ENERGY EFFICIENCY AS A KEY DRIVER FOR SUSTAINABLE GROWTH IN SMEs IN INDUSTRIAL SECTOR IN SERBIA

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Abstract: In light of the post-Covid pandemic and the Ukraine crisis, electricity and natural gas have become goods in high demand and prices. As a result, electricity and natural gas prices reached their highest level, and trends show there is still uncertainty in price forecasting, which leads us to conclude that the value of energy saved by applying energy efficiency measures becomes much higher than the value of primary energy sources themselves. Therefore, the concept of energy efficiency becomes a keyword in every speech to the public. Since the first energy crisis back in the 1970's energy efficiency has been introduced as a critical term in solving the problem of limitations of fossil fuel sources. The second energy crisis accelerated the introduction of new, more energy-efficient technologies and renewable energy sources. Today, we have new challenges – an unfinished energy transition and an artificially induced lack of energy sources like natural gas.

The Republic of Serbia is among the European countries with the highest energy intensity and is significantly dependent on fossil fuels, especially coal. The energy intensity of Serbia (ratio between primary energy consumption and the GDP) has been consistently higher than the EU member states and other non-EU countries of Europe (2 to 3 times higher than in the neighboring EU countries and up to 4 times higher than EU-15). In 2013 Serbia introduced an energy management system (EnMenS). Through this system, significant final energy consumers are recognized and obliged by Energy Efficiency Law to implement energy efficiency measures to reduce energy consumption by at least 1% per annum. However, EnMenS do not recognize "small" energy consumers, where small to medium size enterprises (SMEs) are categorized.

The SMEs sector in the Republic of Serbia accounted for 27.3 % of total active enterprises, employing 46.2 % of employees in the non-financial sector and participating with 43.2 % in the GDP of the non-financial sector. However, the distribution of the number of companies, employees, and their economic activity is highly uneven, where the Belgrade region "carries" 45.8 % of activities in the SME sector, Vojvodina 25.9 %, Šumadija and Western Serbia 18.4 % and Southern and Eastern Serbia 9.8 %. SMEs are primarily concentrated in labor-intensive and service activities - manufacturing, wholesale and retail trade, construction, and transport. The manufacturing industry dominates within the tradable sector - 17.1 % of companies, 28 % of employees, 21.1 % of turnover, and 24.7 % of GDP. It is dominated by sectors of lower complexity and lower productivity (labor and resource-intensive activities).

During 2021 as one of the activities of the EU-funded project, energy audits in ten selected SMEs of the production sector were performed. The primary purpose was to support SMEs in improving the efficient use of energy and reducing costs and emissions, directly contributing to the competitiveness of the Serbian industrial sector and awareness raising in the energy efficiency field. However, although there is a high potential for energy savings in Serbian SMEs, there are several barriers:

- SMEs are not aware of energy-saving opportunities;
- SMEs do not have the human and financial resources to analyze and explore energy-saving opportunities;
- SMEs recognize the direct cost benefits but energy-saving measures categorize as high-cost and high-risk activities.

This paper presents the result of performed energy audits showing that in current conditions, energy efficiency is a crucial driver for the sustainable growth of SMEs in Serbia's industrial sector.

Keywords: Energy audit, Energy efficiency, SMEs, Industrial sector, Energy efficiency measures.

1. INTRODUCTION

Energy efficiency means using less energy for the same quantity and quality of product produced or the same quality and scope of service. As a result, an energy-efficient operation reduces energy and energy costs, reduces greenhouse gas emissions and other pollutants, and contributes to better competitiveness of companies in the market.

When energy is used in the production process, one part of the input energy is used for the production of a product, while one part is inevitably "lost", i.e., converted into a form that cannot be used in that process. Depending on the efficiency, the losses can be lower or higher. Energy efficiency is the optimal energy quantity used for a specific process or activity where the energy losses are minimized. On the other hand, inefficiency is a consequence due to poor design, inadequate equipment and process performance (oversized or undersized and poorly connected equipment), idling or equipment operation when not required (daytime running lights on or when there are no workers in production facilities, running the process at unnecessarily high temperatures, equipment on during the lunch break) and poor maintenance. Improving energy efficiency is usually associated with technological advances but can also result from improved production process organization.

Energy efficiency should not be identified as savings or reduced consumption resulting from either lack of energy to perform a specific activity or excessive energy and fuel prices. In this case, either the volume of production or the quality of service/activity decreases. Savings do not necessarily bring better economic effects and can often have negative consequences (e.g., lowering the temperature in the workplace can cause employees to catch a cold while reducing production volume means less profit for the company).

Energy efficiency represents individual behavior and reflects the rationality of energy consumers, such as avoiding downtime in production, rational energy planning of the production program, energy management etc. Avoiding unnecessary or excessive energy consumption, or choosing the most appropriate technology and equipment to reduce energy costs, contributes to reducing one's energy consumption without compromising the company's activities. Some of the measures to improve energy efficiency are:

- Elimination of all leaks (compressed air, steam, hot water, etc.),
- Elimination of heat losses through uninsulated and poorly insulated parts of equipment and pipelines,
- Using high-efficiency devices,
- Install equipment for monitoring and managing production and energy flows and equipment for automatic regulation and control.

