DOI: 10.2478/bhee-2018-0004

Review scientific paper/Pregledni naučni rad

ANALYSIS OF ENERGY EFFICIENCY MARKET AND POSSIBILITIES OF ENERGY EFFICIENCY IMPROVEMENTS IN INDUSTRIAL SYSTEMS IN B&H

ANALIZA TRŽIŠTA I MOGUĆNOSTI UNAPREĐENJA ENERGETSKE EFIKASNOSTI U INDUSTRIJSKIM SISTEMIMA U BIH

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Abstract: The assessment of technical potential of energy efficiency improvement in industrial power systems in Bosnia and Herzegovina, which is particularly related to electric drive systems, has been presented in the paper. The analysis of energy efficiency market in industrial power systems including various types of industry has been shown as well. Based on analysis of weekly load diagram of selected customers, the assessment of savings when energy efficiency measures are implemented has been given in the paper. The results of techno-economic cost-effectiveness analysis of typical energy efficiency improvement measures in systems that contain electric motors have been given as well. Finally, the assessment of energy efficiency market in industrial power systems in the next ten years has been presented.

Keywords: supplier, energy efficiency, electricity market, emissions trading system

Sažetak: U radu je data procjena tehničkog potencijala poboljšanja energetske efikasnosti u industrijskim elektroenergetskim sistemima u Bosni i Hercegovini, što se posebno odnosi na segment elektromotornih pogona. Prikazana je analiza tržišta energetske efikasnosti u industrijskim postrojenjima u Bosni i Hercegovini uključujući različite tipove industrije. Na osnovu analize sedmičnih dijagrama opterećenja odabranih potrošača data je procjena ušteda pri implementaciji pojedinih mjera energetske efikasnosti, odnosno dat je prikaz rezultata tehno-ekonomske analize isplativosti karakterističnih mjera poboljšanja energetske efikasnosti u sistemima koji sadrže električne motore. Konačno, prikazana je procjena tržišta energetske efikasnosti u industrijskim sistemima u Bosni i Hercegovini u narednih deset godina.

Ključne riječi: snabdjevač, energetska efikasnost, tržište električne energije, tržište emisijskim jedinicama

INTRODUCTION

The oil crisis from 1970s was a stimulus to boost energy efficiency improvement in the economic sectors of many countries. The International Energy Agency (IEA) reports that oil price fluctuations happened in 1970. Therefore, energy guidelines were geared towards more effective control of energy demand growth unlike actual guidelines that have been implemented since 1990s, which are directed to climate targets fulfillment. Today, the increase of energy efficiency is the priority of political agendas of all countries and besides numerous economic and ecological factors it is related to the aspect of reliability of energy supply [1].

To support energy efficiency, many organizations work on developing referral and consulting platforms within identified priority areas. Each country chooses the ones that best suit its orientation when it comes to energy efficiency as well as the unique economic, social and political situations. Despite the huge potential, energy efficiency faces a numerous of barriers, including inadequate access to energy efficiency investments, lack of information as well as other costs that are not included in the energy price. Additionally, the political commitment to maximizing the implementation of energy efficiency measures may be disturbed by the current economic crisis. Energy efficiency programs must compete for funding with other priority issues such as employment, health and social security.

In the industrial context, energy efficiency implies a reduction in energy consumption per unit of industrial production. The level on which the process, the company or even the country consumes energy is described as energy intensity. Energy intensity is defined as energy consumption per unit of production and it is expressed as:

$$SPE = \frac{E}{N_{PR}} \quad (1)$$

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Paper submitted: November 2017 Paper accepted: February 2018

where:

SPE - specific energy consumption,
E - energy consumed for production,
N_{pr} - unit of product.

