

Article

The Impact of Energy Consumption Costs on the Profitability of Production Companies in Poland in the Context of the Energy Crisis

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Abstract: The paper presents the results of the authors' research on the share of energy costs in revenues and their impact on the profitability of companies. This research was inspired by a large increase in energy prices in 2022. The authors analyzed the shares of energy consumption costs in production companies from various industries, using various sources: scientific literature, expert studies, and statistical data. Based on the results of these analyses, the authors simulated the impact of changes in energy prices on the profitability of companies. The research results are as follows: according to the authors, the share of these costs in the value of sales is much lower (several percent) than presented in various literature sources (a dozen or so, and even up to 30% in some cases). Despite this, however, the change in energy prices should significantly reduce profitability according to the simulations conducted by the authors. However, the financial reports analyzed by the authors show that profitability in many cases not only did not deteriorate, but revenues and profits increased in a large number of companies. In many cases, this can be explained by the actions taken by companies to reduce energy consumption costs and by increases in product prices. The authors' research also shows that if factors such as the specificity of the industry or the size of the company have an impact on energy efficiency, it is only to a small extent. The share of energy costs in sales and financial results, even within a given industry and in companies of similar size, varies greatly. The authors therefore believe that the effectiveness of the management of a given company has the greatest impact. Therefore, the results of the analysis differ significantly from the results of studies presented in the literature. Energy consumption data were analyzed using various literature sources from different countries. However, the main analyses conducted by the authors focused on Poland.

Keywords: energy; production processes; logistics processes; efficiency of consumption of energy; consumption of energy; simulations; profitability of companies



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1. Introduction

The share of energy costs in the total costs of companies varies depending on the industry and the specific company. However, even a small share of energy consumption costs in total costs can have a significant impact on the financial results of enterprises, especially production companies, which are usually energy intensive. However, the impact is visible throughout the supply chain—it is experienced by suppliers supplying their customers, distribution and trade companies, and companies from the logistics industry (transport, forwarding, logistics, and companies dealing with the storage and handling of goods).

At each stage, however, the impact of energy costs on profitability depends not only on energy prices, but also on the decisions made by companies. This may result in pressure to raise product prices, but companies may also undertake other actions that may be strategic (e.g., changing the supply strategy), technological (e.g., energy-efficient machines), or

organizational (e.g., forms of production organization). The problem is very important and interesting, and the impact of the various factors on the energy consumption of processes is ambiguous. In the literature, one can find very different views, for example, on the relationship between technological progress and energy efficiency.

The inspiration for the research, the results of which are presented in this paper, was the increase in energy prices that took place in 2022 in the world. It was yet another crisis (after the COVID-19 pandemic and, earlier, the global economic crisis), the effects of which companies had to face. Of course, inflation also made the financial situation of companies difficult.

The increase in energy prices has been observed for several years. Between 2017 and 2021, energy prices in Poland increased by 69.9% [1]. In 2022, within a few months (March to June), the price of a ton of coal increased by 19.2%. Natural gas prices also increased. The reason for the difficult situation on the energy market is the present situation in Ukraine. To some extent, the pandemic (post-pandemic economy) and other factors are also to blame for this—the global climate crisis, ecological policy, and political decisions in Poland, the EU, or the world. As a solution to this problem, investments in Renewable Energy Sources, including primarily photovoltaics, are proposed.

Therefore, the question arises about the effects of the increase in energy prices for enterprises and what actions were taken by enterprises. The authors therefore asked themselves several research questions.

First, how did the change in energy source affect the profitability of the company? To find the answer to this question, it would first be necessary to know the share of energy costs in revenues and the share of these costs in relation to profits.

Secondly, do the share of these costs and their impact on the profitability of companies depend on the type of industry and the size of a company? How do the branches of the economy differ from each other in terms of energy intensity? Is the share of energy costs lower in large companies due to economies of scale than in smaller ones, due to more efficient technological solutions and higher productivity of the resources used?

Third, what actions have companies taken in response to the increase in costs? Are there regularities related to the specificity of a given industry or company size in these activities?

The main purpose of the paper is to present the impact of changes in energy prices on the profitability of production companies and to present the reactions of companies to the increase in energy prices.

The structure of the paper is as follows:

1. Analysis of world and Polish literature presenting the results of research on the energy efficiency of enterprises and its importance for their economic efficiency (Section 1);
2. Presentation of the research methods (Section 2);
3. Analysis of data in financial reports of Polish listed companies (Section 3.1) concerning:
 - Changes in costs and profitability as a result of rising energy prices;
 - Actions taken in this regard;
 - Cost structures and profitability;
 - The share of energy consumption costs.
4. Simulation of the impact of changes in energy prices on the profitability of Polish companies from the food industry (Section 3.2) based on data presented in the literature and data of the Polish listed companies from the food and beverage industry;
5. Simulations of the impact of changes in energy costs on the profitability of the Polish enterprises (Section 3.3) based on data from the PONT Info database.

This paper is a continuation of the authors' research on the impact of changes in fuel prices on companies in the road freight transport industry [2].

Data on the share of energy costs in total costs of manufacturing companies and revenues vary greatly (see Table 1).

Table 1. Analysis of the literature—costs of energy and actions taken.

Costs of Energy	Actions Taken	Sources
4.1% of total revenues of manufacturing companies	Price increase	[3]
15% of the costs of food and beverage producers	-	[4]
10 to 30% (and more) of the total operating costs of SMEs	“green investments”: 44% modernization of production lines, 34%—thermal modernization of buildings	[5–8]
1.51% to 1.78%	Raising prices primarily by small businesses, Poland	[8]

According to the authors of some studies, energy consumption accounts for 4.1% of the total revenue of the processing industry. However, there are five industries (chemicals, metallurgy, oil, paper, and ancillary to construction) that are more energy dependent, ranging from 7.2% (chemical) to 13.6% (ancillary to construction). These more vulnerable industries have been under more pressure to increase the selling prices of their products, given the increase in energy prices seen in 2021 [3]. According to other authors, the costs of energy consumption account for 15% of the costs of food and beverage producers [4].