In the current conditions when energy prices are skyrocketing, the problem of energy efficiency has become one of the most important issues for companies in the manufacturing sector.

2. LEGAL FRAMEWORK FOR ENERGY EFFICIENCY

In the harmonization process of the legal system of the Republic of Serbia with the legal system of the European Union, there are two parallel streams: the process of association with the European Union in terms of the general legal system of the Republic of Serbia, and the Energy Community (EnC) process, which is carried out to create an energy market of the Energy Community, with structural adjustment of legal relations in the field of energy and energy-related fields, in order to link and provide a single market together with the European Union energy market.

The legal framework of the Republic of Serbia in the field of energy efficiency consists of all legislation of the Republic of Serbia which directly or indirectly regulates the efficient use of energy. The main documents in the field of energy efficiency are the Law on energy efficiency and rational use of energy, the Law on Energy, the Law on renewable energy sources (all adopted in April 2021), and their by-laws. Among the abovementioned laws, Law on planning and construction with its by-law is also relevant for the energy efficiency of buildings.

In 2012 the Energy Efficiency Directive (EED) was adopted after a long and challenging discussion in the European Commission, the European Council, and the European parliament. The EED repealed two existing Directives that were the main elements to steer energy efficiency in Europe to that date: Directive 2006/32/EC on energy end-use efficiency and energy services and Directive 2004/8/EC on the promotion of cogeneration. The Directive also included updates to two earlier adopted Directives on eco-design (Directive 2009/125/EC) and labeling of energy-related products (Directive 2010/30/EU). In addition, the EED complements and includes links to Directive 2010/31/EU on the energy performance of buildings ("EPBD") which was adopted in May 2010. A clear link, for example, is that the EPBD defined quality criteria for building renovations while the EED sets ambition levels for such renovations. The EED also strengthened concepts already existing in earlier regulations but had not resulted in sufficient progress in energy efficiency improvements. In 2018, EED was updated as part of the so-called "Clean Energy for all Europeans package" that also included updates to the Energy Performance of Buildings Directive (Directive 2018/844) and a recast of the Renewable Energy Directive (Directive 2018/2001). Article 8 of the EED is related to the Energy audits and energy management systems where the Member States are obliged to promote high-quality energy audits to all final consumers, including at least every four years for large enterprises and active promotion of auditing schemes to SMEs, households, and other smaller end-users. Minimum quality criteria for the energy audits and the energy management schemes are included in Annex VI. Therefore, it is of essential importance to understand the minimum requirements given in Annex VI, as well as to provide funding for energy audits and criteria for determining which parties should be engaged in energy audits. Also, it actively promotes energy audits (e.g., via online campaigns, awareness-raising programs, in-person visits, or by programs or funds that support the uptake of the recommendations resulting from the audits) [1].

3. ENERGY MANAGEMENT SYSTEM IN SMEs IN INDUSTRIAL SECTOR

Today, many companies have introduced a management system according to the international standard ISO 9001. It is a system of responsibility that covers obligations and tasks, working procedures, and records of how, when, and what was done. Also, a large number of companies have introduced an environmental management system by ISO 14001. The energy management system is covered by the international standard ISO 50001, which presents the methodology for introducing the energy management system for legal entities engaged in various activities. Energy management is a system that includes planning and implementing specific organizational and technical actions in an economically reliable way to reduce energy consumption.

In many small and medium-sized enterprises, energy management has a low priority. In everyday business, the main focus is on activities related to the maintenance of production and long-term planning of how to place products on the market. Energy savings, at best, become a problem when:

- the production process needs to be changed,
- it is necessary to invest in the replacement of equipment,
- there are problems with the supply of energy and energy sources or
- there is a bottleneck in the energy supply.

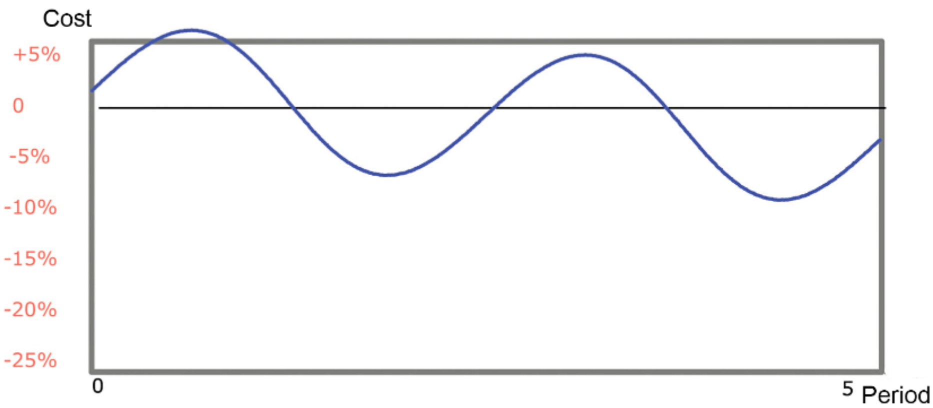
When the problems are solved, energy savings are put aside again.

