establish a basis on which organizations will be able (if they wish) to also achieve a certification system established by an independent certification body. In Serbia, this standard was published as a national SRPS EN 16001:2010 standard in March 2010 by the Institute for Standardization of Serbia, by direct download.

Standard EN 16001 can be used independently, but can also be integrated with other management systems. To a greater extent, it encourages the integration of the other standards designated to management systems such as the ISO 14001:2004 (system of environmental management), OHSAS 18001:2007 (Occupational Health Management System and Safety) and ISO 9001:2008 (Quality Management System). The structure of the EN 16001 is set to fully follow the structure of ISO 14001:2004 (see Table 1).

Standard ISO 50001, identically named EN 16001:2009 (Energy management systems requirements with guidance for use) is an international standard that is being developed within the ISO (International Organization for Standardization). This standard, as opposed to the EN 16001:2009 is an international standard, and for that it has a much wider application.

Within the ISO organization, energy management has been recognized as one of the five priority areas within the development and promotion of standards, so the start of making ISO 50001 was a logical sequence. There are expectations that the application of ISO 50001 will achieve increased improvements in energy efficiency of about 20% in industrial plants [6].

The EN 16001 and ISO 50001 standards are applicable to all types of organizations, regardless of their size and activity, but certainly the biggest improvements in energy efficiency can be expected in industry sectors that are most intensive users/producers of energy. Both of these standards are based on the PDCA methodology known as 'Plan do check act' (PDCA) and have a structure that follows this methodology (see Figure 1).

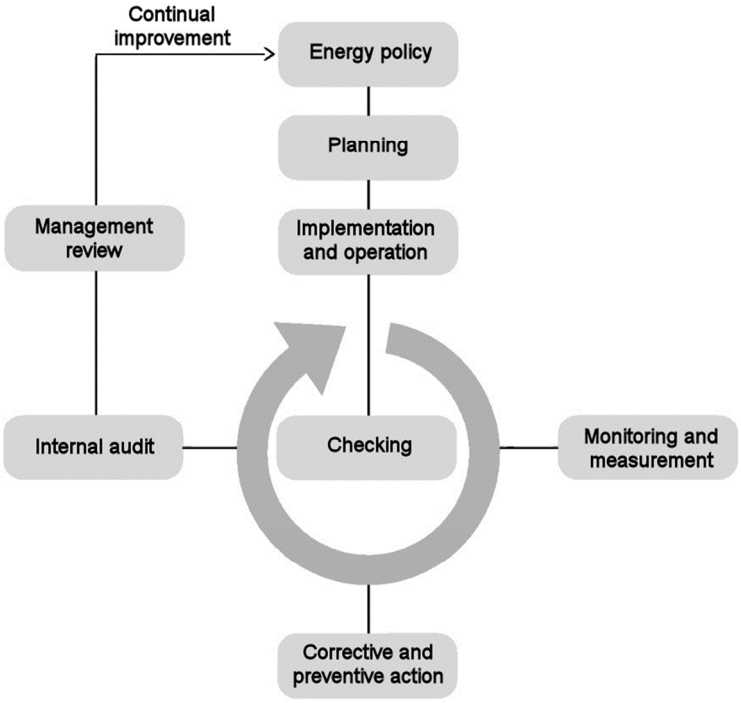

Fig. 1 Display of the model of standard EN 16001:2009 and ISO/CD 50001 [1, 4]

The PDCA as a concept of energy management systems can briefly be described as follows:

1. Plan – Establish objectives and processes required for the result, according to the organization's energy policy;
2. Do – Apply the process;
3. Check – Monitor and measure processes in relation to the energy policy, the general and specific objectives, the legal and other requirements, and reporting of results;
4. Act – Taking measures to effect continuous improvement of the energy management system [1].

Some of the key benefits that organizations can achieve with the introduction and implementation of energy management systems are [2]:

- cost savings (energy costs, efficiency of production);
- reducing greenhouse gas emissions;
- increase awareness of the employees regarding the rational use of energy;
- improving maintenance procedures;
- better understanding and increased knowledge about the equipment;
- increased production efficiency;
- improve the image of the organization;
- the possibility for easier comparison of performance indicators (internally and externally).

3. BENEFITS OF THE IMPLEMENTATION EN 16001 ISO 50001

The requirements regarding the introduction of energy management are essentially very similar to the requirements that exist in ISO 14001:2004. In short, the establishment of the organization's energy management requires the following:

a. to establish a national energy policy;
b. to identify which activities in the organization are accompanied by the highest energy consumption;
c. to identify the applicable legal requirements and other requirements to which it agrees, and which concern the energy;
d. to identify priorities and set appropriate general and specific goals and specific action plans;
e. to establish an appropriate structure and programs for the implementation of policies and the achievement of goals;
f. to facilitate planning, control, monitoring, implementation of preventive and corrective measures, verification and review activities to ensure that the policy will be reconciled and that the energy management system will remain appropriate [1].