In Poland, studies were conducted during the increase in energy prices in 2022 [5–8]. In Poland, electricity and gas prices for enterprises are not subject to tariffs by the Energy Regulatory Office, and thus their scale is significantly larger than in the case of individual consumers. Many companies complained about the growing costs of doing business due to the strong increase in the prices of energy.

According to research conducted among 300 small and medium-sized companies [5], it appears that:

- 70% of companies are concerned about access to energy in the upcoming heating season;
- Companies have generally only partially passed on higher energy costs to buyers, but are actively reducing other expenses;
- High energy prices increase the interest of SMEs in investing in energy efficiency and RES, especially in industrial companies;
- About 2/3 of the companies declare a share of over 10% of energy costs in the company’s operating costs;
- In larger companies, most often it is between 10 and 30% (for more than half of the companies with a turnover of over 10 million last year);
- About half of the companies with higher turnover are industrial companies, and industry is a more energy-intensive sector than services or construction.

According to research conducted by GfK Polonia [5], among 300 small and medium-sized companies, about 40% of them declare that energy costs account for 10 to 30% of their total operating costs, and in every fifth company this the share is even higher [6]. The study also shows that in order to reduce energy costs, a relatively large number of companies are interested in green investments, e.g., 44% of companies are in the process of modernizing their production lines and 34% of buildings.

The pressure to use energy-saving and low-emission solutions is low (only 20% of companies). Larger companies and industrial firms are under greater pressure. It seems that the pressure to act in response to the climate crisis is less in the SME sector than in large companies. This conclusion is supported by our other studies at the global and national level.

Credit Agricole conducted an analysis of the impact of the increase in energy costs on the financial results of companies [6]. This analysis was conducted using data from the PONT Info database. In the scale of the entire economy, the share of energy costs in revenues increased in the first half of 2022 compared to the first half of 2021 by 0.27% (from

1.51% to 1.78% in H1 2021). Therefore, the increase was small, if we compare it with the increase of energy prices. This means that companies have largely succeeded in shifting rising energy costs down the supply chain, including to consumers. In addition, some companies have not yet run out of long-term contracts (assuming a fixed price) for the supply of energy.

According to the Polish Central Statistical Office [7], total primary energy consumption increased by 1.3 Mtoe between 2010 and 2020. This increase in consumption was influenced by an increase in final energy consumption by 4.8 Mtoe, higher electricity consumption (by 4.0 Mtoe), and other factors, which increased consumption by 2.2 Mtoe. The decrease in the demand for primary energy was influenced by the increase in electricity imports, the improvement in the efficiency of thermal power plants (decrease in demand by 3.6 Mtoe), and the increase in the use of energy from renewable sources (decrease in demand by 2.8 Mtoe). The rate of improvement in the energy intensity of the processing industry in Poland exceeded the European average and amounted to 5.2%/year compared to 1.6%/year achieved by the entire EU (energy intensity calculated in the average European structure. The fastest rate of improvement in energy efficiency was recorded in transport (of 2.3%).

Almost all Polish companies (95%) reacted to the increased costs of energy and fuels by increasing the prices of products or services; only 5% managed to avoid it. The second most common way to deal with the situation is to look for cheaper materials and suppliers (77% of companies), followed by cutting other costs (60%) and withholding investment in company development (41%) [8].

Views on the importance of energy costs for the economic efficiency and competitiveness of companies are expressed by many authors (see Table 2).

Table 2. Analysis of the literature—impact on rentability of companies.

Effects	Industries and Countries	Source
A significant impact	Poland, especially large, manufacturing, commercial, construction and transport enterprises	[4–8]
Significant reduction in profits	European companies in many manufacturing sectors	[9]
Negative impact on business profitability	Pakistan	[10]
Possible energy savings in manufacturing companies: 10–40%		[11,12]
Profit margins in SMEs—5%	Iceland	[13]
High potential for improving energy efficiency	in SMEs	[14,15]
Benefits for the environment		[16]

For example, according to Ferriani and Gazzani [9], the increase in energy costs caused by the war in Ukraine significantly reduces the profits of European companies and increases business risk, and even threatens entire production sectors. In Pakistan, rising energy prices have a negative impact on business profitability [10].

According to research conducted by the Polish Economic Institute and Bank Gospodarstwa Krajowego, for 74% of companies, the increase in energy prices is a significant problem [11]. In large companies, 84% of companies indicated difficulties related to this, which is more than in micro-enterprises (69%). Manufacturing enterprises (85%), trade, construction, and transport enterprises (69% each) are particularly affected by this. As a result, 65% of enterprises have increased the prices of goods or services and 18% are planning to do so. As it might seem, large enterprises in particular should raise prices. However, the opposite happened: mainly micro- and medium-sized enterprises (78%) decided to raise their salaries. The largest companies are less willing to raise prices.

Other responses of companies to the energy crisis are also surprising. A total of 28% of companies launched new distribution channels. Only 8% decided to lay off employees and 3% to reduce salaries. This raises questions about what companies are doing: are they looking for ways to reduce their energy costs? As it turns out, only 37% decided to invest in technological solutions that aim to help companies reduce costs, and only 18% have plans to do so. Every third small or medium-sized Polish company intends to invest in solutions that will help reduce energy costs in the future.

The impact of increasing energy costs on profitability depends on, among other factors, the level of profitability. It is estimated that the possible energy savings in production companies in different companies may vary [12,13], which together with low profit margins has a large impact on profitability. For example, in Iceland, SME profit margins are estimated to be 5%, and therefore energy savings and related cost savings can be significant [14]. In small and medium-sized enterprises, the potential for improving energy efficiency is even greater than in large companies, due to the state of the art in the field of energy efficiency [15].

Views on energy efficiency factors also vary (see Table 3).

Table 3. Analysis of the literature—factors of energy efficiency.

Factors of the Energy Efficiency	Industries and Countries	Source
Technology factors		[15,17–23]
Management and human factor	Steel industry	[24]
Lighting, processing equipment and heating, air conditioning and ventilation systems		[25]
The degree of automation, the age of the building, the degree of resource utilization, environmental conditions	Automotive industry	[26]
Energy saving technologies		[27]
Involvement of the highest and lowest level of management, strategy	USA	[28]
Management knowledge and experience	Swedish iron and steel industry	[29]
Artificial intelligence and economies of scale		[30]

Technological factors are considered to be the factors of energy efficiency [15]. However, energy efficiency depends not only on the technologies used. For example, research conducted in the steel industry by Kelchevskaya et al. [24] indicates that an important factor in the energy intensity of production in this industry is the involvement of employees and energy-saving human capital.

