

Energy and Resource Consumption Efficiency in Industrial Sectors

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Abstract – The world is facing significant challenges related to climate change, accompanied by a continuing upward trend in energy consumption that is expected to persist in the coming decades. Consequently, effective measures are required to minimize the environmental impacts associated with energy production and consumption. This paper presents an analysis of electricity and resource consumption across selected industrial sectors within small and medium-sized enterprises (SMEs) in Tuzla Canton, Bosnia and Herzegovina (BiH). Energy efficiency (EE) has been recognized as one of the fastest and most cost-effective approaches to improving energy security while mitigating the effects of climate change. Furthermore, improving EE can strengthen the competitiveness of domestic industry and contribute to the creation of new “green” jobs, thereby supporting the transition toward a green economy. High levels of energy consumption are evident across all consumer categories, ranging from individual households to major industrial energy users, particularly SMEs. In addition, the declining costs of renewable energy technologies, electric heat pumps, and photovoltaic (PV) power plants have significantly increased the interest of SMEs, local governments, and citizens in the adoption and utilization of renewable energy sources (RES).

Keywords – energy and resource consumption, small and medium-sized enterprises, energy efficiency, renewable energy sources, specific energy consumption.

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1. Introduction

When considering total global final energy consumption during the period 1971–2018, it can be observed that it increased by a factor of 2.3 [1], with the largest shares attributed to countries of the Organisation for Economic Co-operation and Development (OECD) and major industrial energy consumers, including the food, iron and steel, chemical, and petrochemical sectors. According to [2], the chemical industry was the largest industrial energy consumer in 2013, accounting for approximately 19% of total industrial energy consumption, followed by the iron and steel industry (approximately 18%), the non-metallic minerals and paper industries (approximately 12%), and the food industry (approximately 10%). According to [3], projections indicate that the industrial sector will account for 30.1% to 30.6% of total global final energy consumption by 2040, depending on the scenario considered. The same source reports that natural gas and electricity are the fastest-growing forms of industrial energy use in both OECD and non-OECD countries [3]. According to [4], total global final energy consumption in 2008 amounted to 492 EJ, of which the industrial sector accounted for 98 EJ, including 11 EJ from renewable energy sources (RES), making it the world's largest energy-consuming sector at that time. The same study projected that by 2035, total global final energy consumption would reach 374 EJ, with the industrial sector remaining the largest energy consumer at 130 EJ, including 30 EJ supplied by RES [4]. According to [5], renewable energy sources are rapidly becoming the foundation of the global electricity sector. Their share in electricity generation is projected to increase from 28% in 2021 to more than 60% by 2030 and nearly 90% by 2050, with solar photovoltaic (PV) power plants and wind energy expected to play a leading role in reducing greenhouse gas emissions from the power sector. In Bosnia and Herzegovina (BiH), the average annual growth rate of electricity consumption is projected to be 1.5% during the period 2017–2035 under a scenario without the implementation of energy efficiency (EE) measures [6].

According to three different scenarios (S1—low-growth, S2—reference, and S3—a scenario including energy efficiency measures and the increased use of renewable energy sources), electricity and natural gas consumption exhibited the highest growth among all forms of final energy consumption in Bosnia and Herzegovina during the period 2005–2020 [7]. According to [8], Bosnia and Herzegovina also faces significant barriers to the implementation of energy efficiency (EE) measures in the industrial sector. The study indicates that most of the identified EE measures are related to auxiliary systems, such as heating, ventilation and air conditioning (HVAC), compressed air systems, lighting, and electric motor drives. Similarly, studies conducted in neighboring countries have focused on assessing the current state of energy efficiency and emphasized the need to implement systematic measures aimed at improving EE in order to establish the conditions necessary for sustainable industrial growth and development [9]. According to [10], assessing energy efficiency in the manufacturing sector at the national level is analytically challenging due to the sector's heterogeneity and the limitations of the indicators most commonly used for its evaluation. It can therefore be concluded that, despite the central role of manufacturing in industrial decarbonization, there is still no comprehensive overview of the quantitative methods employed to assess energy efficiency.