1. ANALYSIS OF ELECTRICITY CONSUMPTION AND APPLICATION OF ENERGY EFFICIENCY MEASURES IN EU

Energy efficiency measures represent an instrument for obtaining sustainable electricity supply through reduction of greenhouse gas emissions, improving the reliability of electricity supply, reducing import costs as well as increasing the competitiveness of industrial companies in the market. The European Council emphasizes the importance of energy efficiency for electricity price reduction through its directives. The goal of European Union (EU) is to improve efficiency in each phase of energy chain, from electricity supply to end consumption.

The results of energy efficiency measures implementation are visible from the fact that, in 2014, the countries of IEA achieved a decrease in imports of primary fuels of natural gas, oil and coal for at least 190 Mtoe, saving 80 billion US dollars. This avoided import of the German market surplus from 12% in 2014 and reduced market deficit of Japan by 8%. In 2014, in countries of IEA the reduction in electricity consumption caused by investing in energy efficiency increased by 10%, which is the fastest growth in the last 10 years. In 2015, electricity consumption of the countries belonging to the Organization for Economic Cooperation and Development (OECD) was at the level of consumption in 2000, while the Gross Domestic Product (GDP) grew by 26%, which indicates that the economic growth of these countries is separated from energy consumption. In addition, a significant reduction of greenhouse gas emissions can be linked to the results achieved by implementing energy efficiency measures. In the case of no investments in energy efficiency since 1990, IEA countries would issue additional 10.2 GtCO2 by 2014. Only in 2014 greenhouse gas emissions decreased by 870 MtCO2 [2].

Electricity consumption of industrial sector of EU amounted to about 26% of total electricity consumption in 2012. In industrial intensive countries such as Austria, Germany, the Czech Republic or Sweden, the share of industrial consumption in total electricity consumption ranges from 30 to 35%. In Finland and Slovakia, the share of electricity consumption of the industrial sector amounts to over 40% of total consumption.

Natural gas and electricity are dominant energy sources in the industrial sector with the share of 32% and 31% of energy market in 2012, respectively. Electricity had a rapid growth from 2000 to 2012 (Figure 1). A small part of the electricity market progress is related to the replacement the fuel by electricity, and if the share of the electricity market was kept constant, electricity consumption would be 9% lower than it was in 2012 [3].

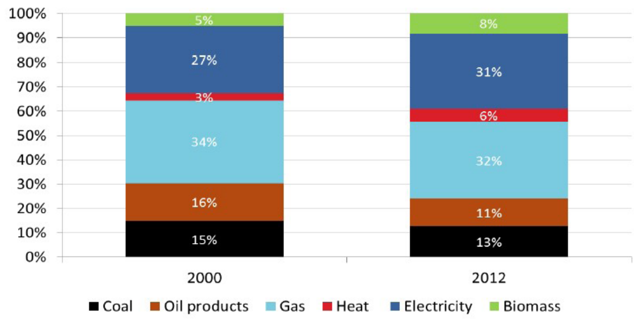

Figure 1: Energy mix of EU [3]

The research shows a high level of justification for implementing energy efficiency measures in industrial sector as evidenced by energy efficiency improvement indicators in the EU, where energy efficiency in the industrial sector increased by 30% between 1990 and 2009. The average annual rate of energy efficiency increase in the mentioned period was 1.8%, while the electricity consumption of electric motors decreased for 40% [2]. According to the EU-27, by 2020, electricity consumption in industrial sector is estimated at 1432 TWh or 859 TWh of industrial engine consumption, if certain measures will not be implemented. If the EU succeeds to implement the planned energy efficiency measures for the reduction of electricity consumption of the engine (estimation of 31%), the result would be a yearly reduction of electricity consumption of 270 TWh, which is equivalent to the total electricity consumption of Spain in 2000.