Efficiency improvements can be achieved by implementing measures to reduce the total amount of energy (e.g., lighting, heating, air conditioning and ventilation systems, heating of production processes, pumps and fans [25]).

In automotive plants, apart from the basic factors, energy efficiency is also influenced by other factors, e.g., degree of automation, age of the building, degree of resource utilization, and environmental conditions [26].

The four main ways to reduce energy costs on the demand side have been identified as energy-efficient technologies, load management, energy carrier switching, and energy saving [27].

According to the results of research conducted in the USA, the effectiveness of actions aimed at increasing energy efficiency depends to a large extent on the involvement of top management. However, it must be supported by the involvement of the operational level [28]. According to Johansson [29], a very important energy efficiency factor in the Swedish iron and steel industry was the knowledge and experience of the energy manager in the field of production processes.

Many authors take up the subject of the impact of the development of technology and technology on energy consumption. According to Rui Zhang and Yuanhai Fu [31], energy consumption in most branches of the manufacturing industry is efficient, but this efficiency

can be further improved by, e.g., the introduction of modern technologies and technological innovations [17].

Other authors also consider technological progress to be a very important factor in energy efficiency. For example, Popp [18] believes that two-thirds of the change in energy consumption relative to price change is due to simple price-induced factor substitution, while the remaining one-third is due to induced innovation [19].

However, opinions on the impact of technological development on energy efficiency are divided. Many authors indicate that the impact of technological development on energy efficiency is positive [20–22]. However, according to other authors, there is a negative correlation between technological progress and energy efficiency, i.e., technological innovations reduce the expected energy savings [23,32–34].

Other authors have similar concerns. For example, the results of research conducted by Tang in Chinese industry [35] indicate that the development of new products and their production probably increase the total energy intensity of production. However, one of the conclusions of these studies is that the development of new products with cleaner technology will reduce the overall energy consumption and energy intensity of industrial production through energy savings.

Perhaps the relationship between technological progress and energy efficiency is more complex. Lei Jin et al. conducted research on the relationship between technological innovations and energy consumption [30]. These studies are innovative because the authors studied short-term and long-term relationships. In the short term, technological innovations lead to an increase in energy consumption. However, energy consumption is positively and bilaterally related to technological innovations.

The research results of Zhang et al. are interesting [36]. The use of artificial intelligence can reduce energy consumption. An important factor may also be the effect of scale—the larger the enterprise, the greater the effect of scale and the lower the energy consumption.

The latter factor, i.e., the effect of scale, has also been the subject of research by the authors of this paper for several years. The authors referred to it in their analyses, the results of which are presented later in this paper.

Of course, the problem of energy efficiency should be viewed in a broader context. Improving energy efficiency in industry is important not only because of the benefits for enterprises but also for the environment [16].

2. Materials and Methods

The aim of the research conducted by the authors of this paper was to examine the impact of the increase in energy consumption costs on the financial results of companies. For this purpose, the authors conducted simulations of changes in energy prices. This was the main research method. The data for the simulation were taken from reports of listed companies and from the literature.

The test results are presented in Section 3 as follows:

- Section 3.1—Analysis of data in financial reports of 100 Polish listed companies.
- Section 3.2—Simulation of the impact of changes in energy prices on the profitability of Polish companies from the food industry based on the data obtained from Section 1 of this paper and on the data of Polish listed companies from the food and beverage industry.
- Section 3.3—Analysis of data on the costs of energy consumption and simulations of the impact of changes in energy prices on the profitability of Polish enterprises from various industries.

In Section 3.1, an analysis of the costs and financial results of the surveyed companies in 2021 and 2022 was undertaken to examine how the sharp increase in energy prices affected the profitability of these companies. The authors analyzed:

- The share of material and energy consumption costs in revenues (data from company reports);
- Revenue changes;

- Profitability changes.

Simulations, the results of which are presented in Sections 3.2 and 3.3, were aimed at determining the financial results the surveyed companies would achieve under the conditions assumed by the authors.

Simulations from Section 3.2 were conducted for companies from the food industry based on data from the literature regarding the share of energy consumption costs in total costs. These simulations were conducted using the following mathematical formula to calculate the profitability at a given level of costs:

$$\text{NPM} = \text{NOP} / \text{R}$$

$$\text{NOP} = \text{R} - \text{TC}$$

$$\text{R} = \text{ARP} * \text{VS}$$

where:

NPM—Net profit margin

NOP—Net Operating profit (loss)

R—Revenue

TC—Total costs

ARP—Average Retail Price

VS—Volume of sales

Total cost (TC) is calculated using the following formula:

$$\text{TC} = \text{TCM} + \text{SC} + \text{AC} + \text{EC} + \text{Tr}$$

where:

TCM—Technical production cost of sold production (reduced by energy consumption costs)

SC—Selling costs (less transport costs)

AC—General administration costs

EC—Energy costs

Tr—transportation costs

In financial reports, TCM covers all costs from the purchase of materials to the manufacture of finished products and the Selling costs (SC) represent the cost of distribution, marketing, and physical delivery of the goods to the place of receipt by the customer (i.e., transport costs).

Profitability is a function of two factors: the costs of energy consumption in production processes and the costs of transport services, which in turn are also dependent on changes in energy costs. This function can be expressed by the following formula:

$$\text{R} = f(\text{EC}; \text{Tr})$$

In our calculations, it was assumed that transport costs are the costs of transport services provided by specialized entities from the logistics industry, which is a common practice in the Polish economy. These costs are part of the cost of sales, because often the supplier has the responsibility for transport. For this reason, transport costs are not included in the supply costs, which are part of the manufacturing costs. Thanks to this formula, it is possible to study the impact of changes in energy prices on the profitability of companies.