2. Energy consumption and energy efficiency in industry

Since the 1970s, the industrial sector has been the largest contributor to total final energy consumption. According to [11], total final energy consumption in 2024 exceeded 450 EJ, representing an increase of approximately 25 EJ compared to 2019. Industry accounts for the largest share of this demand, at nearly 40%, while the residential and transport sectors each account for approximately 30%. Reference [3] presents two future scenarios. Under the Stated Policies Scenario (STEPS), industry is projected to account for approximately 30.1% of total global final energy consumption by 2040, corresponding to approximately 515,848 PJ. Under the Sustainable Development Scenario (SDS), the industrial sector is expected to account for 30.6% of total final energy consumption, equivalent to approximately 390,390 PJ [3]. These projections clearly indicate that, under both scenarios, the industrial sector will continue to represent a substantial share of global final energy consumption in 2040. The main difference between the two scenarios is that the STEPS scenario reflects the continuation of current energy policies, whereas the SDS scenario represents an integrated pathway toward achieving internationally agreed objectives related to climate change mitigation, improved air quality, and universal access to modern energy services (Figure 1).

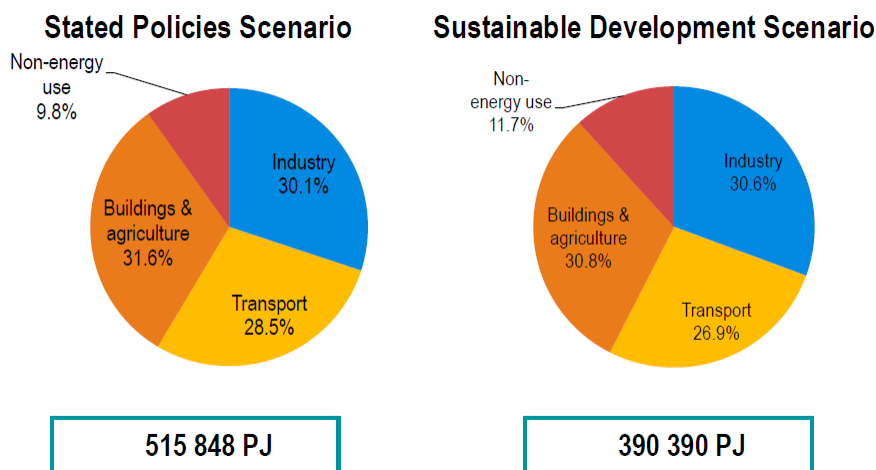


Figure 1. Total Final Energy Consumption by Sector under Two Different Scenarios up to 2040 [3]

Reducing energy consumption through improved energy efficiency (EE) among end users represents one of the most economically viable approaches to managing energy costs while simultaneously reducing greenhouse gas emissions. Consequently, energy efficiency improvement measures occupy a central position in the European Union's (EU) national decarbonization strategies.

This approach is promoted under the principle “Energy Efficiency First,” which emphasizes that improving energy efficiency is a key priority for achieving the EU's 2030 climate and energy objectives.

To reduce total energy consumption in the industrial sector, it is necessary to implement measures aimed at improving the energy performance of industrial buildings, optimizing heating and cooling systems, and enhancing the efficiency of production processes. Such measures include improving the thermal insulation of the building envelope, replacing deteriorated or energy-inefficient windows and doors, installing monitoring and control devices for heating, ventilation, and air conditioning (HVAC) systems, replacing or upgrading HVAC equipment with more efficient technologies, recovering waste heat from HVAC systems, substituting fossil fuels with RES, replacing energy-inefficient equipment with high-efficiency alternatives, utilizing RES for electricity generation, implementing variable frequency drives (VFDs), employing high-efficiency electric motors, recovering waste heat from industrial processes, and using industrial waste for energy production, among other measures [8], [12]. Improving EE in the industrial sector remains a complex challenge. According to [8], the cumulative energy savings achieved through the implementation of EE measures in industry accounted for only 2.2% of the total energy savings recorded during the reporting period from 2010 to 2021.

Although improving EE in the industrial sector has been shown to provide not only energy savings but also numerous non-energy benefits—such as more effective maintenance, improved monitoring and control of production processes, and ultimately enhanced productivity and competitiveness—significant barriers continue to limit the implementation of economically viable EE measures. These barriers exist both at the institutional level and within SMEs themselves [8].

In the industrial sector, energy efficiency is most commonly evaluated using specific energy consumption (SEC), which represents the amount of energy required to produce a given quantity of output in a particular process. SEC is widely used to assess and compare the energy performance of different technologies, machines, and production systems, as well as to evaluate improvements or deteriorations in energy performance over time. Furthermore, SEC serves as an important indicator for identifying processes with the highest energy losses, thereby supporting production optimization and cost reduction. According to [13], SEC is defined as:

$$SEC = \frac{\text{Energy used}}{\text{Product's amount}} \quad (1)$$

The units of SEC are typically expressed as kWh/kg, kWh/m³, or kWh/unit, depending on the type of product being manufactured.