2. ANALYSIS OF THE ENERGY EFFICIENCY MARKET IN BOSNIA AND HERZEGOVINA

Bosnia and Herzegovina, on its way to gaining EU membership rights, faces the transition of the power sector, which includes economic, social, and environmental aspects. The electricity market was opened on 1 January 2015, but it was officially preceded by balance market opening on 1 January 2016. The analysis of electricity consumption of end customers indicates that there is a significant energy reserve in Bosnia and Herzegovina which amounts to even 30% of total electricity consumption and which can be activated by implementing energy efficiency measures. At the beginning of 2017, the Law on Energy Efficiency in FB&H entered into force (Official Gazette of the FB&H from 24 March 2017) and it is expected that implementation of energy efficiency measures will be intensified in the forthcoming period. The law prescribes the obligations of large consumers to carry out economically viable energy efficiency measures, continuously monitor electricity consumption in facilities through information systems and carry out ener-

[1] 1 toe = 11630 kWh = 41870 MJ

gy audits. On the other hand, other actors in the electricity market, large suppliers and distribution system operators (DSO), are obliged to inform the end customers about the manner of electricity consumption and to provide energy services and energy audits to the customers at competitive prices directly or through other companies [4].

Electricity suppliers whose goal is to participate actively in the energy transition in their product portfolio include providing targeted services to the end customers in order to reduce their final electricity costs. The analysis of retail markets of developed countries suggests that a sales strategy based only on electricity prices is not a viable strategy in the long term. Bosnia and Herzegovina is characterized by a high-energy intensity of the industrial sector, so it is of particular importance to implement measures to improve energy efficiency in industrial power systems. The starting point for improving energy efficiency in industrial systems is recognition of benefits that the implementation of certain energy efficiency measures can bring to a company. The implementation of energy efficiency measures in industry, especially in energy intensive production, significantly reduces energy costs, at the same time increasing the company's productivity. However, there are numerous obstacles of technical and non-technical character in the implementation of policies aimed at increasing energy efficiency in the industry.

2.1. The Questionnaire Results

In order to carry out a survey of the energy efficiency market and obtain information on the current level of representation of energy efficiency measures in the industrial sector of Bosnia and Herzegovina, a questionnaire was distributed to consumers with installed power of 300 kW to 95 MW connected to 10 kV, 35 kV and 110 kV network. When selecting consumers who participated in the research, it was considered that research involved different types of industry. The technological processes of analyzed consumers contain a large number of engines, ranging from 100 to 4292. The questions contained in the questionnaire were created based on literature review, which cited measures to improve energy efficiency of industrial consumers. Taking into account that the efficiency of industrial companies is reflected partly in the share of electricity price in the price of the final product, from the implemented research, it can be concluded that two companies of the same type of industry do not have the same share of the electricity costs per final product. Applied energy efficiency measures significantly influence the share of electricity price per final product.

Based on information obtained by research, the share of electricity costs in the total cost is the largest in the wood and metal industry ranging from 7.82% to 30%. The lowest share of electricity costs in the total cost was 0.4% in the automotive industry, while in the chemical industry it ranged from 1.2% to 10.5%. Any reduction in electricity consumption contributes to increasing the company's profit. For energy efficiency measures implementation, it is important to identify the critical points within the plant that have large energy consumption, for which it is necessary to have the ability of monitoring the electricity consumption. In the implemented research, only 33% of consumers have the ability to monitor consumption by individual parts of technological process that indicates that there is enough space for implementing the measures for energy efficiency improvement. From the applied solutions, electricity consumption monitoring is implemented through Power Monitoring System, Poreg, electrical energy meters installed on each larger consumer unit, Supervisory Control and Data Acquisition (SCADA) System. In one technological process, for real time electricity consumption monitoring, electrical energy meters have been connected to the central energy-consuming system, measuring power consumption on transformers that power individual consumer groups. This has been implemented using the SIEMENS SENTRON PAC3200 network analyzer.

Due to Directive 2009/125/EC[2], one of the questionnaire questions was referred to energy efficiency classes of the applied electric motors. The results show that small number of consumers have implemented energy efficiency motors and that the age of the applied engines ranges from 1 to 50 years, depending on the age of the company. From the literature review, one of the characteristics of developing countries is the large share of engines older than 20 years in the industrial sector.