Then the question arises why would the organization implement an energy management system, especially if they already have a system of environmental management? The fact is that in the system of environmental management, the issue of energy consumption can be included as one of the aspects of the environment.

One of the reasons for implementing is that in the organization, practices are often not fully aware of the whole structure of their energy consumption, because they do not have established adequate measurement or do not deal with the analysis of energy consumption in a systematic way. So it happens that the organizations do not have information on the real energy consumption per individual energy consumer, production lines and the like, nor do they recognize the interdependence of energy consumption and activities performed within the organization. Even the information on energy losses often remain hidden due to the outdated or insufficiently well-maintained equipment, increased energy consumption due to oversized capacity etc.

Energy management systems encourage the organization that, in terms of energy use, approaches in a systematic way, focusing on specific values, structures and distribution of energy, defining priorities accordingly, defining objectives, their implementation, and what is especially important, the persistence of these tasks in continuity, thus achieving constant improvements in the established system. What is also important is that the energy management system includes the generation of certain records among which we find some of the most important ones, the ones related to the monitoring of selected parameters of energy performance and which compare values from year to year in relation to the starting position within the organization itself, but also give an external comparison by benchmarking with the best in the particular sector.

3.1. The current situation in Serbian companies

In Serbian organizations the establishing energy management system is more than necessary. The reason is that we are among the countries with the worst results in terms of energy efficiency and such a treatment of energy directly affects the cost of our prod-

ucts and reduces the competitiveness of our companies on the global market. Also, one should not ignore the importance in terms of the following impacts on the environment.

However, note the following: the implementation of the energy management system does not necessarily mean its certification. Neither does it necessarily imply high costs. On the contrary, the implementation of energy management can lead to significant savings, sometimes through a very modest investment. This is supported by the results of the project UNIDO cleaner production [7], which has so far been realized in about 20 Serbian business ventures, where the analysis of reports from the project can determine that a large number of options for cleaner production is exactly in the energy efficiency part and that there very significant savings were realized. It should be noted that good results in the field of energy efficiency are achieved in organizations with established management systems (such as ISO 14001 and ISO 9001), but also in organizations without a formally established management system.

Table 1. Relation between ISO 14001:2004, EN 16001:2009 and ISO / CD 50001

ISO14001:2004	EN 16001:2009	ISO/CD 50001
4. Requirements for a system of environmental management	3. Requirements for energy management	4. Requirements for an energy management system
4.1. General requirements	3.1. General requirements	4.1. General requirements
4.2. Environmental policy	3.2. Energy policy	4.3. Energy policy
4.3. Planning	3.3. Planning	4.4. Planning
4.3.1. Environmental aspects	3.3.1. Identification and review of energy aspects	4.4.1. General 4.4.2. Energy profile 4.4.3. The initial energy profile (Energy baseline) 4.4.4. Energy performance indicators/performance
4.3.2. Laws and other requirements	3.3.2. Laws and other requirements	4.4.5. Laws and other requirements
4.3.3. General and specific objectives and program(s)	3.3.3. General and specific objective energy objectives and program(s)	4.4.6. General and specific objectives and action plans
4.4. Implementation and enforcement	3.4. Implementation and enforcement	4.5. Implementation and enforcement
4.4.1. Resources, tasks, responsibilities and powers	3.4.1. Resources, tasks, responsibilities and powers	4.2. Management responsibilities 4.2.1. General 4.2.2. Resources, tasks, responsibilities and powers
4.4.2. Competence, training and awareness	3.4.2. Competence, training and awareness	4.5.1. Competence, training and awareness
4.4.3. Communication	3.4.3. Communication	4.5.4. Communication
4.4.4. Documentation	3.4.4. Documentation regarding energy management	4.5.2. Documentation 4.5.2.1. The documentation requirements
4.4.5. Document management	3.4.5. Document management	4.5.2.2. Document management

Table 1. (Continued)

