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Energy Efficiency of Kazakhstan Enterprises: Unexpected Findings

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Abstract: The problems of efficient use of energy costs have been actively explored in recent decades in connection with rising energy prices. During this period, the main models for assessing energy efficiency and energy management were developed, including the models Total Quality Management, Six Sigma and Sustainable Value Stream Mapping. The aim of the research was to study the energy efficiency of the production and services in Kazakhstan based on materials of the large-scale national study on the estimation of production and transaction costs by these methodologies. To assess the data obtained, a statistical analysis of the dependence on the indicators of variation and ranking was used. Electricity costs are among the leading manufacturing costs and affect management models. However, according to the maturity model of energy management, energy efficiency in Kazakhstan is low. Despite the government's declarations of effective energy policies, the administrative burden for businesses remains high, and legislation does not stimulate a reduction in energy costs.

Keywords: costs; energy management; energy efficiency; Kazakhstan

1. Introduction

The problem of increasing energy efficiency is connected with the historical development of management systems. One of the purposes of industrial production management has always been to increase productivity. In periods when energy resources were cheap, electricity costs were an insignificant part of production costs and were an accounting item rather than an important management task [1]. Energy consumption was controlled by the accountant as part of overhead costs.

With rising energy prices, the share of energy costs in the value of the created product has increased significantly. It took a change in production processes to reduce these costs and energy management became part of the management system. This change was particularly evident in the development of European management in the last third of the 20th century [2]. During this period, an independent energy management area was formed, which is able to provide organizations with efficient use of production resources [3,4]. Having become part of the management system, energy management has been included in the solution of a wide range of environmental and social problems and has become an integral part of the organization's image [5,6].

We aimed to study the energy efficiency of enterprises in Kazakhstan [7]. In Section 2, we look at issues of improving energy efficiency in industrial systems and the relationship of energy efficiency with creating value for the client. Section 3 is devoted to the research methodology and description of the source data. Section 4 contains an analysis of the results, which are discussed in Section 5. General conclusions are drawn and prospects for future research are determined in Section 6.

2. State of the Art

2.1. Increasing of Energy Efficiency of Industrial System

Improving the energy efficiency of enterprises plays an important role at all management levels. At the national and regional levels, efficient use of energy helps to ensure a territory's energy independence and often ensures its political independence. The ability to create a product with fewer resources, including energy, allows organizations to increase customer satisfaction and increase their own competitiveness. Combining the interests of the state and business in improving energy efficiency has allowed the creation of a set of energy management tools.

Based on modern research, three categories of energy management tools were identified: compulsory, incentive, and educational.

- Let us include legal norms of legislative regulation of business entities into the compulsory measures. Their implementation is possible in countries with an established legal culture of population and business representatives, for example, in the countries of the European Union. In EU, such regulations are gradually evolving on the basis of national technical regulations (e.g., UNI-CEI-EN 16001: 2009), which are being transformed into supranational standards (EN 15900 and ISO 50001). At the international level, we can cite the example of the Kyoto Protocol (localized in Europe by Directive 2006/32/CE), which declares the need to clearly define goals, mechanisms, and incentives aimed at improving energy efficiency of national enterprises of the signatory states.
- Incentive events involve exposure to the manufacturer. In countries that actively use this method, financial incentive instruments as well as PR tools are used. It must be recognized that the domestic market of Kazakhstan is quite limited, which makes it less attractive for international companies with high labor productivity, protecting this way national producers. However, national producers need to increase labor productivity by improving the quality of the workforce. Kazakhstani workers and specialists still do not have the necessary competencies to generate internal resources for productivity growth and cost reduction.
- Educational methods imply an impact directly on the consumer, the formation of a new consumer culture based on careful environmental management, and a conscious choice of energy-saving technologies. In turn, consumer demand determines that supply—manufacturers—introduce "green" solutions to meet the wishes of customers.

Moreover, high complexity of sectoral energy systems becomes an objective barrier to energy efficiency growth in the industry. Production systems of industrial facilities with auxiliary components are not standardized and may differ significantly one from each other. This creates obstacles to creating generalized solutions and therefore does not allow for economies of scale. It also prevents and even leads to refusal of implementing potentially feasible energy-saving technologies [8]. The individual features of some energy-efficient technologies also prevent their implementation at industrial facilities [9].

Companies are constantly improving their production and management optimization processes. Industrial companies lack accessible and effective methods to address energy efficiency issues in production management. Six Sigma, Lean Manufacturing, and Total Quality Management are popular concepts used in many industries around the world, but each of them does not pay due attention to energy efficiency and environmental issues. Bunse et al. [3] suggested that future research should give preference to new control concepts, new visualization approaches, and evaluation methods in order to integrate energy efficiency into production management.

Thanks to the British government, companies use the "Matrix of Energy Management" [10], which makes it possible to understand and evaluate existing energy use patterns that track and measure future improvements and identify energy saving opportunities. The matrix is a five-level structure, which is analyzed on the basis of six main directions of energy management: energy policy, organization commitment, information systems, marketing, and investment. It enables companies to conduct self-assessments through analysis, identify areas for the development of energy management, and formulate measures for improvement not directly related to international standards.

Singh et al. [11] asserted that successful continuous improvement provides many opportunities to achieve the reduction of production cost while simultaneously growing client satisfaction. Ni et al. [12] found that continuous improvement positively influences organizational learning and leads to overall performance improvements. However, studies have found a time gap between continuous learning and improved efficiency. Jeyaraman et al. [13] in turn showed that staff responsibility, strong leadership, and access to relevant data are the main drivers of successful continuous improvement. Albliwi et al. [14] confirmed to a certain extent this conclusion by summarizing the factors of failure to create, maintain, and develop continuous improvements in enterprises, among which the main factors were the lack of committed management, insufficient communication, and insufficient training of operators.