Almost a common question when older engines go bad is whether to replace it with a newer, more efficient one or rewind the existing engine. Although rewinding the engine reduces efficiency by 1 to 3%, developing countries are rarely replacing the old engines with new ones because of the relatively low costs of engine rewinding. However, the literature states that for engines with a low number of hours of operation, quality rewind may be an adequate solution because the efficiency of the engine does not play a significant role in that case. The results of the research show that all companies rewind the old engines while two companies, in addition to rewind, purchase the new ones that are more efficient, as well. Based on the results of the questionnaire, the average number of rewinding during the life span of a single engine is obtained. There are 2-3 times of rewinding on an average, while in some companies there are 7-10 rewinding before replacing the engine with a new one.

The proper selection of motors greatly influences its effective operation in drive. A common problem that varies depending on the type of industry is the oversizing of electric motors. Most of the engines operate in underload mode. In addition to this, idle engine operation regimes are common as well. Therefore, the questionnaire also contained the issue of engine operating regimes. The results show that in 85% of the companies, engines operate in an underload mode, and in 60%, the engines have intermittent operation.

The engine start and stop modes have a major impact on engine efficiency, since starting and stopping the engine re-

[2]Directive 2009/125 / EC from 01 January 2015 requires replacement of the engines nominal power of 7.5-375 kW with engines with efficiency class at least IE3/IE2 equipped with speed controllers, ie from 01 January 2017 all engines nominal power of 0.75 to 375 kW must be at least the class of IE3/IE2 with speed controllers

sults in increased losses. For drives that frequently start and stop, it is important to reduce the losses during starting and stopping, which can be achieved by applying different soft start and stop devices. The research shows that in 50% of drives, starting and stopping are frequent, which indicates the possibility of achieving great savings by implementing appropriate start and stop modes, specifically using soft starter devices or frequency inverters if there is a need of engine speed regulation.

A very important factor influencing the energy efficiency of electrical motors is the way of maintaining, which in industrial terms implies maintaining a critical equipment for production in operational condition or restoring it to the operating state. The reliability, safety and productivity of the technological process in industry depend on applied diagnostic methods. By monitoring the condition of the motor, it is possible to predict failures and avoid unnecessary and sudden stopping of the drive, achieving great savings. Research results show that 58% of the surveyed companies pay close attention to the proper maintenance of the engine, which directly reflects the reliability and profitability of the company's operations. In addition to corrective maintenance, preventive maintenance is also carried out. However, the results show a large representation of corrective maintenance, which implies repair when a failure occurs, which directly reduces the efficiency of the company as a whole. It is possible to change the approach and make small investments that significantly contribute to improving the efficiency of operation.

In order to carry out an analysis of the improvement of the energy efficiency market in the industrial sector, one of the issues of research referred to the question if the energy efficiency measures had been already implemented. Energy efficiency measures had not been applied in 33% of the total number of surveyed companies. The most commonly implemented energy efficiency measures were the replacement of old engines with new ones and installation of frequency controls in order to regulate electric motors. Some companies also decided to make a step forward in terms of energy management and implemented the SCADA system. In addition to this, energy audits were carried out in some companies and the standard EN ISO 50001 was implemented. One company carried out the peak load management and achieved savings of about 5%. In order to reduce the cost of over-taken reactive power from the system, most companies have built-in devices for reactive power compensation. The respondents point out the positive effects achieved by applying energy efficiency measures.

3. ANALYSIS OF LOAD DIAGRAMS AND ASSESSMENT OF THE POSSIBILITIES OF ENERGY EFFICIENCY IMPROVEMENT FOR INDUSTRIAL CONSUMERS IN B&H

For the purpose of analysis of the electricity consumption of large industrial consumers, load diagrams of consumers connected to the 10 kV and 35 kV network have been analyzed, including some consumers connected to 110 kV network. The analysis involved 521 consumers and 736 measurement points. The analysis was carried out based on 15-minutes power readings from April 2016 that included 2880 readings per a consumer. Weekly load diagrams are obtained in a way that load for each hour is obtained as an average value of load achieved at exactly specified hour of the day in week for the observed period.