SEC can also be calculated for an individual product within a given production process as follows:

$$SEC_x = \frac{E_x}{P_x} \quad (2)$$

where E_x is the energy consumption of the observed production process (x), and P_x is the physical output of product (x). Meanwhile, the aggregated specific energy consumption SEC_{agg} for a group of products, for example an entire industrial sector, can be calculated as the ratio of the total energy consumed to the total physical output, provided that the production structure remains unchanged over the period being compared:

$$SEC_{agg} = \frac{\sum E}{\sum P} \quad (3)$$

where $\sum E$ represents the total energy consumed, and $\sum P$ represents the total physical output of all products. Following the principles presented in Equations (1)–(3), individual energy carriers can also be considered separately; for example, specific energy consumption can be calculated for electricity, heat, or a specific production process unit:

$$SEC_{pr} = \frac{E_{pr}}{P} \quad (4)$$

where E_{pr} represents the total annual primary energy consumed by a single process unit, and P represents the annual quantity of products processed within that specific process unit.

3. Analysis of electricity and resource consumption in different industrial sectors

This paper presents an analysis and comparison of energy requirements and resource consumption in selected industrial sectors within small and medium-sized enterprises (SMEs), with a focus on heating, ventilation, and air conditioning (HVAC) systems and production processes. The research was conducted on three companies operating in different industrial sectors: the meat processing industry (X-MI), the plastic production and processing industry (Y-IPP), and the metal processing and panel furniture manufacturing industry (Z-IOMPPN). The analysis covers a three-year period from 2019 to 2021.

Table 1 presents the consumption of electricity and other resources in company X-MI during the research period. In addition to the annual consumption data presented in Table 1, Figure 2 illustrates the monthly electricity consumption profile, showing that electricity consumption remained relatively uniform throughout the years, without significant variations.

Table 1. Electricity and Resource Consumption in X-MI

Year	Electrical Energy [kWh]	Water [m ³]	Beech Beam [kom]	LPG BAS EN 1056 [kg]	Wood Sawdust [kg]	Smokehouse Wood [m ³]
2019	2,457,688.6	7,322	65	18,603	2,145	112.1
2020	2,429,591	18,428	120	15,642	1,830	80.2
2021	2,530,981.6	15,994	70	14,984	1,625	85.7
Total	7,418,261.2	41,744	255	49,229	5,600	278

Electricity consumption was highest during the summer months, resulting in the highest electricity costs. In August 2021, the cost amounted to approximately 29,682.7 Bosnia and Herzegovina convertible marks (BAM).

When electricity consumption is expressed in kWh/m², it can be observed that it remained relatively uniform, at approximately 330 kWh/m², with the highest value recorded in 2021, amounting to 340.55 kWh/m².

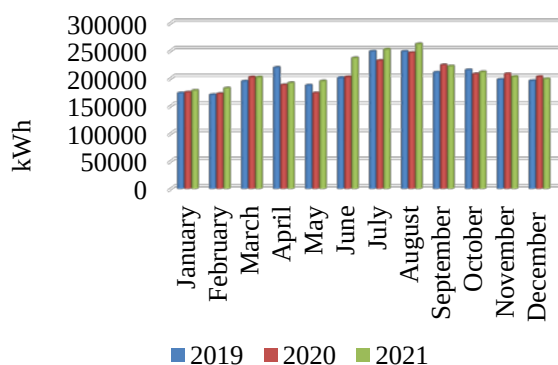


Figure 2. Electricity Consumption in X-MI during the Period 2019–2021

The meat processing industry is a significant consumer of water; therefore, water consumption is higher during the summer months. Variations in water consumption are caused by changes in production volume, weather conditions, and the impact of the COVID-19 pandemic, as shown in Figure 3. For example, water consumption in July 2020 was approximately 3,456 m³, while the lowest consumption was recorded in January of the same year, amounting to approximately 116 m³.

It can be concluded that, in addition to electricity and water, company X-MI uses other resources in its production processes, including beech wood beams, sawdust, and firewood for smoking chambers and drying rooms, as well as liquefied petroleum gas (LPG) compliant with BAS EN 1056 for boiler room operations.