The energy efficiency of the system can be increased through a holistic approach, where the study of individual components and functions is accompanied by the study of production systems and their external and internal customers. One of the possible strategies to find solutions that improve the effectiveness of the system is Value Stream Mapping (VSM). However, according to Faulkner et al. [15], the usual VSM methods do not count how energy contributes to value creation because they do not account for energy flows. Efficient energy management requires not only identification and use of a methodological approach, but also knowledge of energy efficiency methods and tools [16,17].

Svensson et al. [18] showed that modern VSM models underestimate the importance of the energy aspect, and there have been few studies and proposals for adding energy aspects to VSM [15]. Therefore, Alvandi et al. [19] argued that VSM does not take into account energy and resource consumption from a system-wide perspective, as it is limited to presenting the flow of a product family or individual product.

Modern companies realize that energy management is an effective tool for improving overall production efficiency, not just reducing energy costs. This approach is reflected in the provisions of ISO 50001, which describes the global energy management standards in force since its adoption in 2011.

The development of energy management required clarification of the applied concepts of "energy efficiency" and "energy conservation". Energy conservation is the process of reducing energy consumption through less consumption. It is a quantitative method of energy management aimed at reducing non-productive losses. Energy efficiency determines the quality of control by estimating the ratios of input resource to energy flow and result to energy consumption [20]. The task of energy management in this case is to obtain the maximum effect from each unit of energy consumed [21,22].

Over time, changes in the external environment have generated several economic and political factors that have changed the paradigm of managing energy costs. Multiple increases in energy prices were accompanied by increased public attention to environmental issues. As a result, the world community has moved towards the European Union's Greenhouse Gas Emissions Trading System (EU ETS) and the promotion of end-use optimization programs. To maintain their strategic competitive position, producers of industrial products with energy-intensive industries (oil and gas, metallurgical, etc.) had to move to a qualitatively new level of energy management.

In recent decades, significant progress has been made in the development of industrial energy management, but the overall level of energy efficiency remains inadequate. Researchers note that there is a significant potential for the introduction of already developed technologies to ensure high profitability of their implementation. However, a significant "energy efficiency gap" between the achievable and real levels has been formed [23]. Several studies focus on organizational "non-technical improvements", the implementation of which further increases the energy efficiency potential and widens the gap with the real level [24].

In the fight against global warming, the most important means is to improve energy efficiency in the industrial sector. In turn, industrial production thus increases the competitiveness of production and ensures sustainable development [25].

Even though energy management has proved to be effective in ensuring profitability, in real production practice, methods of direct restriction of energy consumption are still used rather than system control of its use in product creation. In general, industrial enterprises, having defined the limitations of direct saving methods, have moved to a more systematic approach to reducing losses, changing consumption principles and methods of energy flow management. Piper wrote thatm in "the past twenty years, energy management has repeatedly demonstrated itself as one of the most cost-effective ways to increase profitability" [26].

The problem of energy management as an independent and important part of the management system is especially topical for production enterprises, where 85% of the energy consumed is used to create a production processes [27]. The development of energy management was formed in the directions of evaluation of programs and practices of energy audit [28,29], development and evaluation of programs and measures for industrial end-use energy policies, benchmarking energy efficiency, and optimizing the power system or processes through statistical modeling [30].

Here are a few more definitions of energy management: "Energy management is considered as the proactive and systematic, coordination of procurement, conversion, distribution and use of energy within a company, aiming on continuously reducing energy consumption and related energy costs" [31]; "To us, energy management is: The efficient and effective use of energy to maximize profits (minimize costs) and enhance competitive positions" [32]; and "In our research we define 'energy management in production' as including control, monitoring, and improvement activities for energy efficiency" [3].

Energy Management (EM) is the smart and efficient use of energy to maximize profit and strengthen competitive position. According to Petrecca [33], "energy management means ensuring that users receive all the necessary energy, when and where it is needed, as well as the required quality, delivered at the lowest cost". The separation of energy management into an independent management function has finally taken shape in the last two decades according to Capehart et al. [34]. Of course, this goal should be achieved while ensuring adequate safety for both production and environmental needs. Thus, the ultimate goal of energy management is the most efficient and effective use of energy supplied [26], which affects not only the supply and distribution of energy, but also its final usage. Energy management requires a systematic and ongoing approach, and it should not be confused with programs or projects that are time-limited, as noted by Piper [26].

2.2. Connection of Energy Efficiency with Value Engineering for Customer

Energy management is developed on the basis of integration of the general management theory, quality management concept, and other modern methodological approaches of economic theories [35,36]. In the application of energy management in production, the decisive role is played by the presence of a leader who consistently conducts the program of increasing the efficiency of energy use [37]. However, an administrative solution along will not ensure success; energy management programs provide for the participation of all members of the organization [38]. Large organizations consuming a significant amount of energy resources, as a rule, form special teams ensuring implementation of energy-saving programs [39]. Support of a leader from among top managers will ensure the efficiency of such team [40].

Modern management increases the value of a product by attracting consumers to create it at all stages of the value chain [41,42]. Different customer requests for consumer value generate different energy demand, which is not considered an important part of the process, since it does not generate revenue, but only reduces costs [43].

Traditional VSM models do not sufficiently take into account energy management capabilities, but Faulkner and Badurdeen included environmental factors and expanded the model to the Sustainable Value Stream Mapping (sus-VSM) format [15].

The sus-VSM model uses visual methods to evaluate the results of measuring energy consumption. Application of the model provides identification of the part of processes that consume significant energy resources, which allows further improvement of its use without compromising the creation of consumer value. However, modern sus-VSM still does not sufficiently take into account environmental and social factors and consumer needs. The lack of a clear methodology limits the widespread use of the model in various industries, since the inclusion of additional indicators in a number of production systems makes it more difficult to use visual maps. Faulkner and Badurdeen [15] recommended further studies using the sus-VSM method for various configurations of production systems to assess their suitability for use and identify problems in assembly and data analysis.