ISO14001:2004	EN 16001:2009	ISO/CD 50001
4.4.6. Control over operations	3.4.6. Control over operations	4.5.3. Control over operations 4.5.5. Projecting 4.5.6. Procurement of energy services, resources and energy 4.5.6.1. Procurement of energy services and goods !! 4.5.6.2. Procurement of energy
4.4.7. Preparedness for an emergency response, and the response		
4.5. Checking	3.5. Checking	4.6. Checking performance
4.5.1. Monitoring and measuring	3.5.1. Monitoring and measuring	4.6.1. Monitoring and measuring and analyzing
4.5.2. Evaluation of compliance	3.5.2. Evaluation of compliance	4.6.2. Evaluation of legal/other compliance
4.5.3. Discrepancies between corrective and preventive measures	3.5.3. Discrepancies between corrective and preventive measures	4.6.4. Non-compliance, corrective and preventive actions and measures improvements 4.6.4.1. Inconsistency 4.6.4.2. Corrective and preventive actions
4.5.4. Records management	3.5.4. Records management	4.6.5. Records management
4.5.5. Intemal checks	3.5.5. Internal checks of energy management systems	4.6.3. Intemal checks
4.6. Management review	3.6. Review of the energy management system by top management 3.6.1. General 3.6.2. Inputs to management review 3.6.3. Outputs to management review	4.7. Review of the energy management system by top management 4.7.1. Inputs to management review 4.7 2. Outputs to management review

4. STRUCTURE EN 16001 AND ISO 50001 AND INTEGRATING WITH ISO 14001

It has already been mentioned that the standards EN 16001 and ISO 50001 have an applied PDCA methodology and the process approach in them and that they have very similar structure like ISO 14001:2004 which indicates that some of the basic structural elements of all three standards are: the general part, planning, implementation and conduction, assessment and review.

If a detailed comparative analysis of the structure and content of the all three standards is performed we can make a correlation table that could serve as an additional tool in the implementation of the energy management system integrated with ISO 14001 (Table 1). In fact, during the implementation of the energy management system, it would be conceptually relatively easy to upgrade certain requirements under the ISO 14001, to address the requirements of EN 16001 that is ISO 50001.

As it can be seen from the first table, EN 16001:2009 has almost an identical structure like ISO 14001:2004. The only exception is the requirement 4.4.7 of ISO 14001 that is related to the preparedness for an emergency response and the response itself, which is not contained in the standard EN 16001. It is also characteristic that EN 16001 introduces the term 'energy aspect' in order to create a greater analogy with ISO 14001 (for a discussion of 'environmental aspects').

However, when it comes to the standard of ISO 50001, the situation is somewhat different, and it can be noted that there are some significant differences in the structure. In order to make the differences more apparent, the most important structural differences are highlighted in gray in Table 1 and the basic explanations for these differences are given in Table 2.

Table 2 Explanation of major differences ISO/CD 50001 compared to ISO 14001 and EN 16001

Request CD / ISO 50001	Explanation
Planning Section (part of the application)	
4.4.1 General 4.4.2 Energy profile 4.4.3 The initial energy profile (Baseline Energy) 4.4.4 Indicators of impact energy/performance	The 'energy aspects' are not mentioned as they are in the case of EN 16001 (and similar to ISO 14001 'environmental aspects'), but they are mentioned as an 'energy profile' and 'energy baseline'. The requirement for energy performance indicators are clearly stated.
Chapter Application and enforcement (of application)	
4.2 Management Responsibilities 4.2.1 General	This part does not exist as a separate item in EN 16001 and ISO 14001
4.5.5 Projecting 4.5.6 Procurement of energy services, resources and energy 45.6.1 Procurement of energy services and goods 45.6.2 Purchase of energy	This part of the demand does not exist isolated like this and it is not directly expressed in ISO 14001 and EN 16001. This requirement indicates the plant design, equipment etc. and procurement of energy services
Other (less formal differences in the structure)	
4.4.6 General and specific objectives and action plans	Instead of the program, the term action plan is implemented and that is a substantial difference. Also, some order has been changed in the structure
4.2.2 Tasks, responsibilities and powers 4.5.4 Communication 4.6.5 Records management 4.6.3 Internal checks	The order of applications in the structure are changed

One question that arises after this analysis is which standard should be chosen. Both standards deal with the same problems, their purpose is the same, and yet there are some differences. Perhaps the best answer to that question is that it is less important which standard will be implemented into the energy management system in a specific organization. It is more important to start with the implementation. In doing so, both standards can be used simultaneously, and it is possible that the generated requirements include both standards, in which case it still might be better to rely more on ISO 50001 as the base, because it is somewhat wider and more specific in demands. It should be borne

in mind that there are expectations that ISO 50001 will have, in time, a wider application than EN 16001 because it is an international ISO and not EN standard.