The aspect of the energy management system is entirely different. It is a systematic approach to energy flow management in the company, defining energy potentials and options for activities that increase energy efficiency. The energy management system means constantly dealing with energy in all company structures to reduce energy consumption and maintain improved energy efficiency. Continuous and organized work, with a clearly defined system of responsibilities, ensures that the company continuously goes through a cycle of analysis of the present energy consumption, defining the energy efficiency strategy, planning and implementing activities to improve EE and reduce energy costs. Part of this cycle is the verification of the results of EE measures. Then, based on the previous step, the strategy for future activities on new EE measures is prepared. Finally, corrective measures

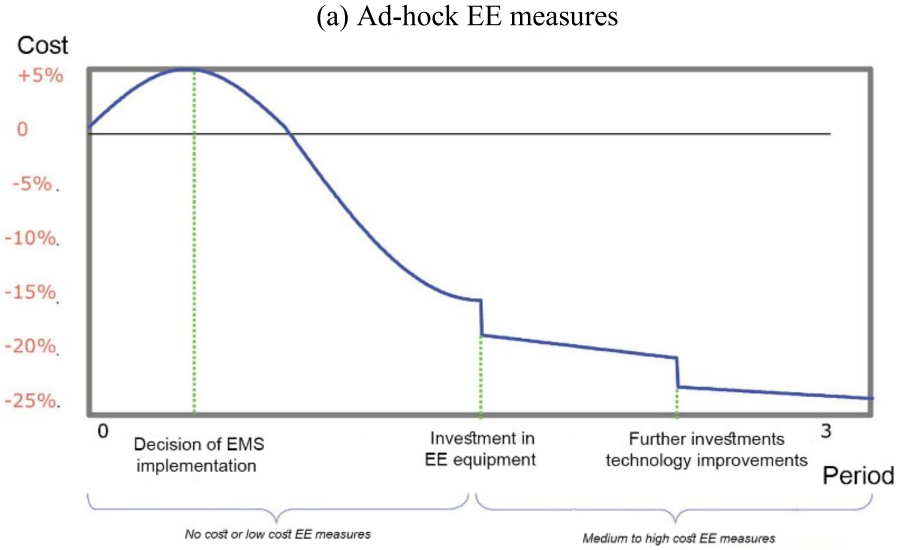
are defined and applied in the last step if the set goals are not achieved. This cycle allows for continuous improvement and is like a time spiral with the same lifespan as the company.
There are several reasons for introducing an energy management system in the company. The two most important reasons are the positive impact on the environment and minimizing costs, i.e., increasing profits. Indirect effects include reduced insurance and maintenance costs, higher employee motivation, better working conditions, etc. The introduction of an energy management system allows:

- monitoring of energy consumption in the company in different production units and sectors, identifying losses and easy definition of possible EE measures;
- real-time monitoring of energy consumption, enabling timely response when a deviation in energy consumption occurs, thus eliminating unnecessary energy consumption;
- preparation of systematized and structured documentation of the energy system in the company.

The differences between unsystematically applied measures for improving EE and the continuous process implemented through the energy management system are reflected in the reduction of costs. A comparison of these two characteristic cases is shown in Figure 1. Figure 1 (a) shows that the ad-hock application of EE measures will not have a significant effect in the long run.



(a) Ad-hock EE measures



(b) EE measures through EMS

Figure 1 Effect of a different approach in the reduction of energy costs [2]

According to the statistics of Western European countries, implementing energy management systems in industrial companies leads to a reduction of energy consumption by 10-15 % without significant investments (e.g., the application of organizational measures and measures related to ordinary maintenance). This can be seen from the diagram in Figure 1. Based on the knowledge of the situation in Serbian industrial companies, it can be expected that the effects will be even more significant.

4. ENERGY AUDIT

The starting point in establishing an energy management system is to define goals related to energy saving. Thus, for example, if energy consumption is reduced by improving the EE of a process, it can affect the increase of production without additional investment in new production capacity. In order to precisely define and quantify energy-saving goals, it is most beneficial to compare a company with similar ones in the same branch (benchmarking). In order to properly conduct the comparison procedure, it is necessary to determine the appropriate indicators (normalized indicators). The most commonly used indicator is specific energy consumption, but as each sector carries certain specifics, particular indicators for certain sectors can be further developed. Standardized indicators can provide guidelines on the characteristic values of energy consumption by individual sectors and can be used as a target value to reduce energy consumption, i.e., to increase energy efficiency. After defining and quantifying the goals, the next important step is to determine the baseline or current situation regarding energy consumption, which is achieved by conducting an energy audit [3].