In order to identify the customer classes in relation to the modes of operation and the business process management, the consumers have been classified in 6 clusters using MATLAB program package. Clusters 5 and 6 represent exceptions, consumers who practically do not have any electricity consumption, which is the reason why they are being excluded from further consideration. Weekly load diagrams, normalized to maximum peak load, for clusters 1-4 are shown in Figure 2.

Cluster 1 includes consumers who work one-day shift per week, with a limited number of consumers that work with lower capacity on Sundays. The peak load usage time for this consumer group is 255 hours on an average, while the share of consumption achieved in the period of higher daily tariff is about 65%. Cluster 2 includes consumers who work in two-day shifts at approximately the same intensity every day of the week. The peak load usage time for this group of consumers is approximately 365 hours, while the share of consumption realized in the period of higher daily tariff is

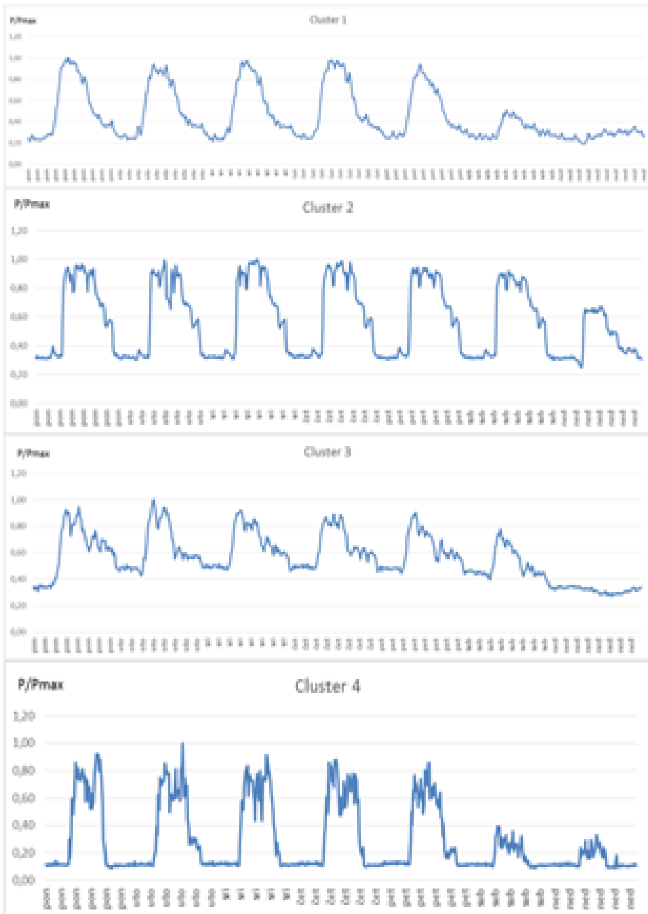

Figure 2: The result of the cluster analysis carried out in Matlab program package for the weekly load diagram

about 56%. Cluster 3 employs consumers who work three shifts a week, where few of them work at lower intensity on Sundays. The peak load usage time is around 305 hours, while the share of consumption realized in the period of higher daily tariff is about 53%. Cluster 4 includes consumers who have a peak load usage time of about 150 hours and mostly work one-day shift during work days while at weekends work at a higher intensity. The share of consumption realized in the period of higher daily tariff is about 67%.

Energy efficiency measures can be applied by industry type, according to technological processes, taking into account the way in which individual companies operate, primarily thinking of working in one or more day shifts. Of course, for a more detailed analysis, nature of the technological process as well as analysis of technological process by its segments and identification the parts that represent large electricity consumers are needed to be taken into consideration.