5. ENERGY MANAGEMENT INTEGRATED IN THE SYSTEM MANAGEMENT OF COMPANIES IN THE FUNCTION OF ENVIRONMENTAL PROTECTION - A CASE STUDY

There are a number of concrete examples of significant savings in terms of energy use, which are achieved without major financial investment: using the host business, better organization of jobs and regular maintenance, which should further encourage organizations to focus more on issues of rational energy use and in that sense approach the implementation of one of the energy management systems.

As a model of efficient energy management within the existing integrated management system, in this work we will use the example of the energy process in the Oil Refinery Belgrade.

In the energy process, four types of energy plants are included: the boiler plant, waste water treatment plant, the compressor station and the water station plant.

The boiler plant is an example of good practice in which one can see the efficient functioning in the system of environmental protection management, safety and health at work, and energy efficiency. Under this part of the plant, there are three boilers with the characteristics which are shown in Table 3.

Table 3 The explanation of the major differences ISO / CD 50001 compared to ISO 14001 and EN 16001

Boiler type	Manufacturer	Year of production	Number of records in IPK	Max./working steam production	Nominal power	Operating pressure
TE - 111/R	Minel-Kotlogradnja Belgrade	1975	C-314-451/76- 11 IPK Belgrade	16/12.5 t/h	12.17 MW	12.5 bar
S-1200	Đuro Đaković Slavonski Brod	1987	09-837/87 IPK Zagreb	12/10 t/h	7.84 kW	13 bar
TE-108 out of function	Minel-Kotlogradnja Belgrade	1993	314-02-234/92	8/6.5 t/h	5.2 MW	12 bar

In the past three years, measurements and calculation of the parameters were carried out that indicate the energy efficiency of the boiler plants, and its impact on the environment and the impact on the health of the employees.

The first year of measurement was 2008 when the first results of the analysis were obtained. Given the obtained results and based on them, programs were prescribed, that is, the measurements of improvement from all three management systems.

Indicators that were observed (KPI) and which show the energy efficiency of the boiler within the framework of the whole boil plant are boiler utilization in % and the consumption of fuel oil in Tn based on the finished product in Tn. For 2008, the average utilization of the boiler was 76% and the ratio of consumption of fuel oil in relation to

production was 0.35. This indicates the low utilization of the boiler and a high consumption of fuel oil in relation to the manufacture of the finished product. The boiler used over 33 years has a nominal capacity several times higher than the current requirements. The system for steam supply and condensate return has numerous deficiencies: collapsed and/or insufficient insolation, steam traps and other equipment in poor condition.

Measurements that indicate the status of health and safety at work in the boiler room refer to the physical, chemical hazards, microclimate and brightness. The results show that the micro-climate and the brightness in the comfort zone which satisfy the prescribed measures for safety and health at work. The measured noise at the workplace exceeds the permissible level in the frequency range of 500 Hz to 8000 Hz, and due to possible health risks it is necessary to apply the measures. The measurement of chemical hazards including: carbon monoxide, hydrocarbons, carbon dioxide, sulfur dioxide and nitrogen oxides do not exceed the MCL, but are close to the upper limit, so it is necessary to take action because of the potential negative impact on the health of the employees.

The parameters that indicate the impact of the boiler on the environment are the measurements of the flue gas from the boilers by authorized institutions. Harmful substances from the combustion of liquid fuels whose values were determined are: carbon monoxide, nitrogen oxides (CO_2), sulfur oxides (SO_2), gaseous inorganic chlorine compounds (HCl), total particulate matter. RE-111/R values for carbon monoxide and the total particulate matter for the boiler are close to the upper limit of MAC, while the concentration of sulfur oxides exceeds the upper limit. It is necessary to take measures for negative impacts on the environment and avoid paying fines for emissions of harmful substances into the atmosphere.

We have a program related to all three management systems (the protection of the environment, safety and health at work, energy management). The program consists of four parts, but each part is related to all three areas, that is, improves the parameters of observation.

1st part of the program – Repair and commissioning of 108 T boiler, instead of the TE 111 boiler to suit the current needs. Boiler T 108 has a nominal power of 5.0 MW while boiler TE 111 has an output of 12.17 MW. Boiler T 108 uses less fuel oil and is of recent production from 1993. It has better sound and thermal isolation, so that in a working environment it does not produce harmful chemicals and does not produce noise above the permissible values.

2nd part of the program – Reconstruction of the accompanying installation and thermal isolation of pipes and vessels.

3rd part of the program – Refers to the supply of crude oil that is, heating oil. Strict criteria should be implemented when it comes to oil, which is obtained for operation of the boiler with a smaller mass fraction of sulfur and ash. Heavy oil, which is of better quality, can be used in smaller amounts and during firing it releases smaller values of harmful substances into the air.