The energy audit is conducted to determine the energy performance of the organization. An energy audit analyzes the energy and fuel consumption profile and the state of both individual energy systems and the final energy consumers. This procedure identifies EE measures that contribute to improving the organization's energy performance, thus ensuring more efficient use of energy and resources. In this way, in addition to the benefits related to reducing energy costs, the organization can also benefit from reducing its negative impact on the environment (reducing GHG emissions into the environment).

The procedure of planning and conducting energy audits is under the provisions of the Law on Energy Efficiency and Rational Use of Energy, the Rulebook defining the scope and manner of conducting the energy audits, as well as the international standards (SRPS ISO 50002 and SRPS EN 16247). The energy audit aims to analyze and determine the baseline of energy efficiency and the appropriate measures, activities, procedures, or actions that should be implemented to improve EE. The result of the energy audit is an assessment of the current energy performance of the organization, as well as a proposal and ranking of the list of EE measures and recommendations with an assessment of their economic and other effects (e.g., positive effect on environmental protection).

On-site energy audit includes:

1. preparatory activities,
2. implementation of energy audit,
3. preparation and submission of reports on the energy audit and
4. final meeting with the presentation of the most important conclusions.

The analysis within the energy audit includes all aspects of production, characteristics of operation and maintenance of equipment, condition of all systems using energy and water, energy management, previously applied measures to improve energy efficiency and their effects, as well as plans for reconstruction, improvement, expansion or changes in the production and the impact of these changes on energy efficiency.

The energy audit includes the following steps:

1. An introductory meeting where the Client is acquainted with the procedure and goal of the energy audit, as well as with the obligations in terms of providing the necessary information and data;
2. Collect and analyze data on monthly energy consumption and energy costs in the previous period (usually three years);
3. Collect data concerning the production for the same period covered in item 3;
4. On-site inspection of plants and systems that use energy, including short measurements if necessary;
5. Data analysis and definition of potentials and measures for reduction of energy consumption;
6. Preparation of a simple cost-benefit analysis for the proposed measures;
7. Preparation of lists with ranked EE measures;
8. Preparation of the final report on the energy audit;

9. Presentation of the main results to the company's management.

During the procedure of energy audit, data is collected using the standardized questionnaire. In addition to primary data (consumption and costs for energy, fuels, water, and production volume), the questionnaire also collects data on the technical characteristics of devices within energy systems and production lines. The data collected in this way are processed and analyzed, thus preparing a team of experts to visit the on-site production plant. Additional important data are collected during this tour, and short measurements of relevant process parameters are performed. Measurements are used to indicate the points of irrational energy use and quantify energy losses. The following steps are analysis of collected data and preparation of the material and energy balance, calculation of relevant indicators, the proposal of EE measures, and their cost-benefit analysis. All these activities are performed to prepare the final report on the energy audit. At the very end, the most significant results of the energy audit are presented to the company's management.

5. SECTOR OF SMALL AND MEDIUM ENTERPRISES IN THE REPUBLIC OF SERBIA

In 2018, the sector of small and medium enterprises (SMEs) in the Republic of Serbia accounted for 27.3 % of total active enterprises, employed 46.2 % of employees in the non-financial sector, and participated with 43.2 % in the gross value added (GVA) of the non-financial sector. The SME sector in 2018 included 99,967 companies, generated 1,118.9.2 billion dinars of value-added products, and employed 645,395 people.

Compared to 2017 number of small enterprises increased by 6.0 %, while the employment, value-added product, turnover, and imports growth was 5.5 %, 9.7 %, 8.4 %, and 3.4 %, respectively. On the other hand, exports in small enterprises decreased by 0.6 %.

For medium-sized enterprises indicators, like growth in the number of enterprises, employment, value-added products, turnover, exports, and imports were 6.1 %, 6.1 %, 10.5 %, 7.7 %, 3.3 %, and 6.6 %, respectively.

The sectoral structure of SMEs is unchanged compared to previous years: trade and manufacturing have dominated all business performance indicators. There is an apparent territorial inequality regarding SME development by regional areas in Serbia. Measured by the GVA indicator per employee, the ratio of the area with the highest (City of Belgrade) and lowest value (Bor) of this indicator was 2.7: 1. The most productive companies in the non-financial sector operate in the City of Belgrade, Srem and South Bačka region, while the lowest values of this indicator are in Bor, Jablanica, and Zaječar regions.

The manufacturing industry dominates within the tradable sector with a share of 17.1 % of companies, 28 % of employees, 21.1 % of turnover, and 24.7 % of GVA. This branch dominates sectors of lower complexity and lower productivity (labor and resource-intensive activities).

SMEs are primarily concentrated in manufacturing, wholesale and retail trade, construction, and transport.

Regarding foreign trade, the following branches stand out: production of food products, production of metal products except for machinery, production of rubber and plastic products, production of electrical equipment, and production of unmentioned machines and equipment.