The development of energy management methods will increase the involvement of consumer requests in the processes of improving energy efficiency.

Historically, the formation of the existing structure of the electric power industry of the Republic of Kazakhstan and economic relations in it was determined by the goal of preserving the potential of the industry and its further development. In the period of transition of the economy to market relations, since 1995, the privatization of the main electric power facilities and the restructuring of the industry have been carried out. The reform of the electric power sector has led to a change in the form of public administration of the industry. Electricity transmission is carried out through the national electric network, by the state company "KEGOC" JSC. The national electric network consists of a set of substations, switchgears, and inter-regional and interstate power lines with a voltage of ≥35 kV. Electricity production in the country is carried out by 138 powerplants (including renewable energy facilities) of various forms of ownership, most being private. Electricity distribution in Kazakhstan is carried out by 18 regional energy companies (RECs) and about 150 small transmission companies that control regional-level electric networks with a voltage of 0.4–220 kV.

3. Materials and Methods

3.1. Kazakhstan Energy Data

The program of the Government of the Republic of Kazakhstan "Energy Conservation—2020" provided for a reduction in the energy intensity of the gross domestic product by at least 40% by 2020 from the 2008 level. However, no significant improvement was achieved, about 100 energy conversation projects were implemented annually, and the program was canceled [7]. In terms of energy intensity, Kazakhstan's Gross Domestic Product (GDP) is 119th of 143 countries.

Since 2012, Kazakhstan has passed a series of legislative acts defining the basic requirements in the field of energy efficiency. Currently, the law "On Energy Saving and Improving Energy Efficiency" is the main document. By 2020, the energy intensity of GDP should have decreased by 40%, but the government's goal was not met. Given the conditions for the availability of cheap fuel and maintaining low tariffs for electricity and heat in Kazakhstan, energy conservation measures require significant investments and have relatively long payback periods. The main task of the state in achieving its goals to reduce the energy intensity of GDP is to create an effective legislative framework with the aim of stimulating energy efficiency in energy-intensive sectors of the economy. According to the data of Ministry of Energy of Republic of Kazakhstan, the annual increase in electricity consumption in the republic is about 5%, while industry accounts for 58% of the consumption.

In 2017, a large-scale national study was conducted in Kazakhstan to assess production and transaction costs by the methodology Standard Cost Model (SCM), which was developed [44] to provide a simple and reliable method for assessing administrative costs incurred by government and individual departments to determine the magnitude of administrative barriers and measure the impact of reduction policies on them. SCM is designed to measure the administrative consequences of established regulation and requirements for enterprises. SCM does not aim to answer whether the barrier is justified—it gives an answer about how much it costs the business. The essence of SCM is to divide regulation into its constituent parts in the form of so-called "information" (that is, requiring the provision of information to authorities or other parties) obligations or requirements and administrative actions for their implementation. In addition, the time spent on individual operations are operationalized and evaluated. The total amount of time translated into money through labor and overhead costs gives the cost of the barrier from the standpoint of administrative costs.

The study examined the possibility of reducing the level of influence of state regulation om existing business relations with natural monopolies and the quasi-public sector. The tasks noted are an integral part of the energy management content, which allowed the authors to use the data of the primary research for secondary processing and analysis of the efficiency of energy costs at enterprises and organizations in Kazakhstan.

3.2. Methods

The methodology of this national study is presented in detail in an open publication [45]. The sample of research objects was 2,963 organizations, which provides a probability of 97% and a sampling error of 2% from the total population of 1,185,163 business entities. Sector quotas were carried out on the basis of GDP share, since costs are part of the final cost of the product.

As part of the study, a mass survey was conducted where 5,546 subjects were interviewed: owners, managers, and accountants. The sample corresponded to the planned probability level of 97%. The survey form contained open and closed assessment questions on the Likert scale. Based on a mass survey, the impact of costs on energy supply for enterprises was assessed using the following rating scale: "costs did not change", "increased (up to 10%)", "increased very (10–20%)", "grew very much by 20–30%", "critically increased from above 30%", and "I find it difficult to answer" (Table 1).

Table 1. The share of organizations with a growth in production costs of more than 25%.

№	Costs	Manufacturing Sector	Services Sector
1	Raw materials	48	33
2	Salary of production workers	31	23
3	Salary of auxiliary workers	18	16
4	Depreciation	37	20
5	Auxiliary materials	22	14
6	Social package for workers	15	11
7	Fuel	50	27
8	Transportation	38	22
9	Electricity	39	35
10	Heating	26	34

Source: [7].

Electricity costs and transaction costs for energy supply monopolies are among the most significant for the economy of the republic. Kazakhstani managers point out that rising energy prices are a serious problem for business development. According to Kazakhstan managers, a significant problem for business development is primarily the rising prices for fuels and lubricants, energy, and raw materials. More than a third of respondents called energy supply costs a serious obstacle to current activities in industry and services. The scale of the answers allowed us to name the urgent problem of managing these costs and consider them as part of the broader problem of inefficient energy management.

The authors investigated the formation of energy management efficiency as control systems at various levels (see Figure 1).