It can be concluded that when assessing the feasibility of applying some energy efficiency measures and calculating the return on investment (*ROI*), it is necessary to know daily habits of a consumer, since the electricity savings through the price, which depends on the period of peak load usage, directly reflect on *ROI*.

Consequently, it is necessary to carry out a techno-economic analysis for each characteristic group of consumers in order to assess the potential for investing in energy efficiency as well as to determine the approach to raising the final consumer's awareness of benefits of energy efficiency measures implementation.

3.1. Estimation of the techno-economic feasibility of energy efficiency measures implementation for electric motors

Electric motors make up for about 60% of the industrial electricity consumption (where asynchronous motors are the most commonly used, 90%) and about 15% of final energy consumption in industry worldwide (IEA 2007). The research shows great potential for improving the efficiency of electric motors with *ROI* of only a few years. It is estimated that the introduction of measures for energy efficiency improvement of electric motors can reduce world electricity consumption by around 7% (IEA 2008), [5]. Investment in increasing the energy efficiency of the engine in order to reduce losses is driven by economic and environmental considerations and legislation.

Electric motors belong to "Energy using Products" or EuPs. Purchase and maintenance costs represent only parts of the cost of a single engine life span. Increasing the cost of electricity at any time of usage the engine causes an increase in overall investment/consumption and further increases the justification for the investment in energy efficiency. This is very important, both economically and ecologically [1]. Savings generated by an energy-efficient engine can be calculated according to (2):

$$Savings = P_n\left(\frac{1}{\eta_s} - \frac{1}{\eta_E}\right)t \cdot c \qquad (2)$$

where:

$Savings$ - savings generated by energy efficient motor (BAM),
P_n - motor nominal power(kW),
η_S - energy efficiency of actual motor,
η_E - energy efficiency of a more efficient; motor,
t - number of engine operation hours,
c - electricity price (BAM/kWh).

In the case of the need to purchase a new engine, savings based on the electricity bill earned by a more efficient engine should only cover the difference in prices of engines of different energy efficiency classes. In the simplest case, the budget covers only the annual electricity savings, assuming equal annual savings in the period of repayment of the investment as well as realizing the investment from own financial resources. Based on the aforementioned, the period of *ROI* in an energy efficient engine can be estimated as it is given in (3):

$$ROI(years) = \frac{investments_{IE3}(BAM) - investment_{IE2}(BAM)}{anual\ savings(BAM\ /\ year)} \qquad (3)$$

Based on the relations (2) and (3),annual savings obtained by decrease in electricity consumption that would be achieved by purchasing IE3 energy efficiency class engine instead of the IE2, for each of the clusters 1-4, were calculated. Energy efficiency of certain types of motor given in [6], the price of four-pole asynchronous motors nominal power 22 kW energy efficiency classes IE3 and IE2 given in [7] have been used for the purpose of the analysis. The results of the analysis are shown in Table I.

Table I: The results of calculation of *ROI* for purchasing IE3 energy efficiency class engine instead of the IE2 for clusters 1-4

	ROI (years)
Cluster 1	4.87
Cluster 2	4.07
Cluster 3	4.09
Cluster 4	4.98

Depending on the way on which the operations are being performed, the *ROI* of the purchasing motor of IE3 energy efficiency class instead of motor of IE2 efficiency class is 4 to 5 years. The calculations also show that consumers who work a large number of hours per year often work in regime of idling and thus unnecessarily consume the electricity. Idle losses represent approximately 1/3 of total engine losses and it can be estimated due to relation (4):

$$Cost_{P_O} = \frac{P_n}{3}\left(\frac{1}{\eta} - 1\right)t \cdot c \tag{4}$$

where:

$Cost_{P_o}$ – the cost of electricity of engine working in an idle mode,
P_n – nominal power of engine (kW),
η – energy efficiency of engine,
t – number of hours per year in which motor works in an idle mode,
c – electricity price (BAM/kWh).