If we look at the SME sector in the Republic of Serbia, we can conclude that the distribution of the number of companies, employees and their economic activity is extremely uneven where the Belgrade region "carries" 45.8 % of activities in the SME sector, Vojvodina 25.9 %, Šumadija and Western Serbia 18.4 % and Southern and Eastern Serbia 9.8 %.

6. SELECTION OF SMEs

The project "Technical Assistance to the Ministry of Mining and Energy for the Implementation of the New Energy Law, National Action Plan for Energy Efficiency and the Renewable Energy

Directive" (TAEERES) is being implemented from March 19, 2019, to December 23, 2021. Several activities of the TAEERES Project were devoted to:

- developing a methodology for the selection of small and medium enterprises in which energy audits will be conducted;
- promoting the benefits of energy audits to the clients;
- preparing and publishing a public call for the implementation of ten free-of-charge energy audits in SMEs;
- collect, evaluate and select eligible applications from SMEs;
- prepare a methodology for conducting energy audits and develop a general template for reporting and presenting results to the interested parties.

Table 1 shows the final ranking list of selected companies where free-of-charge energy audits were conducted.

Table 1 Final ranking of selected SMEs for free-of-charge energy audits [2]

Item	Name of company	Production sector	Region
1.	Zorka-Keramika d.o.o. for the production of ceramics	Manufacture of non-metallic mineral products	Belgrade
2.	Sladara Soufflet Serbia d.o.o.	Beverage production - malt production	Vojvodina
3.	Metal-Cinkara d.o.o.	Manufacture of fabricated metal products, except machinery and equipment - hot-dip galvanizing of steel elements	Vojvodina
4.	Spice, additive and flavor company, Milex d.o.o.	Production of food products - production of spices and other food additives	Vojvodina
5.	Company for production and trade Petković export-import d.o.o.	Production of food products - processing of meat and meat products	Šumadija and Western Serbia
6.	Company for production, trade and services SANVI d.o.o.	Manufacture of fabricated metal products, except machinery and equipment - manufacture of metal structures and parts of metal structures	Šumadija and Western Serbia
7.	Planinka a.d. natural spas, tourism, catering and manufacturing	Production of beverages - soft drinks, mineral water, and other bottled water	Southern and Eastern Serbia
8.	Resor d.o.o.	Manufacture of other machinery and equipment - manufacture of lifting and handling equipment	Southern and Eastern Serbia
9.	Tester-al d.o.o.	Manufacture of fabricated metal products, except machinery and equipment - manufacture of metal windows and doors	Šumadija and Western Serbia
10.	Gomma Line d.o.o.	Manufacture of motor vehicles, trailers - manufacture of other agricultural and forestry machinery	Šumadija and Western Serbia

7. RESULTS OF ENERGY AUDITS

An overview of systematized data on companies that participated in energy audits, which were collected in the application process, is shown in Table 2.

The analysis of the submitted data on energy and fuel consumption clearly shows the difference between the consumption profiles of small and medium enterprises. Conducted energy audits cover five small and five medium-sized enterprises, of which two medium-sized enterprises are subject to the energy management system under the Law on Energy Efficiency and Rational Use of Energy. When analyzing the share of consumed electricity in medium-sized enterprises, it ranges from

11.42 % up to 75 %. In small enterprises, the dominant share is electricity, whereas in three small enterprises, only electricity as an energy source is used, and in the remaining two companies share of electricity is about 50 %.

Table 2 Overview of basic company data [2]

Item	Description	Result
1.	Share of energy costs	0.5 – 32 %
2.	Number of working hours	2100 - 8200
3.	Number of employees in the energy sector	0 - 15
4.	Number of employees who monitor energy consumption and perform analyzes and predictions of energy consumption	0 - 3
5.	It has introduced ISO 50001	1
6.	It has procedures for monitoring energy consumption and costs	4 internal procedure 4 via received invoices
7.	Number of energy sources used	1 - 3
8.	Number of energy fluid supply systems	1 - 6
9.	Measurements of consumed energy	electricity natural gas and pellets
10.	Implementation of energy efficiency projects in the last three years	8 of 10
11.	Plan for the implementation of energy efficiency projects in the next three years	8 of 10
12.	Rising costs for energy and energy sources	all predict growth
13.	The estimated potential for savings	0 – 20
14.	Calculation of specific energy consumption	2 of 10

The following text will systematically present the findings of energy audits for each energy system individually.

7.1 Compressed air system

Compressed air is the factory's most expensive form of energy fluid, but its good features, such as ease of use, safety, and availability almost everywhere in the factory, often lead people to use it where there are cost-effective solutions. Therefore, users should consider more cost-effective energy sources before applying compressed air energy.

Eliminating air leaks is based on detecting and repairing the leak spot and eliminating the causes in the system. As part of regular maintenance, it is necessary to determine a program to prevent compressed air leaks and maintain the compressed air system.