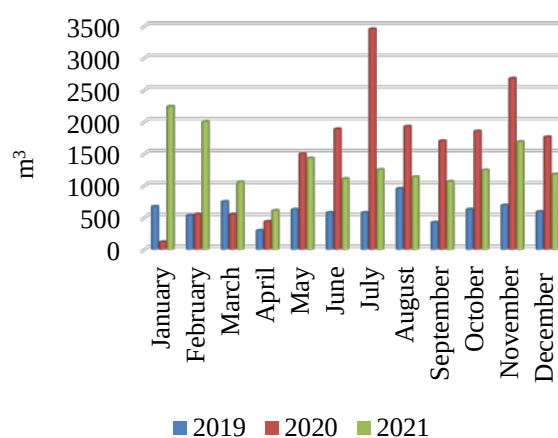


Figure 3. Water Consumption in X-MI during the Period 2019–2021

As shown in Table 2, the total annual costs increased during the observed period, with the highest expenses related to electricity, water, and LPG compliant with BAS EN 1056. When these costs are expressed as specific costs, they can be observed to have remained relatively constant throughout the analyzed period, despite variations in consumption levels, increases or decreases in resource use, and fluctuations in the prices of individual resources (approximately 45 BAM/m² in 2019 and approximately 48 BAM/m² in both 2020 and 2021).

Table 2. Summary of Energy and Resource Costs in X-MI

Year	Electrical Energy [BAM]	Water [BAM]	Beech Beam [BAM]	LPG BAS EN 1056 [BAM]	Wood Sawdust [BAM]	Smokehouse Wood [BAM]	Total [BAM]	Total [BAM/m ²]
2019	281,907.2	18,305	969.7	19,979.2	2,753.8	6,730.6	330,645.5	44.68
2020	278,821	46,070	1,793.3	15,956.9	2,360.7	5,137.8	350,139.7	47.31
2021	289,330.4	39,985	1,029	18,502.1	2,093.5	5,552.3	356,492.3	48.17
Total	850,058.6	104,360	3,792	54,438.2	7,208	17,420.7	1,037,277.5	140.17

Figure 4 presents the share of energy and resource costs for company X-MI over the three-year period.

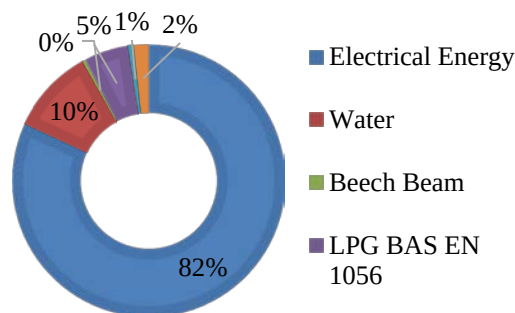


Figure 4. Percentage Share of Energy and Resource Costs in Total Costs over the Three-Year Period in X-MI

Regarding thermal energy in company X-MI, it is supplied by heat pumps with capacities of 21 kW and 2×36 kW. In this analysis, data on the electricity consumption associated with the operation of the heat pumps, as well as their share of the total annual electricity consumption, were not available. Therefore, it was not possible to perform a separate analysis of thermal energy consumption.

Furthermore, data for company Y-IPP, which operates in the plastic production and processing sector, were analyzed. The company uses only water and electricity as resources (Table 3). Total electricity consumption in 2019 was the lowest during the three-year observation period, followed by a significant increase in electricity consumption in the subsequent years.

Table 3. Electricity and Water Consumption in Y-IPP

Year	Electrical Energy [kWh]	Water [m ³]
2019	1,652,132.8	1 753
2020	2,150,152.1	2 511
2021	2,151,108.01	2 100
Total	5,953,392.91	6 364

Figure 5 shows that there are no significant variations in monthly electricity consumption within each individual year; however, larger variations can be observed when comparing the same months over the three-year period. For example, in November, electricity consumption amounted to approximately 153,730.1 kWh in 2019, increased to 236,544.7 kWh in 2020, and reached 195,137.4 kWh in 2021.

In 2021, slightly higher electricity consumption was recorded during the winter months, whereas in 2020, the highest consumption occurred during the autumn period. When electricity consumption is expressed in kWh/m², it amounted to approximately 430 kWh/m² in both 2020 and 2021, while the lowest value was recorded in 2019, at approximately 330 kWh/m².