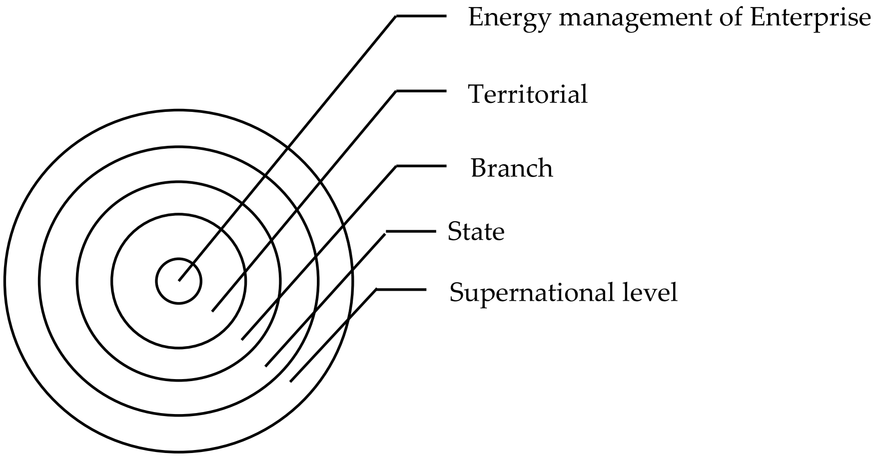

Figure 1. Schematic representation of energy management levels. Source: personal elaboration.

The level of energy costs was formed under the influence of factors of all levels. Each energy management level has a specific set of influence tools (Table 2).

Table 2. Energy Management Levels.

Levels	Factors and Instruments of Influence
Supranational	Dominant and innovative technologies, global market conditions, international agreements (quotas, norms, sanctions, etc.)
State	Laws, standards, tariffs, energy and environmental policies, social programs
Branch	The existing infrastructure, industry-specific management models, internal cooperation.
Territorial	Territorial infrastructure, resource availability, local statutory regulation
Enterprise	Production technology, control system

Source: personal elaboration.

Energy management problems become more acute when assessing their effectiveness at various levels.

At present, the state manages the electric power industry through such levers as licensing, setting limit tariffs, regulating the activities of natural monopolies, etc. From the beginning of 2019 in Kazakhstan, along with the electric energy market, there is an electric power market. The tariff is divided into two components:

- The electricity tariff is a variable part that will provide a recoupment of costs for the production of electric energy.
- The capacity tariff is the permanent part, which will ensure the return on investment in the construction of new powerplants, while updating, modernizing, reconstructing, and expaning the existing ones.

However, the average levels of energy supply costs that have formed in various regions of the country show the heterogeneity of the implementation of state policy (Table 3).

Table 3. The share of electricity costs in the total cost structure (%).

Regions	**Akmola region**	**Aktubinsk region**	**Almata region**	**Atyrau region**	**West-Kazakhstan region**	**Zhambyl region**	**Karagnda region**	**Kostanay region**
Portion	5.7	6.5	5.6	9.7	7.5	2.5	10.1	7.7
Regions	**Kyzylorda region**	**Mangistau region**	**South-Kazakhstan region**	**Pavlodar region**	**North-Kazakhstan region**	**East-Kazakhstan region**	**Astana city**	**Almaty city**
Portion	9.1	8.7	8.0	15.9	4.6	5.7	5.1	2.8

Source: personal elaboration.

The spread of electricity costs is significant across the republic. The average value of the indicator for manufacturing enterprises is 7.2%, with a range of variation of 13.4% (R = Xmax − Xmin = 15.9 − 2.5 = 13.4). In the most energy-intensive industrial region of Pavlodar region, where energy-intensive metallurgical production is located, the average cost of electricity is 15.9% of the cost structure. The lowest indicator −2.5% falls on the Zhambyl region with low volumes of industrial production.

Graphical analysis involves checking the normal distribution, which would be characteristic for the implementation of a unified energy management policy in the republic (see Figure 2).

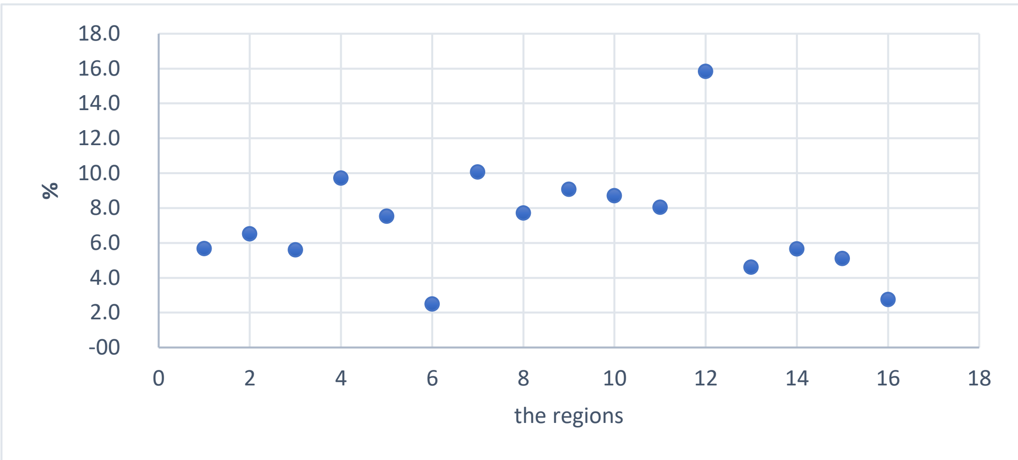

Figure 2. Distribution of the average share of energy costs across the republic (%). Source: personal elaboration.

To assess the degree of difference in the territorial significance of energy costs, standard indicators of variation were calculated.

Coefficient of variation—as a measure of the relative spread of the values of the population—shows the ratio of the standard deviation to the mean.

$$v = \frac{\sigma}{\overline{x}} = \frac{3.136}{7.2} 100\% = 43.56\%, \quad (1)$$

Each value of the series differs from the average value of 7.2% by an average of 3.136%. Since the coefficient of variation is within 30% < v < 70%, the variation is moderate. The presence of moderate variation may indicate the presence of a single (state) policy in the field of energy supply management. However, such national energy management is not efficient enough, which creates an asymmetry of indicators. The degree of asymmetry determines the moment coefficient of asymmetry.

$$As = M_3/S^3, \quad (2)$$

where M3 is the central moment of the third order, S is the standard deviation.

$$M_3 = 482.38/16 = 30.15,$$

$$A_s = 30.15/3.1363 = 0.977$$

A positive value indicates a right-handed asymmetry. The right-sided asymmetry of the values of the share of energy costs indicates a shift in costs towards their increase, which may arise due to insufficient efficiency of state energy management, which increases costs due to an increase in the administrative burden. In the future, this assumption should be checked, including the possibility of corruption.