By replacing the engine with more efficient one, idle losses and thus the cost of electricity are reduced. The savings, which can be achieved by replacing the engine with a more efficient one, can be calculated according to the relation (5):

$$Savings_{P_O} = \frac{P_n}{3}\left(\frac{1}{\eta_s} - \frac{1}{\eta_E}\right)t \cdot c \tag{5}$$

where:

$Savings_{P_o}$ - savings that is achieved due to using a more efficient engine (BAM),
P_n - nominal power of engine (kW),
η_S - energy efficiency of actual engine,
η_E - energy efficiency of a new more efficient engine,
t - number of hours per year in which engine works,
c - electricity price (BAM/kWh).

3.1.1. Application of frequency inverters for the electric motors control

For drives that require speed control, investment in installing a frequency converter that allows motor speed control by changing the power frequency of 0-f_n is justified. The main role of the controlled electric motors drive is to control the energy flow between the energy source and the technological process. For power management, the torque and shaft speed are most closely monitored, with the regulation being effected by acting on the mechanical characteristic of the engine. The greatest savings in electricity can be achieved by regulated drive of centrifugal pumps, fans and compressors that operate under normal operating conditions relatively long time a year. As media flow is proportional to engine speed and engine power is proportional to the third degree of rotation speed, it can be concluded that if it is necessary to provide 80% of the media flow, only 51% of the nominal motor power is required which can be achieved by applying a frequency converter. In this way, it is possible to significantly reduce the electricity consumption as well as the costs for the final consumer. In order to estimate the ROI of the frequency converter, it is necessary to analyze each case of application since it depends on the operation mode of the engine as well as the engine load characteristic. For a motor that drives a pump, nominal power of 15 kW, in the case of a need to reduce the media flow to 80% of nominal, the annual reduction of energy consumption is estimated on 49% and, if the calculation is done for the customer from cluster 3, the results of ROI is 6 months.

3.1.2. Impact of energy efficiency measures implementation on reducing greenhouse gas emissions

Given the importance of CO_2 emissions in the context of the global climate change struggle and in long-term significant increase in CO_2 emission costs, it is concluded that the savings in electricity generation through the implementation of energy efficiency measures have a benefit in terms of contributing to the reduction of greenhouse gas emissions. The goal of the European Emission Trading System (EU ETS) at European level is not just reducing emissions in accordance with the established quotas. Every unrealized tone of CO_2 equivalent is associated with a certain financial value. Therefore, the whole process of implementing energy efficiency measures must be observed through the market prism of both electricity and energy services and emission units markets.

In 2014, total electricity produced in power plants of JP Elektroprivreda of Bosnia and Herzegovina - d.d. Sarajevo amounted 7.403 GWh, with the ratio of electricity production from hydro and thermal power plants (TPP) of 21.82%: 78.13% [8]. The current specific emission of production units of JP Elektroprivreda of Bosnia and Herzegovina - d.d. Sarajevo is 1176 kg / MWh [9]. Taking into account the amount of electricity produced in thermal power plants in 2014, the amount of emissions of 6801942 tCO_2 was calculated. If it is assumed that the industry represents 30% of the total electricity consumption of customers supplied by JP Elektroprivreda of Bosnia and Herzegovina - d.d. Sarajevo, total annual emissions from electricity generation in TPP of JP Elektroprivreda of Bosnia and Herzegovina - d.d. Sarajevo obtained to fulfill the needs of the industrial sector is about 2040582 tCO_2.

In [10] it is stated that by introducing carbon price support (CPS), up to 943 million tons of CO_2 in the EU or an average of 105 million tons per year will be avoided. It was estimated that during 2017 electricity production by coal and lignite burning falls by 28% at EU level. The CO_2 emissions charge is estimated at € 23 billion (additional costs), which if it is transferred to electricity consumption, there is an addition to the unit price of electricity of 0.08 ct/kWh. The average cost of reducing CO_2 emissions is estimated at 24 €/tCO_2, which if it is only applied to the reduction of annual CO_2 emissions due to the application of more efficient engines to industrial customers supplied by JP Elektroprivreda B&H d.d. - Sarajevo represents annual savings of 1.4 million BAM.