However, Section 3.3 presents the results of simulations conducted for all companies analyzed in Section 3.1 using data on the share of energy consumption costs obtained from the PONT Info database. The difference with the simulations in Section 3.2 is not only the larger number of analyzed companies, but also a different share of energy consumption costs. In addition, it is the share of energy costs not in costs, but in the value of sales.

The method and purpose of these simulations are similar—the authors examined the possible impact of changes in the share of energy consumption costs on the profitability of companies, assuming that all other conditions did not change. The authors tried to adjust the classification of industries from this database to the industries represented by the analyzed companies as much as possible. A similar simulation model was used as in Section 3.2, with the difference that only data from this database were taken into account, so changes in energy costs and the effects of these changes were not estimated separately in production and distribution.

Then, the results of these simulations were compared with the actual financial results, which were analyzed in Section 3.1, and the authors attempted to interpret these results.

The tool that was used for these simulations and analyses was an Excel spreadsheet.

3. Results—Changes in the Costs of Energy Consumption in Poland and the Impact on the Profitability of Polish Companies

3.1. Data Analysis of Financial Reports of Polish Listed Companies

The purpose of the analyses presented in Section 3.1 was to examine how the profitability of companies changed in 2022, i.e., in the period of a large (24.4%) increase in energy prices, and the reaction of companies to this situation. The authors analyzed reports of Polish companies from various manufacturing industries:

- Chemical (8);
- Wood paper and furniture (8);
- Electromechanical (29);
- Rubber and plastics (2);
- Automotive (9);
- Clothing and cosmetics (16);
- Drug production (6);
- Food (22).

In total, 100 manufacturing companies were analyzed. In addition, the data of six companies from the logistics industry were also analyzed.

Polish companies have been affected to varying degrees by the increase in energy prices. They took various actions. Information taken from the analyzed reports is presented below.

Due to the increase in energy prices, operating costs increased, which had an impact on the profitability of the companies. Not only did the costs of energy consumption increase, but also the costs of materials for production and transport, which had an impact on the costs of production of finished products, and also distribution. This was felt, for example, by large companies from the clothing industry that have their own showrooms, such as LPP S.A. and Vistula.

However, in some companies that reported significant increases in costs, profitability increased. An example of such a company is ERG SPÓŁKA AKCYJNA. In others, the prices of materials, raw materials, and energy carriers actually increased, and at the same time, profitability decreased, as, for example, in the company SANOK RUBBER COMPANY SPÓŁKA AKCYJNA.

In order to reduce the impact of the increase in energy prices, the STALPROFIL SA Group has taken measures such as diversification of energy sources (SKONSOLIDOWANY RAPORT ZA I KWARTAŁ 2023 <https://www.stalprofil.com.pl/pobierz/634/skonsolidowany-raport-kwartalny-za-1-kw-2023-pdf> (accessed on 28 July 2023)).

Thanks to photovoltaic installations, the UNIMOT Group achieved savings of 50% per year, and also relocated its operating activities in the field of fuel trading.

Helio invested in renewable and alternative energy sources (Quarterly Report—Q1 of the financial year 2022/2023) (including photovoltaics and installations aimed at reducing energy consumption).

Actions taken by VISTULA RETAIL GROUP SPÓŁKA AKCYJNA include changing the LED lighting in company stores; reducing consumption of energy or more efficient

use of energy; using alternative energy sources; reducing the amount, or more efficient use, of water or sewage; reducing the amount of generated waste and sorting it; automatic temperature sensors; automatic water-saving systems; energy-saving drives in all new machines in production plants; and conducting trainings and making employees aware of the need to save energy and water.

Only one of the surveyed companies provided information on the share of energy costs in revenues, namely, FABRYKA MBRABIAREK RAFAMET; the share of energy costs is 3%, which is much less than the value indicated by the literature sources quoted earlier in this paper.

Some of the surveyed companies list the items “costs of materials and energy”. To some extent, this could be helpful information, given that the increase in energy prices has also affected the financial situation of the suppliers delivering materials to the producers. However, only 36 of the surveyed companies provided such information. The authors used this information in the analyses to show how the energy crisis of 2022 affected the situation of the surveyed companies. First, this is presented on the basis of two industries that did well during the energy crisis: the chemical industry and the wood, paper, and furniture industry.

Table 4 presents data from the chemical industry. In two companies from the AZOTY group, the average share of material and energy costs in revenues is 69% and 74%, which is significant. The increases were also significant because they were, respectively, 40% and 14%. Nonetheless, in both of these companies, sales increased significantly in 2022, which also resulted in a significant increase in profitability. Such a situation also took place in other companies in this industry. At POLWAX, profitability increased by as much as 156.43%.

Table 4. Financial results in 2021 and 2022—Chemistry.

A Company	Share of Costs Materials and Energy	Change in the Share of the Costs	Revenues (mln PLN)		Rentability		Change in the Rentability
			2021	2022	2021	2022	
HUB.TECH	0%	0%	121.7	175.1	14.4%	15.0%	4.0%
POLWAX	0%	0%	271.9	353.9	1.8%	4.5%	156.4%
PCC EXOL	0%	0%	807.1	1135.0	7.2%	10.9%	51.0%
PCC ROKITA	0%	0%	2203.3	2820.7	7.2%	10.9%	51.0%
ZAKŁADY CHEMICZNE POLICE	0%	0%	3219.9	5044.5	3.5%	4.2%	19.5%
CIECH ZAKŁADY AZOTOWE PUŁAWY	0%	0%	3459.9	4877.6	8.4%	6.0%	−29.3%
AZOTOWE PUŁAWY	69%	40%	5488.8	9181.1	3.8%	10.4%	172.4%
GRUPA AZOTY	74%	14%	15,901.3	25,035.2	4.0%	7.9%	97.3%

The authors have more information on the share of energy and material costs in the second surveyed industry, “Wood, paper and furniture” (Table 5); here, too, the share of energy costs in revenues is high and there were significant increases in energy costs compared to 2021. However, in this sector, sales and profitability also both increased. The only exception, however, is the company FABRYKI MEBLI FORTE SPÓŁKA AKCYJNA, in which the profitability decreased by −16.16%, probably because the revenues also decreased.

Table 5. Financial results in 2021 and 2022—Wood, paper and furniture.