The industry level of energy management was considered separately for production and services. The industry-wide assessment of the level of influence of energy costs in production is presented in Table 4.

As noted above, electricity costs are in the top 10 costs of industrial enterprises. The share of the item "electricity" in the total cost structure of manufacturing enterprises also has a spread from 6.2% to 10.5% in the processing of agricultural products. However, graphical analysis suggests the proximity to the normal distribution and the relationship between cost increases and the assessment of the strength of influence on the management model (Figure 3).

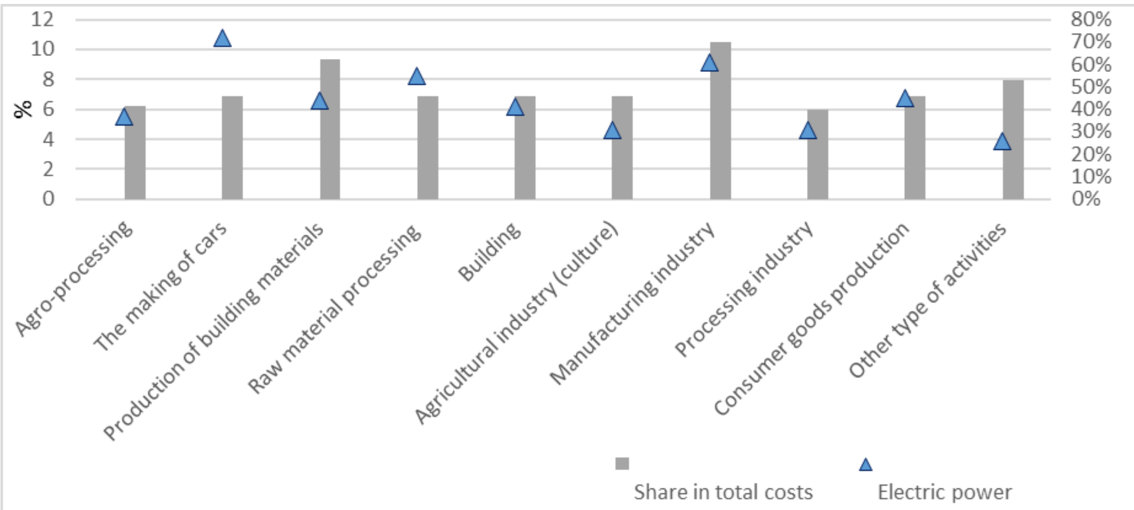

Figure 3. Effect of energy costs in production.

Note that the impact of the cost item was assessed according to the responses of managers who indicated that the cost of electricity at their enterprise increased by more than 25% and had a significant impact on the production process. Respondents' answers are a subjective assessment but reflect the effectiveness of production management models that can regulate the overall cost structure and production efficiency.

Table 4. Sectoral assessment of the level of impact of costs on electricity (production).

Electricity Costs	Agro-Processing	The Making of Cars	Production of Building Materials	Raw Material Processing	Building	Agricultural Industry (Culture)	Mining Industry	Processing Industry	Consumer Goods Production	Other Type of Activities
Portion of cost summary,%	6.2	6.9	9.3	6.9	6.9	6.9	10.5	6.4	6.9	7.9
Portion of answers affects strongly and more, %	37	72	44	55	41	31	61	31	45	26

Source: personal elaboration.

The relationship between the opinions of managers and the share of costs was checked using Spearman's rank correlation coefficient.

Since among the values of the signs x and y there are several identical ones, i.e., related ranks are formed, in this case, the Spearman coefficient is calculated as:

$$p = 1 - \frac{\sum\ 6d^2 + A + B}{n^3 - n}, \quad (3)$$

where

$$A = \frac{1}{12} \sum\ (A_j^3 - A_j)$$
$$B = \frac{1}{12} \sum\ (B_k^3 - B_k)$$

j is the number of ligaments for characteristic X.

A_j is the number of identical ranks in the jth connective along X.

k is the number of ligaments for characteristic Y.

B_k is the number of identical ranks in the kth bunch according to U.

$$A = [(53 - 5)]/12 = 10$$

$$B = [(23 - 2)]/12 = 0.5$$

$$D = A + B = 10 + 0.5 = 10.5$$

$$p = 1 - \frac{6 \times 112.5 + 10.5}{10^3 - 10} = 0.308$$

The calculation shows that the connection between the attribute Y and factor X is weak and direct.

The presence of a direct, but weak connection shows that, in production, an increase in electricity costs and an increase in their share in the total cost structure leads to the need to change production management models. However, the specifics of production are such that, in the value chain, energy is an input resource and is involved in the process of creating a product at the initial stage. The increase in the cost of electricity in production falls on the total costs and in the future the negative impact is smoothed out either by increasing the price or by adjusting the costs at the subsequent stages of the chain.

4. Results

Processing interviews with Kazakhstani managers shows that they do not consider energy saving at the production stage as a priority task of developing production and increasing its efficiency. The model of Kazakhstan's energy management at the enterprise level can be assessed as passive.

An assessment of the level of impact of electricity costs in the services sector is presented in Table 5 and differs significantly from the situation in production.