Figure 2 shows some of the compressed air leaks detected during energy audits.

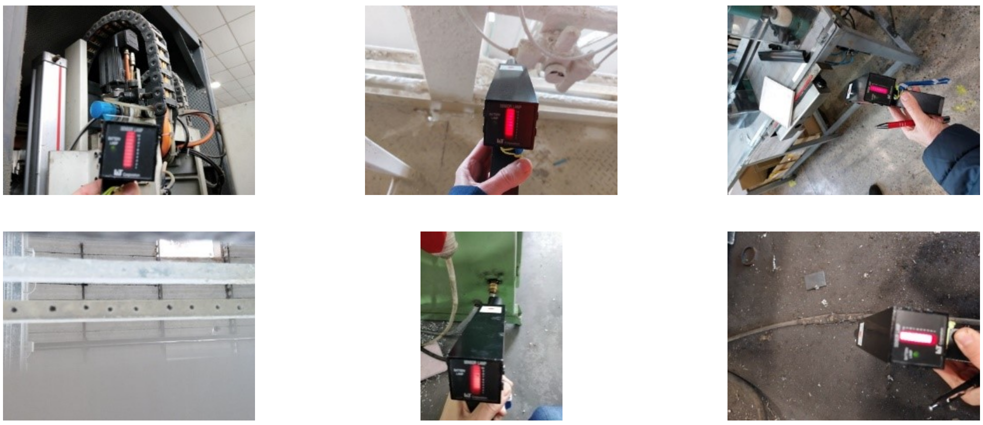


Figure 2 Leaks detected during energy audits [2]

Energy audits showed that:

- The simple payback for measures of regular maintenance and eliminating leakages is 2 to 6 months;
- Investment in nozzles in places where compressed air is used for drying pays off for up to 6 months;
- A simple payback period for investment in the installation of blowers where a significant amount of air at lower pressure is required is 1 to 3 years;
- Investment in compressor's waste heat recuperation (space heating) pays off in less than one year;
- The compressed air system and leak detection should be performed at least once a month. As the system becomes more efficient, the installation audit can be done once every three months.

7.2 Heat isolation

Insulation reduces heat losses and gains, affecting the process's efficiency, i.e. reducing operating costs. In most cases, mineral wool with a protective aluminum sheet is used.

Whenever the surface temperature (heated or cold) differs significantly from the ambient temperature, it is necessary to consider the insulation of such a surface. Insulation serves to:

- reduce the heat flux from the surface to the environment (if the surface temperature is higher than the ambient temperature) or from the environment to the surface (if the surface temperature is lower than the ambient temperature);
- prevent the appearance of condensate and its collection on surfaces;
- prevent possible injuries to personnel (burns) servicing the installation.

Figure 3 shows the thermograms of process devices and pipelines recorded by a thermal imaging camera during energy audits.

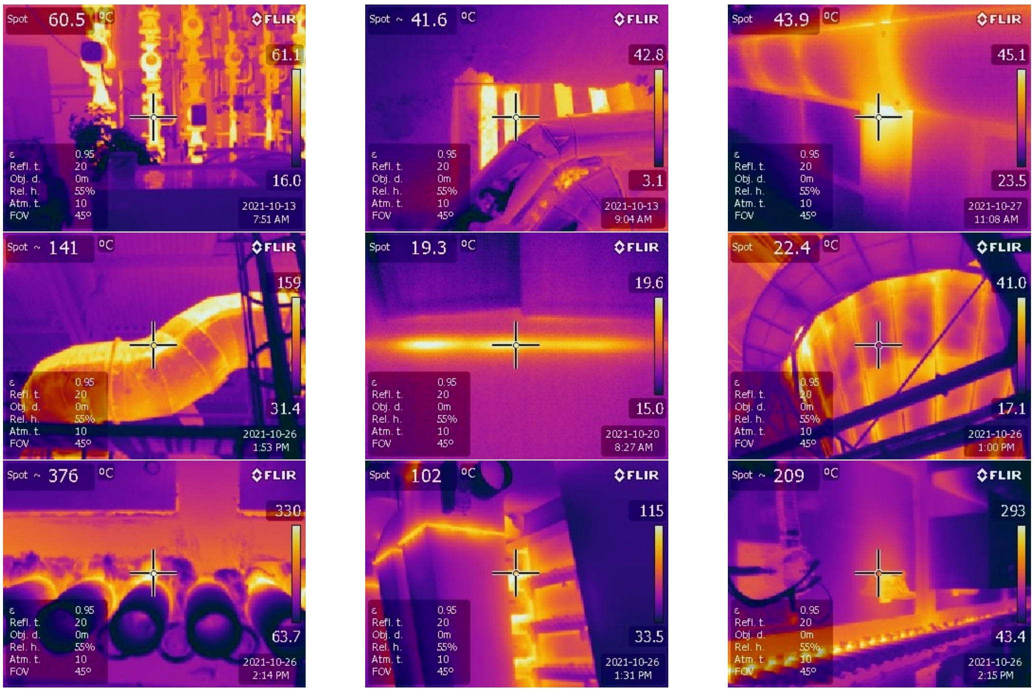


Figure 3 Thermogram images of heated surfaces [2]