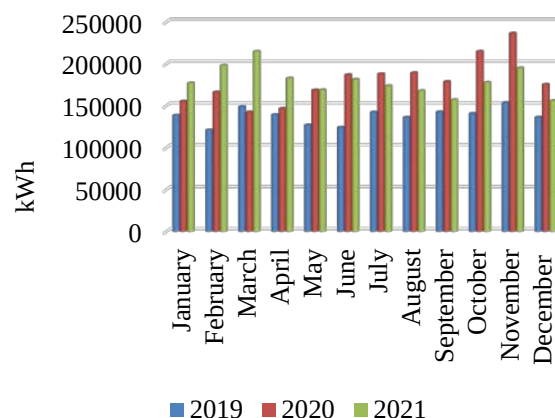


Figure 5. Electricity Consumption in Y-IPP during the Period 2019–2021

Figure 6 presents the monthly water consumption of company Y-IPP over the three-year period. The data indicate significant variations in water consumption (for example, in March 2020, water consumption was approximately 43 m³, while in September of the same year, it reached approximately 561 m³).

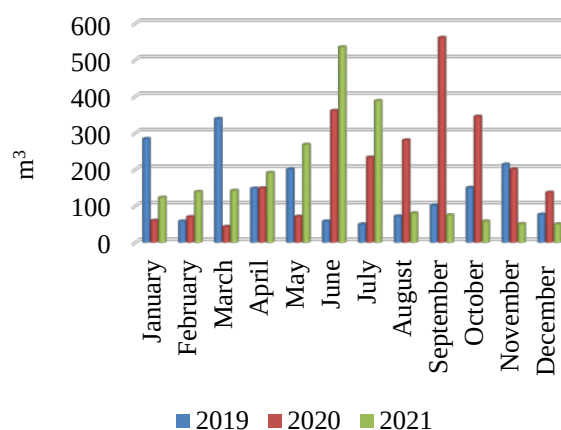


Figure 6. Water Consumption in Y-IPP during the Period 2019–2021

A summary of the energy and water costs for company Y-IPP is presented in Table 4. Similar to company X-MI, data on the share of electricity consumption used to operate the heat pump, as part of the total annual electricity consumption, were not available.

Table 4. Summary of Electricity and Water Costs in Y-IPP

Year	Electrical Energy [BAM]	Water [BAM]	Total [BAM]	Total [BAM/m ²]
2019	179,090.5	5,061.6	184,152.1	36.83
2020	241,968.2	7,140.8	249,109.08	49.82
2021	242,736.8	6,027	248,763.8	49.75
Total	663,795.5	18,229.4	682,024.98	136.4

Figure 7 presents the percentage shares of energy and water costs in the total consumption costs of company Y-IPP over the three-year period. It can be observed that electricity costs are dominant, accounting for 97% of the total costs, while water costs account for only 3%.

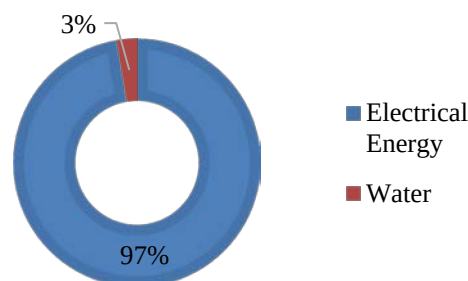


Figure 7. Percentage Share of Energy and Water Costs in Total Consumption Costs in Y-IPP during the Three-Year Period

The collected data on electricity consumption and other resources for company Z-IOMPPN over the three-year observation period are presented in Table 5. The data indicate an increase in electricity consumption, from approximately 1.28 million kWh in 2019 to nearly 1.59 million kWh in 2021. Water consumption varied, with a decrease in 2020 followed by an increase in 2021. LPG consumption increased significantly, while heating oil consumption continuously decreased.

Table 5. Consumption of Electricity and Resources in Z-IOMPPN

Year	Electrical Energy [kWh]	Water [m ³]	LPG BAS EN 1056 [kg]	Fuel Oil BAS 1002:2004 [l]
2019	1,281,136.8	1,747	34,693.8	41,000
2020	1,314,069.6	1,358	66,687	15,230
2021	1,591,513.2	2,305	84,561.5	12,260
Total	4,186,719.6	5,410	185,942.3	68,490

Figure 8 presents the monthly electricity consumption of company Z-IOMPPN during the period 2019–2021.