The authors believe that in the service sector a fundamentally different role is played for electricity costs in the value chain. Due to the specifics of the service (it is impossible to save, separate from the consumer, etc.), electricity consumption is necessary at almost all stages of the chain. Different types of services require a different share of energy costs and fundamentally different energy management models are implemented. Graphical analysis also shows differences and contradictions in assessing the strength of the impact of rising energy costs in various types of services (Figure 4).

Table 5. Branch assessment of the level of influence of cost items (services).

Electricity Costs	Transport, Logistics	IT	Trading	Public Catering	Health Care	Art, Fun, Relaxation	Accommodation and Food Services	Finance	Real Estate Operations	Other Type of Activities
Portion of cost summary, %	5.2	13.8	9.3	5.7	6.9	7.2	6.9	6.9	6.9	6.3
Portion of answers "affects strongly and more", %	33	14	26	57	36	51	58	24	19	38

Source: personal elaboration.

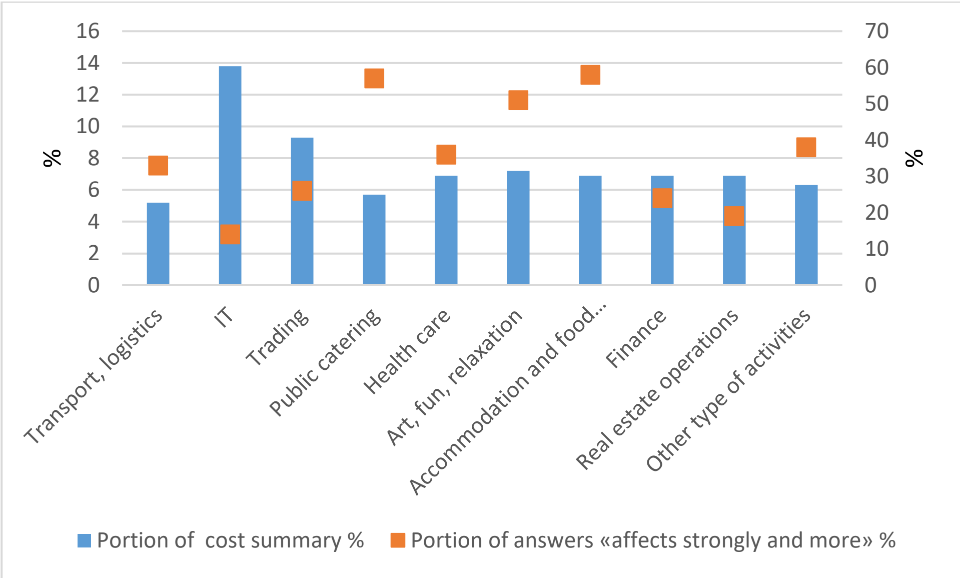

Figure 4. The impact of energy costs in the service sector. Source: personal elaboration.

The relationship was also checked according to the Spearman rank correlation criterion (see Table 6).

Table 6. Ranking by Y and factor X.

X Portion of Cost Summary, %	Y Portion of Answers "Affects Strongly and More", %	Rank X, d_x	Rank Y, d_y
5.19	33	1	5
13.78	14	10	1
9.3	26	9	4
5.67	57	2	9
6.94	36	4	6
7.2	51	8	8
6.94	58	4	10
6.94	24	4	3
6.94	19	4	2
6.33	38	3	7

Source: personal elaboration.

Since among the values of the signs x and y there are several identical ones, i.e., related ranks are formed, in this case, the Spearman coefficient is calculated as:

$$A = [(43 - 4)]/12 = 5$$

$$D = A + B = 5$$

$$p = 1 - \frac{6 \times 226 + 5}{10^3 - 10} = -0.375$$

Calculations showed that the relationship between trait Y and factor X is weak and inverse. In a number of types of services, an increase in the share of electricity costs does not lead to a strong influence on the overall business efficiency. IT services have the largest share of energy costs in the overall cost structure, but their management is such that they are less concerned about the growth of these costs. At the same time, public catering has a rank of 2 in terms of costs, but in assessing the impact a rank of 9. In this type of service, energy supply is involved at all stages of the value chain from cooking to creating conditions for consumption.. The cost of electricity in this type of service is not so high in terms of the share of total costs, but catering management is energy-sensitive. A similar situation exists in the field of accommodation services.

In general, the energy management of Kazakhstan's business services sector is more heterogeneous than in production. Non-volatile control models and energy-sensitive models are used, where electricity takes part in the chains of creating the material and emotional value of the service. Such industries (food, accommodation, and recreation) have not yet developed an effective energy management model.

Energy management at the enterprise level is formed not only under the influence of industry or territorial factors, but is also largely determined by the dimension of the business. During the study, an assessment was received of 83 microbusiness entrepreneurs, 817 small businesses, 348 medium-sized enterprises, and 100 large business companies. Electricity costs have a steady tendency to decline in proportion as the enterprise grows. The share of electricity costs in large business is three times less than at the initial stage of development, i.e., in microbusiness (Figure 5).