A Company	Share of Costs Materials and Energy	Change in the Share of the Costs	Revenues (mln PLN)		Rentability		Change in the Rentability
			2021	2022	2021	2022	
BIOFACTORY	57%	0%	14.8	17.3	7.2%	6.2%	−14.5%
STANDREW	0%	0%	18.6	21.1	4.7%	3.6%	−21.9%
KLON	61%	11%	23.5	28.2	4.1%	1.6%	−59.8%
EUROSNACK	54%	12%	76.8	116.0	3.9%	4.0%	2.0%
KOMPAP	0%	0%	91.3	102.6	5.8%	7.3%	26.0%
KPPD	0%	0%	415.9	502.6	8.4%	11.9%	41.5%
FABRYKI MEBLI FORTE	39%	0%	1326.9	1273.9	8.4%	7.0%	−16.2%
ARCTIC PAPER	0%	0%	3412.6	4762.7	5.2%	15.5%	200.1%

In other industries, the situation was worse: slightly more companies experienced a decrease in revenues, and there were even more cases of a decrease in profitability. In general, the situation in the companies was as follows:

Revenues fell in only 8% of companies. In 41% of companies, profits fell, but only by more than 50% in 16% of companies. The largest decrease in profitability was −432.28%, and the largest increase was 5626.92%

In order to determine whether there is a relationship between energy efficiency and the specificity of a given industry or the scale of operation, more thorough research should be conducted.

Table 6 presents the average values of changes in costs, sales, and profitability for all analyzed industries. While some companies have indeed felt the effects of the energy crisis, many companies have seen both sales and profits increase. The conclusion is that it is probably not so much the specificity of a given industry that has an impact here, but how a given company is managed.

Table 6. Average figures for industries.

Industry	Material and Energy/Sales Costs	Increase in Sales	Profitability Increase
Chemical	72.0%	93.0%	56.0%
Wood, paper and furniture	26.0%	88.0%	50.0%
Electromechanical	20.0%	93.0%	55.0%
Rubber and plastics	78.0%	50.0%	50.0%
Automotive	4.0%	78.0%	33.0%
Clothing and cosmetics	14.0%	88.0%	44.0%
Drug production	7.0%	100.0%	67.0%
Food	3.0%	77.0%	50.0%

3.2. Simulation of the Impact of Changes in Energy Prices on the Profitability of Polish Companies in the Food Industry

The purpose of the analyses presented in Section 3.2 was to simulate the impact of the increase in energy prices on the profitability of companies in the food and beverage industry in Poland, assuming that the share of energy costs in this industry is 15% of total costs, as stated by the authors cited earlier in the paper [4].

Tables 7–9 present data and simulation results based on data from Polish listed companies from the food and beverage industry. The data for the simulation are presented in Table 7. The authors here examined both the direct and indirect impacts of rising energy costs on the profitability of companies. Direct costs resulted from the increase in energy prices, and indirect costs from the increase in the prices of external services (e.g., logistics) also caused by the increase in energy prices, e.g., fuels. It was assumed that road transport

is used, in which the rates in 2022 increased even to 50% [2]. The share of transport costs in revenues was assumed at the level of 4%, i.e., the same as in The Establish Davis Logistics Cost and Service Database, which largely coincides with the results of research conducted for several years by the authors of this paper.

Table 7. Assumptions for calculations.

Energy Cost/Total Costs	Increase in Energy Costs	Share of Transport Costs	Increase in Transport Costs
15%	26%	4%	50%

Table 8. Financial results of the Polish companies from the food industry in 2021—before the energy crisis 2022 (mln PLN).

Company	Hortico	Eurosnack	Excellence	Wawel	Tarczyński	Krynica Vitamin	Żywiec	Marie Brizard Wine & Spirits
Revenue	152.27	76.82	62.78	517.95	1194.46	395.31	3467.29	986.09
Total costs	137.44	71.86	57.56	461.43	1059.54	355.78	3011.49	959.91
Energy costs	20.62	10.78	8.63	69.21	158.93	53.37	451.72	143.99
Transport costs	6.09	3.07	2.51	20.72	47.78	15.81	138.69	39.44
Net Operating profit (loss)	12.10	3.01	3.51	43.23	95.62	13.08	406.58	25.61
Net profit margin	7.94%	3.92%	5.59%	8.35%	8.01%	3.31%	11.73%	2.60%
Energy costs/Revenue	13.54%	14.03%	13.75%	13.36%	13.31%	13.50%	13.03%	14.60%

Source: Own calculations based on the financial reports.

Table 9. During the energy crisis (2022)—Comparison: simulation vs. real data (mln PLN).

Company	Hortico	Eurosnack	Excellence	Wawel	Tarczyński	Krynica Vitamin	Żywiec	Marie Brizard Wine & Spirits
Simulation								
Energy costs	26.4	20.3	10.9	87.2	200.3	67.2	569.2	181.4
Transport costs	9.1	4.6	3.8	31.1	71.7	23.7	208.0	59.2
Total costs	154.0	116.3	63.6	510.5	1172.5	393.4	3337.0	1056.5
Net Operating profit (loss)	−1.7	−39.5	−0.8	7.5	21.9	1.9	130.3	−70.4
Net profit margin	−1.1%	−51.4%	−1.3%	1.4%	1.8%	0.5%	3.8%	−7.1%
Decrease in margin	−114.3%	−1411.0%	−122.6%	−82.8%	−77.1%	−85.2%	−67.9%	−375.0%
Price increase	necessary to maintain the same level of profits							
	9.1%	55.3%	6.9%	6.9%	6.2%	2.8%	8.0%	9.7%
Net profit margin in 2022—data from financial reports	10.8%	4.0%	7.0%	6.4%	10.5%	5.7%	5.3%	3.4%

Source: Own calculations based on financial reports.

Table 8 presents the results of these simulations for eight listed companies from the food and beverage industry listed on the Warsaw Stock Exchange. Rows 1, 2, 5, and 6 present data from the reports of these companies. The costs of transport and energy consumption are calculated on the basis of previously adopted assumptions and presented in lines 3 and 4. In line 7, the share of energy costs in revenues based on the adopted assumptions is calculated. This share is over 13% in all analyzed companies, i.e., similar to the that of the previously quoted studies.