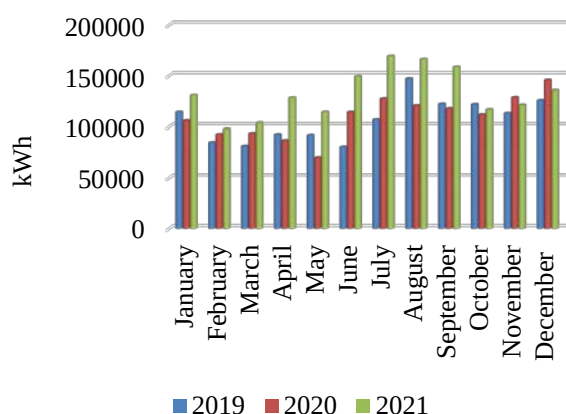


Figure 8. Electricity Consumption in Z-IOMPPN during the Period 2019–2021

It can be concluded that larger variations in electricity consumption occur during the spring and, particularly, summer months, while consumption remains relatively uniform during the remaining months.

When electricity consumption is expressed in kWh/m², the highest value was recorded in 2021, amounting to approximately 200 kWh/m², whereas the values for the other years were approximately equal, at around 160 kWh/m².

Figure 9 presents the water consumption of company Z-IOMPPN. The data indicate significant variations in water consumption throughout the year, with more pronounced increases occurring during the summer months.

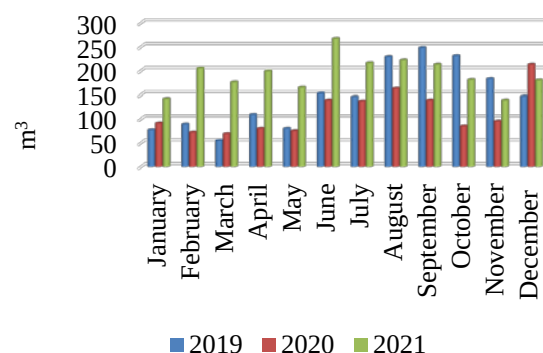


Figure 9. Water Consumption in Z-IOMPPN during the Period 2019–2021

Regarding the consumption of domestic hot water (DHW) for production processes, it is supplied by a gas boiler with a capacity of 920 kW. Due to the increased demand for DHW, higher quantities of gas are required.

For thermal energy supply, company Z-IOMPPN uses gas heaters with capacities of 103 kW, 75 kW, and 50 kW, an electric boiler, and an oil-fired boiler with a capacity of 12 kW, which is also used to meet production process requirements.

The analysis showed significant variations in gas and heating oil consumption during different periods, resulting from changes in heating systems and production processes.

Gas consumption increased from approximately 34.7 tonnes in 2019 to approximately 84.5 tonnes in 2021, while heating oil consumption decreased from 41,000 L in 2019 to 12,260 L in 2021. A summary of the energy and resource costs for company Z-IOMPPN is presented in Table 6.

Table 6. Summary of Energy and Resource Costs in Z-IOMPPN

Year	Electrical Energy [BAM]	Water [BAM]	LPG BAS EN 1056 [BAM]	Fuel Oil BAS 1002:2004 [BAM]	Total [BAM]	Total [BAM/m ²]
2019	194,184.5	3,843.4	44,721.9	80,688	323,437.8	40.42
2020	182,746.8	2,987.6	93,863.7	25,726.5	305,324.6	38.16
2021	263,673.9	5,071	155,883.2	19,388.6	444,016.7	55.5
Total	640,605.3	11,902	294,468.8	125,803.2	1,072,779.1	134.09

Figure 10 presents the percentage shares of energy and resource costs in the total costs of company Z-IOMPPN over the three-year period.

During the three-year observation period, the highest electricity consumption was recorded in company X-MI, followed by Y-IPP and Z-IOMPPN (Figure 11).

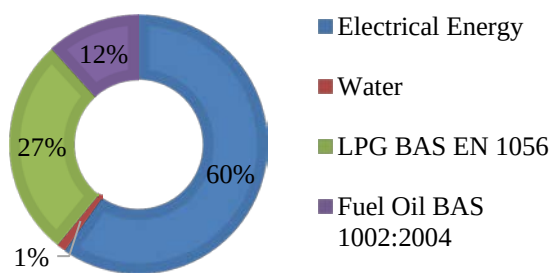


Figure 10. Percentage Share of Energy and Resource Costs in Total Consumption Costs in Z-IOMPPN during the Three-Year Period

It can be observed that electricity has the largest share of the total costs of company Z-IOMPPN, accounting for 60%, followed by LPG compliant with BAS EN 1056 at 27%, heating oil compliant with BAS 1002:2004 at 12%, and water at 1%. Since both gas and heating oil are used for space heating as well as for production process requirements, it is not possible to accurately determine the share of total costs attributable exclusively to thermal energy. Company Z-IOMPPN does not have a dedicated monitoring system for separately analyzing the consumption of these resources.