Energy audits have shown that by insulating uninsulated sections of pipelines, fittings, and equipment (circulation pumps), savings in thermal energy are achieved, with a simple repayment period of up to 1.5 years. It is recommended to repair all cracks in industrial furnaces where, depending on the value of the pressure in the working space of the furnace, there is either a leakage of hot gases or a suction of cold air from the environment. Both phenomena have a negative effect on the operation of the furnace: on the one hand, heat losses increase, and on the other hand, the quality of the product deteriorates.

7.3 Combustion optimization

The optimum fuel-air ratio and low temperature of combustion products reduce losses from the combustion chamber where combustion occurs. Out of ten companies in which the energy audit was performed, in six companies, fossil fuel (natural gas, light fuel oil, or pellets) was used in boilers for heat production and industrial dryers and furnaces. In industrial furnaces and dryers, as well as in a hot water boiler where the pellets are burnt, the fuel-air ratio was within the recommended limits. However, in the case of combustion of natural gas in the wall-mounted boilers for the production of hot water for space heating, measuring the content of combustion products composition found that, at lower loads of boiler units, combustion was not within optimal recommended limits. Also, it was determined that only one boiler unit operated in condensing mode. In that sense, the effects of combustion optimization are calculated, i.e., installing new boilers that will operate in condensing mode. Therefore, the investment in the replacement of classic wall-mounted boiler units with condensing ones pays off in less than two years. For good maintenance of burners, it is proposed to adjust the burners (hot water boiler systems) at least once a year or twice a year for burners located on the furnaces and dryers.

7.4 Refrigeration systems

The energy audit determined that in companies where there were cooling systems, the waste heat of condensation of the cooling fluid was not used. Only one company combined the consumers of cooling energy and heat, which maximized the use of input energy. In this sense, it is recommended that companies conduct a detailed analysis of the possibility of using waste heat in the production process from refrigeration systems. For this analysis, it is necessary to conduct detailed and longer on-site measurements.

7.5 Engaged (approved) power

The approved power supply is a necessary element of all electricity supply contracts. For it, the consumer will pay a fixed monthly price at the unit price for the approved power. If the maximum value of the measured average 15-minute active power does not exceed the approved value, the price of the approved power will not change, and no penalties will be charged. However, if this value exceeds the value of the approved power, for each kilowatt difference between the maximum measured and approved active power, a unit price for excessive power will be paid (it is four times more than the unit price of approved power).

The selected power also defines the network and metering equipment installed on the boundary of taking over the electricity and increasing it is not always easy. Therefore, increasing the engaged power in terms of price is not a linear process, and the cost varies from the available capacity in the on-site distribution network. Therefore, when selecting the approved power, it is necessary to consider the current consumption data and a possible planned increase in production. The contracted value of the approved power can be revised by signing a new contract, usually signed for two years.

During the activities of conducting ten free energy audits in small and medium enterprises, analysis of available data from monthly bills for paid electricity, and based on the analysis of the share of approved power costs in total electricity costs, it can be seen that they are many times higher for small firms relative to medium ones. Thus, in a small company where the value of the approved power is optimally defined, the cost of the same ranges from 5 % to 10 % of the total electricity bill. When the value of the approved power in the contract with the supplier is significantly higher than the required one, the cost of electricity can be over 20 % of the bill. When this analysis is done for medium-sized companies, even when this value is chosen as suboptimal, the cost of approved power does not exceed 5 % of the electricity bill.

Small enterprises need the most help choosing the optimal value of approved power, while medium and large enterprises manage this cost optimally.
Optimizing the value of approved power is a non-technical measure, and the possible cost may be related to the measurement of the electricity consumption profile, i.e., the cost of hiring a consultant who would analyze and define the optimal value for this contract item. Another fact supports this analysis - the price of electricity has increased significantly since mid-2021, and projections are that it will continue to grow, so the motive to reduce the amount of electricity bills has undoubtedly become a priority.

7.6 Reactive energy

The analysis of the data collected during the visit of companies shows that reactive energy management is present in all plants, i.e., there are reactive energy compensation systems, showing that there is an awareness that the cost charged by the supplier for the reactive energy taken over can be reduced and almost wholly annulled. However, energy audits have identified some gaps in the maintenance and management of reactive energy compensation.
Several companies have shown that failures in only one part of the reactive energy compensation system (burnout of the compensating battery) do not affect this system to stop working entirely, but only that it no longer works optimally. Such failures usually remain either unnoticed or ignored as they are not of the breakdown type and do not lead to the termination of the compensation system. In these cases, the power factor remains high and generally does not exceed the allowable reactive energy, but the cost is sometimes multiplied compared to the case when the compensation system is correct and works optimally.
A similar thing happens if there is a change in the production process, such as adding one or more large consumers of electricity (e.g. heat pumps) or installing frequency regulators on existing motors in electric consumers. Such changes in the production process can drastically increase or decrease the total reactive energy consumption at the site. If a larger consumer is added and the reactive energy compensation system is not reconstructed in capacity expansion, it cannot fully cover peak reactive energy consumption. In the second case, if reactive energy consumption is significantly reduced due to changes in the production process, compensating batteries can become oversized for optimal compensation of reactive energy consumption. Then the batteries are either off most of the time or too often on and service life.