4th part of the program – The purchase of electronic instrument TESTO 325 for internal monitoring and control of the parameters of the boiler, the determination of the volume fraction of O_2 and CO_2 in the flue gas. It is possible to save fuel by changing the auto-regulation of the burner by measuring the volume fraction of O_2 in the flue gas.

During 2009, we had approached the implementation of programs section by section; as each section was realized, the changes were seen in the indicators of measurement.

In 2009, the average utilization of the boiler was 83% and the ratio of consumption of fuel oil in relation to the manufacture of the final products decreased to 0.22. The monitoring parameters IN 2010 indicates a significant improvement, the average utilization of the boiler had climbed to 92%, the ratio of consumption of fuel oil in relation to the production reached the target value of 0.09.

In the period from 2011 to 2012 the average utilization of the boiler continues to grow to 95%, while the ratio of consumption of fuel oil in relation to the production of finished goods fell to 0.08.

Table 4 Tabular overview of the value of process indicators for the energy drive [5]

Year	Utilization of the boiler in %	The consumption of fuel oil in Tn for the production of finished goods in TN
2008	76	0.35
2009	83	0.22
2010	92	0.09
2011	95	0.08
2012	95	0.08

After repair and use of the boiler T 108, the level of noise in the workplace decreased, so that the employees no longer had to wear protective gear. The concentration and chemical hazards of carbon monoxide, hydrocarbons, carbon dioxide, sulfur dioxide and nitrogen oxides also decreased, so that putting an additional hood on the boiler was not needed as it was originally a measure of protection from chemical hazards. The purchase of higher quality crude oil reduced its consumption and harmful emissions sulfur dioxide, carbon monoxide and total particulate matter into the atmosphere. Everyday measuring and monitoring of the volume fraction of oxygen in the flue gas is regulated by the burner's work and fuel saving was achieved.

The implementation of a program that provides an analysis of several aspects of risk allowed the advancement and improvement of the system of environmental management, energy management, and unnecessary investment was avoided, which would have been made if we had observed the quality systems separately and independently from each other, and not as an integrated management system. It is necessary to observe the integrated management system with as many aspects that are relevant to business and observe them interacting with each other together.

6. CONCLUSION

The appearance of external pressure from the government, which is demonstrated through the adoption of numerous laws and regulations and through extremely harsh punishments for the slightest mistake, and strengthening public pressure requires a healthy and safe working environment, and urges companies to review their practice areas of application management system. The answer lies in the implementation of an integrated management system, a system that focuses on the process of improving work in all areas that are important for the company. The application of these systems is not simple, because all the stakeholders put extra high demands.

New standards for energy management systems EN 16001:2009 and ISO 50001 can serve as a significant incentive and help organizations to establish energy management. Both standards are designed in a way that can be integrated with other management systems, such as, for example, ISO 9001, ISO 14001 and OHSAS 18001, but can also be applied independently. According to their structure they are similar to ISO 14001:2004, but there were certain differences which are expressed in ISO 50001th.

The implementation of energy management is more than necessary in Serbian companies. In addition, the most important motive of companies can be concrete financial savings, but we should not underestimate the positive impact on the environment. There are a number of concrete examples of significant savings in energy use, which are achieved without major financial investment: by enforcement of the host business, better organization of work and regular maintenance, which should further encourage organizations to focus more on issues of rational use of energy and with that goal approach the implementation of an energy management system.

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ENERGETSKI MENADŽMENT INTEGRISAN U SISTEM UPRAVLJANJA KOMPANIJA U FUNKCIJI ZAŠTITE ŽIVOTNE SREDINE – STUDIJA SLUČAJA

Energetska efikasnost i bolje upravljanje energijom su sve više u centru interesovanja u svetu ali i kod nas. Razlozi su u značajnom potencijalu koji postoji u pogledu energetskih ušteda, smanjenju pratećih troškova, kao i smanjenju emisija gasova staklene bašte.

Uspostavljanje sistema energetskog menadžmenta u srpskim preduzećima je više nego neophodno. Razlog je u tome što smo među zemljama sa najgorim rezultatima u smislu energetske efikasnosti i takav tretman energije direktno utiče na cenu naših proizvoda i smanjuje konkurentnost naših preduzeća na globalnom tržištu. Takođe, ne treba zanemariti značaj podrške u smislu uticaja na životnu sredinu.

Kao model efikasnog sistema energetskog menadžmenta u okviru postojećeg integrisanog menadžment sistema, u ovom radu predstavljen je primer energije procesa u Rafineriji Beograd.

Ključne reči: *sistemi energetskog menadžmenta, energetska efikasnost, integrisani menadžment sistemi, EN 16001, ISO 50001, ISO 14001*