4. Comparison of Results and Indicative Energy-Efficiency Measures

The analysis of total consumption is based on costs (Tables 2, 4, and 6). It can be concluded that electricity represents the dominant share of total energy consumption costs across all three companies.

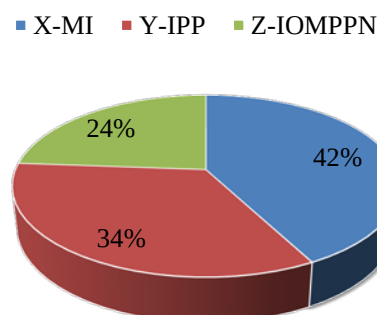


Figure 11. Percentage Share of Different Industrial Sectors in Total Electricity Consumption

This can be explained by the fact that the meat processing industry involves complex production processes, in which the final product undergoes a series of consecutive stages, including preparation, meat cutting, cooking, shaping, packaging, and other processing operations.

Analogous to energy consumption, the analysis of costs shows that company X-MI has the highest total electricity costs among the analyzed industrial sectors, followed by Y-IPP and Z-IOMPPN. The contribution to total electricity costs amounts to 39% for X-MI, 31% for Y-IPP, and 30% for Z-IOMPPN. The analysis revealed that electricity consumption in Y-IPP is significantly higher than in Z-IOMPPN (by 1,766,673.4 kWh); however, these two companies account for almost identical shares of total electricity costs.

This can be explained by differences in electricity supply contracts, including the price per kWh of delivered electricity and fluctuations in electricity prices during the observed period for company Z-IOMPPN, as well as by different operating schedules, including higher tariff (HT) and lower tariff (LT) periods and single- or double-shift operation. When electricity consumption is expressed in kWh/m², company Y-IPP has the highest specific electricity consumption, primarily due to its smaller building area.

When considering water as a resource, company X-MI has by far the highest water consumption (Figure 12).

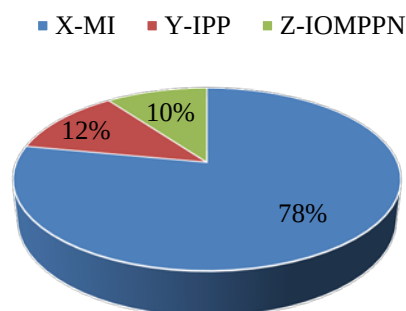


Figure 12. Percentage Share of Different Industrial Sectors in Total Water Consumption

These results are a consequence of the specific characteristics and complexity of processes within the meat processing industry, which require large quantities of water, as well as the strict requirements and standards imposed on this industrial sector. In the other two analyzed sectors, water is not directly associated with the production processes; it is mainly used for purposes such as tool cooling and similar applications. Therefore, groundwater can be used to a greater extent, resulting in significantly lower consumption of purchased municipal water. The costs follow the same pattern.

Overall, the highest total costs were recorded in company Z-IOMPPN, although it has the lowest total consumption of both electricity and water. However, this company has significantly higher consumption of LPG compliant with BAS EN 1056 and heating oil compliant with BAS 1002:2004. Based on the observed energy and resource consumption patterns, the existing heating system can be considered a potential area for energy-efficiency improvement, particularly due to the use of several heating technologies and the significant consumption of LPG and heating oil.

Domestic hot water (DHW) for production processes in company Z-IOMPPN is supplied by a gas boiler. As an indicative energy-efficiency (EE) measure, the recovery of waste heat from the boiler flue gases could be considered. The recovered heat could potentially be used for domestic hot water preparation or other suitable thermal demands within the production process. Company Z-IOMPPN has considerable thermal losses, and appropriate measures should be considered to address this issue. Following the examples of companies X-MI and Y-IPP, the integration of heat pump technology could be considered as another potential EE measure for meeting part of the thermal energy demand of company Z-IOMPPN. However, the technical and economic feasibility of such an intervention would require further assessment, including an analysis of the required heating capacity, operating conditions, investment costs, expected energy savings, and payback period.