Table 9 presents the results of simulations concerning the impact of the increase in energy prices on the financial results of these companies, and especially on profitability. This is shown in the first six rows of this table. These are the results based on the assumption

that all other conditions (costs, prices, sales volume) were unchanged. The simulation shows that corporate profits would be greatly reduced—from -67.9% to -375.0% (row 6).

The seventh line presents the results of the simulation of the necessary increase in the price of products in order to maintain the previous level of profitability—from 6% to almost 10% .

The eighth line shows the actual profitability levels from the companies' reports, which are much higher than the levels obtained from the simulations; none of these companies actually suffered losses. Furthermore, profit margins increased significantly at all companies, several of which reported losses before the "energy crisis" and profits in 2022.

The conclusions are as follows: either the actual share of energy costs in revenues is lower than that stated in the source quoted here, and/or companies, in response to the increase in energy prices, have taken measures to reduce these costs or pass them on to consumers.

3.3. Simulations of the Impact of Changes in the Energy Costs on the Profitability of the Polish Enterprises

The authors analyzed energy costs and changes in these costs in the years 2017–2023 using data obtained from PONT Info.

The data are grouped according to several criteria:

- Company size;
- Types of business;
- Years.

As for the size of the companies, they are grouped as follows:

A Medium and large entities (employing < 9 persons);

C Medium units (employing >9 and <50 people);

B Large units (employing ≥ 50 people);

D Intermediate units (employing ≥ 50 and ≤ 250 people);

E Large entities (employing >250 people).

For the purposes of the analysis, the authors selected production companies and analyzed data for the years 2017–2023. Industries are grouped according to the Polish Classification of Activities (PKD). For the purposes of the analysis, the authors have selected industries that most closely correspond to the industries analyzed in the previous sections:

- 10 PRODUCTION OF FOOD PRODUCTS;
- 11 BEVERAGE PRODUCTION;
- 13 MANUFACTURE OF TEXTILE PRODUCTS;
- 14 GARMENT PRODUCTION;
- 16 MANUFACTURE OF WOOD AND CORK PRODUCTS, EXCLUDING FURNITURE; MANUFACTURE OF PRODUCTS FROM STRAW AND PLAITING MATERIALS;
- 17 MANUFACTURE OF PAPER AND PAPER PRODUCTS;
- 20 MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS;
- 21 MANUFACTURE OF BASIC PHARMACEUTICAL SUBSTANCES, DRUGS AND OTHER PHARMACEUTICAL PRODUCTS;
- 27 MANUFACTURING OF ELECTRICAL APPLIANCES;
- 28 MANUFACTURE OF MACHINERY AND EQUIPMENT NES ELSEWHERE CLASSIFIED;
- 29 MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS, EXCLUDING MOTORCYCLES;
- 31 FURNITURE PRODUCTION.

The results of the analysis are presented in Table 10.

Table 10. Share of energy consumption costs in production companies in 2022.

PKD	Group					
	Units	A	C	B	D	E
10		2.3%	2.3%	2.3%	2.0%	2.4%
11		1.5%	4.8%	1.5%	2.5%	1.2%
13		3.1%	2.4%	3.1%	4.4%	2.3%
14		1.9%	1.4%	2.1%	1.6%	2.7%
16		3.4%	2.3%	3.6%	2.2%	4.2%
17		4.1%	1.0%	4.3%	2.1%	5.3%
20		4.0%	2.1%	4.2%	4.0%	4.2%
21		1.5%	0.8%	1.5%	1.2%	1.5%
27		1.5%	0.8%	1.5%	1.2%	1.5%
28		1.8%	0.9%	1.9%	1.6%	2.1%
29		2.1%	1.3%	2.1%	1.7%	2.1%
31		1.9%	1.0%	1.9%	1.4%	2.1%

It is difficult to notice regularities regarding, for example, the impact of company size on energy consumption. There are no economies of scale in terms of energy efficiency. Only in two cases of large companies (D—production of food products and production of wood products) and in two cases of the largest companies (E—production of beverages and production of textiles) was the share of energy costs in revenues the smallest. In the remaining cases, medium-sized companies were the most energy efficient. Perhaps the lack of a clearly visible effect of scale in this respect in large companies results from a higher degree of technological advancement, and in small companies, low labor productivity. However, this is a topic for a separate study.

However, the problem seems to be more complex—the data presented here are average values. If we analyze them more thoroughly, it is found that the differences in individual groups are greater if we compare deciles. For example, in group B in individual industries, for decile 1, the share of energy costs is at the level of 1–2% of the value of revenues, and for decile 9, it is 6–10%; thus, the differences are significant. Very similar levels are found in the group of the largest enterprises, i.e., in group D. Once again, the conclusion here is that energy efficiency results from the efficiency of company management.

On the basis of the obtained data, it is also possible to analyze changes in the share of energy costs in sales over recent years. Such an analysis was conducted for the smallest and largest companies (A and E), as presented in Tables 11 and 12.

Table 11. Medium and Large Entities (Employing < 9 People)—Group A.

Medium and Large Entities (Employing < 9 People)—Group A							
PKD	2017	2018	2019	2020	2021	2022	Change
10	1.4%	1.6%	2.1%	1.6%	1.6%	2.3%	66.7%
11	1.0%	0.9%	1.0%	1.0%	0.9%	1.5%	51.0%
13	2.0%	1.8%	1.8%	2.1%	2.4%	3.1%	55.3%
14	1.5%	1.4%	1.4%	1.4%	1.5%	1.9%	28.5%
16	2.7%	2.8%	2.9%	3.3%	3.2%	3.4%	27.5%
17	2.5%	2.3%	2.7%	2.8%	2.9%	4.1%	69.0%
20	2.6%	2.7%	3.2%	3.7%	3.3%	4.0%	54.8%
21	0.9%	1.2%	1.2%	1.0%	1.1%	1.5%	61.5%
27	0.9%	0.8%	0.9%	1.0%	0.9%	1.9%	114.9%
28	1.3%	1.3%	1.4%	1.5%	1.5%	1.8%	38.4%
29	0.8%	0.8%	0.8%	0.9%	1.0%	2.1%	160.8%
31	1.1%	1.3%	1.2%	1.3%	1.5%	1.9%	69.4%
Average change in group A							66.5%

Table 12. Large Entities (Employing > 250 People)—Group E.