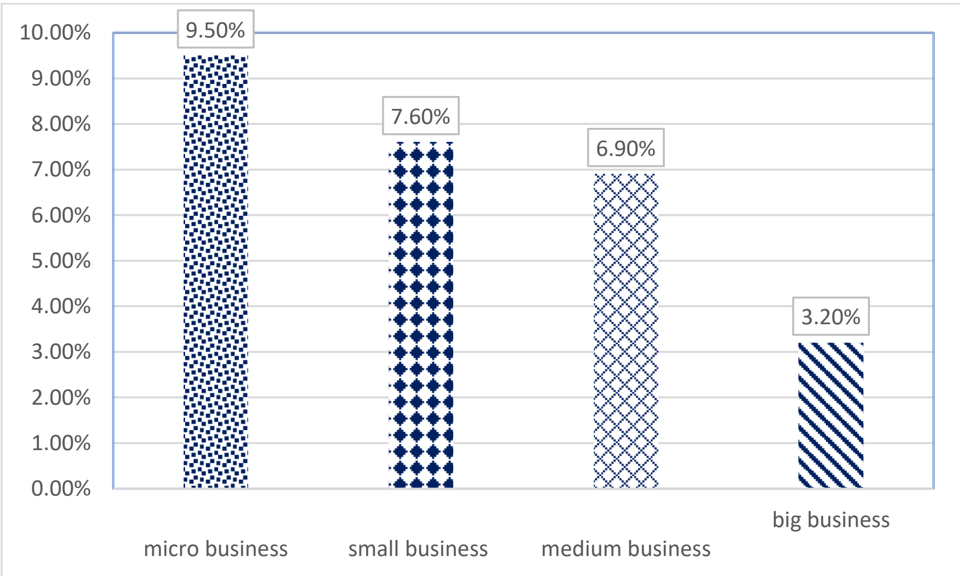

Figure 5. The portion of electricity costs for a business of various sizes. Source: personal elaboration.

5. Discussion

As the study showed, for small businesses, the cost of electricity is more significant, because enterprises do not have efficient energy management models. Large enterprises build their own energy management models taking into account international experience and global influence factors. The state provides for the requirements to introduce energy management systems in enterprises consuming more than 1050 tonnes of oil equivalent per year, while ISO 50001 was chosen as the main energy management standard, for which the corresponding state standard was adopted and approved.

Small-and medium-sized enterprises need help in mastering energy-saving models. According to the estimates of Kazakhstan Institute for the Development of Electric Power and Energy Saving (JSC), on average, enterprises can reduce energy consumption by 10% by budget organizations and small businesses up to 40%.

In addition to direct production costs, enterprises in Kazakhstan bear the additional administrative burden of providing electricity. In the Doing Business—2019 rating, Kazakhstan took 67th place [46] in terms of connection to the energy supply system. Every fourth entrepreneur noted the strong impact of cost costs in obtaining permits from the state (monopolists and the quasi-public sector) and in the process of state control. Our studies show that, in addition to the costs directly related to the payment of energy consumption services, business entities have to bear serious financial costs for obtaining additional services of monopolistic enterprises.

In the course of a survey of specialists from companies conducting financial and/or accounting, the following types of additional services of natural monopolies holder (NMH) in the energy sector were found and analyzed:

- connection (disconnection) of electrical installations to electrical networks of energy-transmitting organizations;
- connection to heat networks of an energy transmission (energy producing) organization;
- connection of electrical installations to electric networks of energy-transmitting organizations of NMH according to the requirements reflected in the technical conditions of NMH;
- connection of heat consumption systems to heat networks of a power transmission (energy producing) organization according to the requirements of technical conditions for connecting heat energy consumers issued by NMH;
- obtaining permits from NMH when carrying out work related to changing the electricity metering scheme;
- payment of the costs of extraordinary verification of a commercial meter for electric energy for connection (if the consumer is disconnected for violation of the terms of the power supply agreement);
- payment of the costs of extraordinary verification of a commercial water meter and connection (if the consumer is disconnected for violation of the terms of the contract);
- payment of costs for the extraordinary verification of a commercial meter for thermal energy and for connection (if the consumer is disconnected for violation of the terms of the heat supply agreement); and
- costs associated with obtaining information about the availability of free capacities of natural monopolies (information costs for electricity, heat, and water).

The administrative burden for energy is not only an extensive list, but also a large variation in prices for similar services. The authors carried out a secondary grouping of the cost of services for connecting to the elements of the electric grid infrastructure (Figure 6).

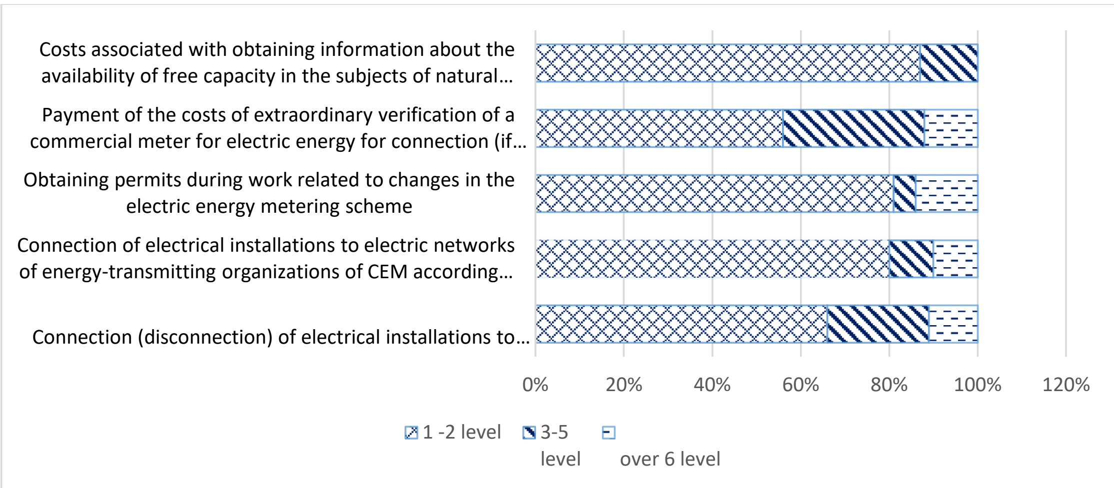

Figure 6. Cost of services for connecting to elements of the power grid infrastructure. Source: personal elaboration.

Data on the cost of services were brought to six conditional levels. The first level at the time of the assessment was 20 thousand tenge (equivalent to 64 dollars at the rate in April 2017). The third level is from 300% to 500% of the first level, while the sixth level includes costs exceeding the initial level by six times or more. According to the article "Obtaining permits from NMH when carrying out work related to changing the electricity metering scheme" for 10% of entrepreneurs, marginal costs were 35 times higher than the services that 80% of enterprises received at the base cost.