The second-highest total costs were recorded in company X-MI, which is also the largest consumer of electricity and water, as well as other resources required to provide thermal energy for production processes. In 2020, company X-MI replaced its previous heating systems (pellet boilers and a geothermal heat pump) with new air-to-water heat pumps. In addition, two heat recovery systems were installed to provide additional heating of hot water. The lowest total costs were recorded in company Y-IPP, since this industrial sector uses only electricity and water, while other resources are not required for production processes. Thermal energy in Y-IPP is supplied by a water-to-water heat pump system. As additional support to the heat pump system, a pellet boiler has also been installed; however, due to the very low pellet consumption (approximately 1–1.5 tonnes per heating season), this resource was not included in the analysis. For company Y-IPP, waste heat recovery from production machinery could also be considered as a potential EE measure. The recovered heat could potentially be used for domestic hot water preparation or to support selected production processes. However, the feasibility of this measure would depend on the available waste-heat temperature, heat availability, operating schedule, and thermal demand of the company. Both X-MI and Y-IPP have installed their own photovoltaic (PV) power plants, whose contribution to reducing electricity consumption and pollutant emissions is significant. Figure 13 presents the overall share of the analyzed companies in total energy and resource costs.

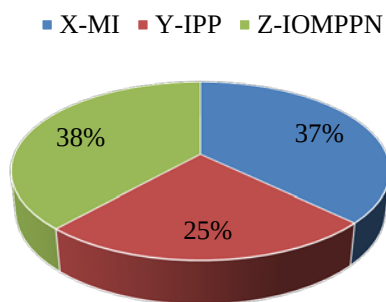


Figure 13. Percentage Share of Different Industrial Sectors in Total Costs during the Period 2019–2021

Since detailed technical and economic data required for a comprehensive assessment were not available, the proposed measures are presented as indicative recommendations rather than as fully quantified or optimized solutions.

For the calculation of specific energy consumption (SEC) for the analyzed companies, the average energy consumption over the three-year observation period was considered. The analysis included electricity and other energy sources specific to individual industrial processes, which were converted into kWh for comparison. In addition, the average annual quantity of products manufactured during the same period was taken into account.

For companies X, Y, and Z, according to Equation (1), the following values were obtained: $SEC_{X-MI} = 0.74$ kWh/kg, $SEC_{Y-IPP} = 0.82$ kWh/kg and $SEC_{Z-IOMPPN} = 2.24$ kWh/kg.

The obtained SEC values indicate differences in the energy performance of the analyzed companies. X-MI has the lowest SEC, followed by Y-IPP, whereas Z-IOMPPN has the highest SEC value. Within the scope and assumptions of the present analysis, these results indicate that Z-IOMPPN has the highest energy use per unit of product among the three analyzed companies. However, direct benchmarking of SEC values across different industrial sectors should be interpreted with caution due to differences in production processes, products, operating conditions, and system boundaries.

5. Conclusion

Within the scope of the research conducted in this paper, three companies belonging to different industrial sectors within the SME sector were analyzed. The results indicate that electricity represents the dominant share of total energy consumption costs in all analyzed companies. The contribution of electricity to total consumption costs varies depending on the type of industry, production volume, operating mode, production processes, specific regulations and standards, the use of other energy sources, as well as HVAC systems.

The meat processing company X-MI is characterized by more complex production processes compared to the other analyzed companies. The production of final products involves a series of consecutive and complex stages, resulting in higher consumption of electricity and other resources. Water consumption is also the highest in this company due to the specific characteristics and scale of its production processes, which require significant quantities of water, as well as the strict hygiene and technological standards typical of this industry. In contrast, water consumption in the other two analyzed industrial sectors is not directly associated with the production processes. Company Z-IOMPPN recorded the highest total costs during the observed period. It also recorded the highest SEC value among the three analyzed companies, indicating the highest energy use per unit of product within the scope and assumptions of the present analysis. These findings indicate potential for further assessment and implementation of appropriate energy-efficiency (EE) measures in company Z-IOMPPN.

This type of analysis could be extended to a wider range of industrial sectors, including various branches of the food industry, the chemical and petrochemical industries, the textile industry, the cement production industry, and other relevant sectors. Furthermore, at least two or three companies from each industrial sector should be analyzed, considering different production capacities and numbers of employees. Such an approach would provide a clearer understanding of electricity consumption patterns, particularly the consumption of resources that are specific to individual industrial sectors. The obtained results could be compared with analyses conducted at the European or global level within the same field. Based on these comparisons, conclusions could be drawn regarding the current state and position of companies in BiH in relation to European and global benchmarks.

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