PKD	Large Entities (Employing > 250 People)—Group E							
	2017	2018	2019	2020	2021	2022	2023	Change
10	1.4%	1.5%	2.4%	1.7%	1.7%	2.4%	2.8%	102.2%
11	0.9%	0.8%	0.8%	0.8%	0.7%	1.2%	2.1%	123.4%
13	1.5%	1.3%	1.2%	1.6%	1.6%	2.3%	2.5%	74.5%
14	2.1%	1.9%	2.0%	1.9%		2.7%	2.7%	29.8%
16	3.2%	3.3%	3.6%	3.9%	3.9%	4.2%	5.9%	86.2%
17	2.9%	2.7%	3.4%	3.3%	3.6%	5.3%	6.0%	105.9%
20	3.0%	3.1%	3.9%	4.5%	3.8%	4.2%	7.7%	153.1%
21	0.9%	1.2%	1.2%	1.1%	1.2%	1.5%	2.1%	133.7%
27	0.9%	0.8%	0.9%	1.0%	0.9%	1.9%	1.7%	98.8%
28	1.4%	1.4%	1.5%	1.7%	1.7%	2.1%	3.0%	109.7%
29	0.8%	0.8%	0.8%	0.9%	1.0%	2.1%	2.4%	219.7%
31	1.1%	1.2%	1.3%	1.4%	1.6%	2.1%	2.3%	106.3%
Average change in group E								112.0%

As the data in Tables 11 and 12 show, Polish companies, regardless of their size, are able to outpace the increase in energy prices. In small companies, the average increase in the share of energy consumption costs in 2022 was higher than in 2017 by an average of 66.48%, and in large companies in 2023, the difference was 111.95%. This is much less than the increase in energy prices in the Polish market, which was 111.2% in 2022 and 443.7% in 2023.

At the end of this section, the authors wanted to comment on the information presented earlier, which showed that energy costs of 10–30% seem exaggerated. Data from the PONT Info database seem to be closer to reality.

Perhaps the answer is that, in fact, the ranges are very wide. For example, according to studies conducted in Austria, the share of energy costs in the textile industry ranges from 5% to 20% [37].

Very interesting results were obtained by the authors by analyzing and estimating energy costs for the metal production industry (PKD 24). At the beginning of 2022, steel prices in Poland reached 950 PLN/tonne. According to the data obtained by the previously cited authors [24], energy consumption in the steel products industry is very diverse and amounts to 252.3–540.4 KWh per ton of steel. If we now assume that the price of energy in Poland is 345.8 PLN per MWh, the share of energy costs in the value of sales would range from 9.18% to 19.67%, which practically coincides with the data from the PONT Info database for “Production metals”.

For this reason, these data were also used by the authors to simulate the impact of energy costs on the profitability of listed companies analyzed in the previous sections. Data corresponding as much as possible to the type of activity and size of companies were used. The simulation results for the two industries are presented in the Tables 13 and 14.

It was found that, even with such a small share of energy costs, the change in these costs will also have a large impact on profitability. For example, in the chemical industry, increasing the share of energy costs in revenues from 3.8% in 2021 to 7.7% in 2023 results in profits falling from −53.3% (HUB.TECH) to −435.8% (POLWAX).

Similar results are found in other industries: in “Wood, paper and furniture”, the minimum decrease of −70.6% was in the case of KPPD and the largest (−146.8%) in the case of the KLON company.

Table 15 shows the average simulation results for all industries analyzed in this paper. The conclusions are similar: even if the share of energy costs in the sales value is only a few percent, the increase in energy prices has a significant impact on profitability.

Table 13. Simulation of the impact of changes in energy costs on the profitability of companies—chemical industry.

A Company	Energy Costs/Revenues			Profits Fall		
	Year	2021	2022	2023	2022	2023
HUB.TECH		3.8%	4.2%	7.7%	−29.3%	−53.3%
POLWAX		3.8%	4.2%	7.7%	−239.8%	−435.8%
PCC EXOL		3.8%	4.2%	7.7%	−58.7%	−106.6%
PCC ROKITA		3.8%	4.2%	7.7%	−58.7%	−106.6%
ZAKŁADY CHEMICZNE POLICE		3.8%	4.2%	7.7%	−120.2%	−218.4%
CIECH ZAKŁADY		3.8%	4.2%	7.7%	−50.1%	−91.0%
AZOTOWE PUŁAWY		3.8%	4.2%	7.7%	−110.5%	−200.8%
GRUPA AZOTY		3.8%	4.2%	7.7%	−105.9%	−192.5%

Table 14. Simulation of the impact of changes in energy costs on the profitability of companies—wood, paper, and furniture industry.

A Company	Energy Costs/Revenues			PROFITS FALL		
	Year	2021	2022	2023	2022	2023
BIOFACTORY		3.9%	4.2%	5.9%	−57.8%	−82.6%
STANDREW		3.9%	4.2%	5.9%	−89.2%	−127.3%
KLON		3.9%	4.2%	5.9%	−102.8%	−146.8%
EUROSNACK		3.9%	4.2%	5.9%	−106.1%	−151.4%
KOMPAP		3.9%	4.2%	5.9%	−71.4%	−101.9%
KPPD		3.9%	4.2%	5.9%	−49.5%	−70.6%
FABRYKI MEBLI FORTE		3.9%	4.2%	5.9%	−49.8%	−71.1%
ARCTIC PAPER		3.9%	4.2%	5.9%	−80.7%	−115.2%

Table 15. Simulation of the impact of changes in energy costs on company profits (average values for the industry).