4. CONCLUSION

Energy efficiency can be understood as a domestic fuel that plays a big but hidden role in strengthening the energy security of a country. The results of energy efficiency improvement vary depending on the sector in which the measures are applied but each one increases the level of energy services per each energy unit. Investing in energy efficiency improvement reduces the amount of energy required to fulfill demand, even though demand grows with rising living standard.

To improve energy efficiency in industrial companies, the starting points are recognition of benefits that the application of certain energy efficiency measures can bring to the company. As the profitability and competitiveness are the basis for survival of the company in the market, even small improvements in efficiency have a major impact on the company's business. Reducing energy consumption is directly reflected in the reduction of greenhouse gas emissions, especially CO_2 generated in the electricity production units, and it has an effect on local, regional and international levels.

In Bosnia and Herzegovina, there is a particularly low awareness of environmental protection. Therefore, almost none of the companies that apply energy efficiency measures correlate the achieved results with social responsibility, which would have a significant impact on the competitiveness of the company in a healthier environment. The underlying causes of the low level of energy efficiency measures appliances in the industrial sector of Bosnia and Herzegovina are the lack of resources and knowledge in the area of energy-efficient technologies, which is a consequence of the underdevelopment of awareness of the opportunities and ways of increasing the profit of industrial companies from the one hand, and the awareness of the consequences of global warming and environmental protection on the other hand.

Raising awareness of energy efficiency, modelled on countries in the region and EU as well, could result in the establishment of an industrial energy efficiency grid that has an aim to connect electricity consumers, experts from the subject area, and representatives of state institutions. The main purpose of such functional networks is to exchange experiences in order to improve energy efficiency and reduce energy consumption in broader proportions. Identification of industrial branches in which energy efficiency measures can be implemented through the installation of an energy management system and employee training through the organization of various workshops is of a great importance.

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BIOGRAPHY

Ajla Mehinović completed the first Bologna study cycle at the Faculty of Electrical Engineering of the University of Tuzla, Department for Energetics, in 2014. She received diploma of the second study cycle from the same University in 2017 where the focus of her research was on electric power networks and systems. She is currently attending the third Bologna study cycle at the Faculty of Electrical Engineering of the University of Ljubljana. In 2015, she was appointed a teaching assistant at the Faculty of Electrical Engineering of the University of Tuzla where she has been still engaging in teaching. She is employed by JP Elektroprivreda B&H d.d. - Sarajevo as an expert associate for market electricity supply. Areas of interest of her are: electric power drives control, energy efficiency of electric motors in industrial plants, electricity market and smart grids.

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Džemo Borovina graduated at the Faculty of Electrical engineering of University of Belgrade in 1989. He received his master's and doctoral degrees at University of Sarajevo and University of Tuzla, respectively. He has expertise in telecommunications, information technology and management systems. He is an author of many scientific papers and member of the Executive Board of BHK CIGRÉ. He has been employed by JP Elektroprivreda B&H d.d. - Sarajevo since 2000. Since 2015, he has been the Executive Director for Electricity Supply and Trading of JP Elektroprivreda B&H d.d. - Sarajevo. Current areas of his interest are electricity market, telecommunications and management systems.

Meliha Džizić was born in 1976 in Gračanica, B&H. She graduated at the Faculty of Electrical Engineering of the University of Tuzla in 1999. She received a master's degree at the Faculty of Economics of University of Sarajevo in 2007. She has been employed by JP Elektroprivreda B&H d.d. - Sarajevo since 2000, where she has been a Head of Sector for Electricity Supply since 2018. The main object of her research is electricity price for end-customers.