We did not set a special goal to investigate the problem of corruption, but Petrenko et al. [45] indicated the significant role of corruption in the economy of Kazakhstan. A special role in this context is given to the energy sector, in which corruption can reach 75%. To a large extent, for this reason, a significant gap in the cost of similar services across territories and entities is noted not only by the low level of energy management, but also contains a corruption component. The study identified the costs of enterprises associated with corruption costs (Table 7).

Table 7. Corruption costs.

Transactional Corruption Costs	Answers "Affects Strnogly". %	
	Production	Services
Bribery to the officer of state	13%	16%
Bribery to the bank representative of the second level	10%	13%
Bribery to the representative of natural monopoly holder (NMH)	10%	9%

Source: personal elaboration.

The costs incurred by enterprises under the article "Obtaining permits from NMH when carrying out work related to changing the electricity metering scheme" averaged 277.5 thousand tenge (890 dollars) according to the calculations for the year; 446.5 thousand entities used the service and incurred cumulative costs of 123.9 billion tenge (397 million dollars). According to experts, this service should be completely canceled. Connection (disconnection) of electrical installations to electric networks of energy-transmitting organizations on average in the republic costs 183.3 thousand tenge (588 dollars); it was proposed to reduce it by 50%, which would lead to a reduction in costs of 41 billion tenge (131 million dollars).

According to the maturity model of energy management [47], the matrix indicators—"Awareness, knowledge, and skills", "Methodological approach", "Energy characteristics of leadership", "Organizational structure", and "Strategy and alignment"—at the first level are described by the values "fragmented" and "does not exist." The second level of the energy matrix of maturity is characterized by "Appointment of a person responsible for energy" and "Definition of policy and public information campaign".

According to the results of the study, it is obvious that Kazakhstan companies can be considered as being at the first (Initial) or, for larger organizations, possibly at the second (Occasional) level (see Table 8).

The government of Kazakhstan also sets mutually exclusive tasks in the current period: frontal reduction of costs while replenishing the budget. It is obvious that for state executive bodies the need to replenish the budget will always be a priority and therefore motivates the fiscal authorities to impose finesand other penalties in every possible case, which places an additional burden, especially on small- and medium-sized businesses. "The Energy Conservation—2020" program, which sets ambitious goals and whose adoption in 2013 was widely reported in the media, was relatively quietly canceled already in 2016, which may indicate both the lack of development of the program itself and its objective inefficiency.

In these conditions, to increase the energy efficiency of national companies, there is a need to review the regulatory framework and enforce the abolition of all unsustainable penalties that impede business development, since they are not only a financial burden, but also a psychological barrier.

Table 8. Levels and dimensions of maturity in EMMM.

Level	Maturity Measurement				
	Awarness, knowledge, skills	Methodological approach	Energy characteristics of leadership	Organizational structure	Strategy and alignment
5	Optimized	Optimized and used	Optimized and used	Optimized and used	Optimized and used
4	High-technology	Energy management system used	Improved, Stable and Used	Improved, Stable and Used	all justification
3	considerable progress	project-based approach in usage	Standardised and used	project organization	Considerable progress (general progress)
2	Basic	Random Identification Intervention	Basic	Appointment of a responsible person for the energy sector	Policymaking and Public Information Campaign
1	Segmental	It does not exist	It does not exist	Scattered (nonexistent)	It does not exist

Source: [47].

Thus, the conclusions obtained in this article suggest a further study of the resulting phenomenon, which is characterized by:

1. Small business interest in developing energy management and improving corporate energy efficiency.
2. The declarative interest of the state and a small movement in the real implementation of the model of energy management systems (ISO 50001: 2011), which is a guide for organizations. Additionality in the world division of labor, world trade and, therefore, global competition suggests the possibility of further research on obtaining non-trivial conclusions for national enterprises.

6. Conclusions

The national economy of Kazakhstan is characterized by high energy intensity. The main gross product is created in the sectors of mining, oil and gas production, and metallurgy. Labor productivity in industry remains low, and the state protects domestic producers by various measures. It must be recognized that the domestic market of Kazakhstan is quite limited, which makes it less attractive for international companies with high labor productivity, thus protecting national producers. However, national producers need to increase labor productivity by improving the quality of the workforce. Kazakhstani workers and specialists still do not have the necessary competencies that can generate internal resources for productivity growth and cost reduction. Therefore, rational management practices are needed to maintain long-term energy efficiency gains. The GDP of Kazakhstan is produced with unreasonably high energy costs. There are significant and clear opportunities to reduce energy consumption in industry, transport, and utilities. In this context, Kazakhstani business lacks the necessary level of productivity to compete internationally. Therefore, any increase in costs not absorbed by productivity growth puts enterprises at risk and, when significant, has a negative impact on the national economy. In turn, the task of productivity growth lies in the plane of technological restructuring of production. As long as production uses obsolete tangible assets, productivity will be low and costs excessive. Kazakhstani industry needs renovation of fixed assets and the government should stimulate introduction of modern energy-saving equipment.

The materials in this article expand the analysis of previously conducted studies that determined that research on production costs should be conducted separately by industry [45]. A significant part of production energy costs is unproductive. Sale of energy on the Kazakhstan market is carried out on a monopoly basis by quasi-public suppliers on an overestimated tariff [48].

The Government of Kazakhstan in the current period sets mutually exclusive tasks: frontal cost reduction and budget replenishment. The need to replenish the budget motivates fiscal authorities to impose fines, and other penalties in every possible case, and this places an additional burden, especially on small- and medium-sized businesses. It is necessary to revise the regulatory framework and abolish all irrational penalties that impede the development of a business at such a critical time, being not only a financial burden, but also a psychological barrier.

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