Industry	KPD	The Share of Energy Costs in the Value of Sales			Change in Profits
		2021	2022	2023	
Chemical	20	3.8%	4.2%	7.7%	−96.6%
Wood, paper and furniture	16	3.9%	4.2%	5.9%	−75.9%
Electromechanical	28	1.7%	2.1%	3.0%	−133.9%
Rubber and plastics	20	3.8%	4.2%	7.7%	−39.3%
Automotive	29	0.9%	1.0%	2.1%	−28.5%
Clothing and cosmetics	14	2.1%	2.7%	2.7%	−50.3%
Drug production	21	1.2%	1.5%	2.1%	−13.7%
Food	10	1.7%	2.4%	2.8%	−73.0%

Despite the positive assessment of the data, according to the authors, further research is needed. While the data on the industry seem to be accurate, when attempting to broadly understand the logistics industry, they already raise a large number of doubts.

Table 16 presents data on the share of energy costs in the turnover of a company from the logistics industry, also obtained from PONT Info. Their levels are also very low, that is, a few percent. Meanwhile, from both the research conducted by the authors and other sources, the share of these costs is much higher; in road transport they oscillate around 40% and in sea transport they are 30–60% [2,38–40].

Table 16. Share of the energy costs in the revenues of companies in the logistics sector.

KPD	2021	2022	2023
49 LAND TRANSPORT AND PIPELINE TRANSPORT	4.3%	Group E 4.3%	7.7%
50 WATER TRANSPORT	Group A 0.2%	Group A 0.1%	Group D 0.9%
51 AIR TRANSPORT	Group A 0.1%	Group A 0.1%	Group D 0.1%
52 STORAGE AND SERVICE ACTIVITIES SUPPORTING TRANSPORT	Group E 1.4%	Group E 1.9%	Group E 2.6%

4. Conclusions and Policy Implications

Quite often in the scientific literature, in various types of publications such as expert studies, opinions are expressed that the share of energy consumption costs in relation to total costs or sales value is quite large, which leads to the conclusion that an increase in energy prices may cause a significant deterioration in the financial results of companies. According to some authors, the average share in the sales value of the processing industry may amount to several percent. According to other sources, energy consumption costs can reach up to 30%.

According to the authors of the paper, the actual ratio of energy consumption costs to sales is lower than that reported in many literature sources, at least in Poland. However, the increase in energy prices has a significant impact on the profitability of companies, and companies could be expected to suffer large losses due to the large increase in energy prices. However, this did not happen in the case of many companies. Perhaps Polish companies are very effective and efficient in responding to unfavorable changes in the environment. In fact, they have taken steps to reduce these costs or to pass them on to customers.

Actions taken by Polish companies in response to the increase in energy prices are primarily investments in renewable and alternative energy sources aimed at reducing energy consumption.

The authors analyzed the financial results of companies listed on the stock exchange in Poland in order to examine whether their profitability deteriorated in 2022 due to the increase in energy prices.

Mainly, manufacturing companies from various industries were surveyed. The analysis leads to several important conclusions:

- The share of technical manufacturing costs is very high in many industries, especially in the food industry. Therefore, assuming that the most energy is consumed in the production processes, such an increase in energy prices experienced by the economy in the previous year may actually have a significant impact on the financial results.
- The energy crisis also affected suppliers supplying these producers with materials or components for production. The costs of distribution of finished products also increased, as the rates for transport services increased in all branches of transport. Entire supply chains have been affected by rising energy prices.
- However, contrary to what it might seem, the profitability of only some producers (46%) has deteriorated. Half (53%) even improved their financial results. Only in 16% did the profitability decrease by more than 50%. Therefore, the authors believe that shares at the level of a few percent, and not a dozen or several dozen, are closer to reality.

The authors used data provided by the PONT Info company on the share of energy consumption costs in Polish companies from various industries and companies of various sizes. In addition, this analysis, similarly to the analysis of financial reports, leads to the conclusion that the “economy of scale” in large companies is not conducive to energy efficiency. The largest share of energy consumption costs was in the smallest and largest companies. In the literature, one can find views that technological progress may not be conducive to improving energy efficiency, because more advanced technologies require

more energy consumption. This may explain the reasons for the high share of energy consumption costs (group E).

On the other hand, the results of the conducted research show that large enterprises are the least willing to respond to the increase in costs by increasing prices. Clearly, however, large enterprises are the most efficient, even if they are relatively less energy efficient. Higher energy consumption is compensated for by lower production costs or logistics costs. Thus, economies of scale do exist. Nevertheless, there is a problem related to the impact of the functioning of companies on the natural environment. Higher energy consumption in large companies, even if it does not involve increased costs, means higher external costs. Large companies also have to operate in geographically larger markets, which is connected with the problem of the external costs of transport.

Companies also do not try to compensate for losses at the expense of employees and lower wages. This is most likely influenced by the situation on the labor market, i.e., the labor market (at least currently in Poland) is still an employee's market.

The surprising low impact of the increase in energy prices on the profitability of companies should, therefore, not be explained by the low importance of the level of energy consumption, but rather by the high level of adaptation of Polish enterprises to the changing conditions in their environment. Of course, the simplest way is to respond to rising costs by increasing product prices; this solution has also been chosen by many companies.

The results of research conducted by various institutions differ greatly in terms of the share of energy consumption costs, the impact on the profitability of enterprises, and actions taken by companies, e.g., depending on the industry or company size (investments, prices, employment, wages). Perhaps the given branches of the economy should still be divided into sectors (e.g., in the food industry, into production of dairy products and production of sweets). Very large differences in energy efficiency between companies, even within a given industry, seem to support the hypothesis that it is not the specificity of a given industry that is the most important factor here, but the ways of operating and managing the company, innovation, and involvement of both direct production employees and managers at all levels.

It seems that in the era of technical progress, automation, and robotization, the way of managing a given company, organization of processes, strategic decisions, and the human factor are still important. Thus, traditional factors still play an important role.

The explanation of the large diversification of the share of these costs can be explained by the management method implemented and management concepts. According to the research results, the implementation of Lean Management may result in the reduction in energy consumption costs from 15.1% to 72.37% [41,42].

However, it is difficult to draw any major conclusions at this stage. Further comprehensive research in this area is needed, which is one of the conclusions and recommendations of the authors of the paper.

Such studies are also needed because one can get the impression that there are large differences in the data presented in the literature regarding both the share of energy consumption costs in revenues and the reactions of companies to the increase in these costs. Therefore, they require verification.

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