7.7 Solar power plant

The construction of a solar power plant on the site enables long-term money savings and predictability of the price that the company will pay for the consumed electricity. The latter benefit may be a more significant motive for investment, given the current state of the electricity market.
During the energy audits, many companies showed interest in investing in a solar power plant and a full understanding of its benefits. However, before the commissioning of a solar power plant, the primary tasks should be defining the installed power of the solar plant and the approved power at the point of connection with the distribution system (DS).
When the power plant operates in the mode when the energy is not delivered to the network, if the production on the site is higher than the consumption, the production of the power plant must be reduced. The assessment of the profitability of the investment is mainly done under the assumption that the power plant always delivers energy at the maximum capacity, so this reduction in production represents losses and directly affects the extension of the payback period of the investment. When the status of producer-buyer is obtained, on the technical side, the solar power plant's operation mode is the same as the parallel mode of operation with DS where part of the energy is handed over to DS, and part is used to supply its own needs. The difference is reflected in the fact that the surplus is not sold (status producer-buyer) but can be used to reduce consumption in the coming period when there is no surplus production.
For small companies that operate only in one shift and do not operate on weekends, it is proposed to use parallel with DS, where part of the energy is handed over to DS, and part is used to power their

own needs in the status of producer-buyer. For larger companies with significant electricity consumption but limited space (available area on which to install photovoltaic solar panels) for the solar power plant operation, parallel operation with DS without handing over energy to DS is proposed. In this case, the produced electricity is used exclusively to supply its needs. Finally, for companies that do not have a limit in the space for installing a solar power plant and that work in several shifts and on weekends, the proposal is to calculate the installed power of the solar power plant so that it is most profitable in the period in which the return on investment is expected.
Thus, it is necessary to make a detailed analysis of all parameters that affect the price of a solar power plant, from fulfilling legal requirements to choosing the power plant mode to define the optimal installed power plant for a given location.

7.8 Energy management system

Only one of the ten companies has an energy management system (ISO 50001). In this sense, in most companies, no factory sector deals only with monitoring and analyzing energy consumption. The experience of developed EU countries shows that the introduction of energy management systems in factories achieves savings in energy costs of at least 10 %. Considering the level of energy efficiency in Serbian small and medium enterprises, this cost reduction could be twice as high.

8. CONCLUSIONS

The paper presented the result of performed energy audits within the TAEERES project showing that in current conditions, energy efficiency is a crucial driver for the sustainable growth of SMEs in Serbia's industrial sector.
The main findings of the energy audits regarding the effects of the proposed energy efficiency measures are as follows:

- Compressed air leaks range from 7 to 45 % of the installed compressor capacity;
- Regular maintenance measures and elimination of leak points could be paid off for a period of two to six months;
- Installation of highly efficient nozzles in places where it is possible is paid off for a period of up to six months;
- Investment in the installation of blowers and the use of lower-pressure air in places where it is necessary to dry or blow the product pays off for a period of one to three years;
- Investment in compressor's waste heat recuperation (space heating) pays off in less than one year
- One of the primary measures that contribute to the reduction of compressed air losses is the regular maintenance of this system;
- Replacement of classic hot water boilers for heating buildings with condensing ones pays off in less than two years;
- Adjustment and optimization of fuel-air ration is a vital measure of good boiler energy management;
- Insulation of uninsulated sections of heating pipes and tanks in which heated water is stored pays off in six months to a year and a half;
- Repair of cracks at high-temperature devices such as industrial furnaces pays off in less than a year;
- Utilization of waste heat of combustion products and lowering the temperature by 60 to 100°C without condensing will enable savings of 2 to 3.5 % related to the consumed fuel;
- Optimization of the operation of the reactive energy compensation system by repairing defective capacitor batteries has a simple payback period of less than two years;
- Good choice of tariff for energy supply can lead to money savings to companies up to 1,000 EUR per year;

- In order to determine the optimal capacity of the solar power plant, companies must have a detailed insight into the profile of electricity consumption, as well as a straightforward way of operating the solar power plant concerning the distribution system; before any investment decision, it is advised to perform recordings of electricity consumption during some longer time;
- Before deciding to invest in additional sources in the company's energy systems, it is necessary to eliminate all places of irrational energy and energy fluids consumption.

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