Chapter 2
The Critical Recommendations for Providing Energy Efficiency

Laura M. Baitenova, Lyailya M. Mutaliyeva, and Fi-John Chang

Keywords Development · Ecosystem · Economic growth · Energy technologies · Clean energy

2.1 Introduction

Despite the widespread introduction of the international standard in the field of energy management systems, which regulates the basic principles and aspects of systems operation, there is an urgent need to develop methods and approaches for its implementation in the context of continuous modernization of fixed assets of metallurgical enterprises and the transition from generally accepted business processes to management using digital transformation and digitalization technologies. The key problem, in my opinion, is that the majority of large metallurgical enterprises, when upgrading their main production equipment, ignore the issues of modernization of the energy system and insufficient involvement of personnel in the process of energy saving. This situation leads to a lack of consistency in the volumes of resources produced and consumed, a low level of energy consumption culture and, as a result, a decrease in energy efficiency in general.

The list of the most promising areas for improving management approaches, in addition to managing the infrastructure of energy farms, includes the development of

L. M. Baitenova (✉)
Almaty University of Power Engineering and Telecommunications (AUPET) named after G. Daukeev, Almaty, Kazakhstan

L. M. Mutaliyeva
L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan

F.-J. Chang
Department of Bioenvironmental Systems Engineering, National Taiwan University, Taipei, Taiwan
e-mail: changfj@ntu.edu.tw

H. Dincer, S. Yüksel (eds.), *Economic Development and the Environmental Ecosystem*, Contributions to Economics,
https://doi.org/10.1007/978-3-031-26596-9_2

incentive tools for energy conservation and improving the quality of innovation activities of personnel.

The energy power and security of a country, the development of the economy and the standard of living of the population are determined by the amount of extraction, production and consumption of fuel and energy resources. Current trends in the development of modern industrial production, despite the relatively low prices for energy resources in Russia, in comparison with the prices of the world market, the value of fuel and energy costs in the cost of production ranges from 15 to 35%, depending on the type of growth. In total, industrial enterprises consume 125–130 million, which is more than a third of the country's fuel and energy resources and more than 50%7 of the electricity generated. According to the data of GDP growth dynamics, which reflect the main result of the functioning of industry, we can conclude that the Russian industry is lagging behind the industry of developed countries, such as the United States and China.

Energy efficiency is vital for the profitability of businesses to be sustainable (Eti et al., 2023; Li et al., 2022a, 2022b; Haiyun et al., 2021). In this context, it is necessary to determine the ways for businesses to carry out the same work with less energy (Li et al., 2022a, 2022b; Yüksel et al., 2022; Mikhaylov et al., 2022a, 2022b). In this way, it is possible to reduce energy costs. Thanks to the use of less energy in the production process, it will be possible to increase the profit margins of the enterprises. In this study, it is aimed to propose the necessary applications in order to ensure the energy efficiency of the enterprises.

2.2 Literature Review

In the context of existing trends for technological modernization of the country's economy and the introduction of innovations, the need to improve energy efficiency is becoming an important direction for the development of technologies and improving organizational processes for managing energy efficiency. The pace of development of information and telecommunications technologies leads to an increase in the growth of energy consumption in non-manufacturing industries, such as the development of information technologies, significantly outstripping the average growth rate of energy consumption. In these conditions, given the importance of the availability of electric energy as a limiting condition for infrastructure development, the current vector for digitalization of the economy leads to an increasing urgency of energy conservation and energy efficiency issues. In many developed countries, over the past decade, the energy intensity of the economy has decreased by 15–20%, while previously planned plans for improving energy efficiency have to be revised upwards (Nie et al., 2020; Bhuiyan et al., 2021; Dong et al., 2021; Mikhaylov, 2021a, 2021b; Barykin et al., 2022a; Liu et al., 2022a, 2022b; Bhuiyan, 2022b; Danish et al., 2022a, 2022b; Saqib et al., 2021; Mukhametov et al., 2021; Candila et al., 2021; Mikhaylov & Grilli, 2022; Li et al., 2022a,2022b, 2022c).

In the United States of America, it is planned to reduce the energy intensity of the economy by 25% by 2025 compared to 2005, in the European Union-by 20% compared to 2007, and in China, after 13 repeated revisions, the current goal is to reduce the energy intensity of the economy by 49% by 2025 compared to 2006. In the Russian Federation, the decline in the indicator in comparable prices was observed until the beginning of the 2008 crisis. Since then, no significant changes in real terms have been observed, and Russia has to catch up with its partners, whose energy intensity of the economy is 1.5–2 times lower (Khan et al., 2022; Dinçer et al., 2022a, 2022b; Badr et al., 2022; Barykin et al., 2022b; Mehta et al., 2022; Kalinina et al., 2022; Shaikh et al., 2022; Mikhaylov et al., 2022a, 2022b; Nyangarika et al., 2022).

In addition to the main task of reducing the energy intensity of GDP, targets were set for a number of industry indicators, such as the depth of oil refining, losses of electric energy in electric networks from the total volume of electric energy supply, and specific resource expenditures for the extraction of fuel and energy resources (Denisova et al., 2019; Nyangarika et al., 2019a, 2019b; Huang et al., 2021a, 2021b; Mikhaylov, 2018, 2022; Mikhaylov et al., 2019; Conteh et al., 2021; Sediqi et al., 2022; Khan et al., 2021; Bhuiyan et al., 2022a; Liu et al., 2021a, 2021b; Daniali et al., 2021; Moiseev et al., 2023).

The observed socio-economic situation significantly differs from the forecasts that formed the basis of the initial goal setting in the field of energy conservation and energy efficiency improvement (Zhang et al., 2022; Yüksel & Dinçer, 2022; Carayannis et al., 2022). Changes in the structure of the economy associated with the introduction of modern energy-saving technologies and the development of digital business transformation were supposed to reduce the energy intensity of GDP by 25% by 2020, but according to Rosstat research, the forecast was not confirmed and in fact it was possible to reduce the share of energy-intensive industries by only 2%, which indicates that energy consumption (Mikhaylov et al., 2023; Mikhaylov, 2021a; Varyash et al., 2020; Zhao et al., 2021; An & Mikhaylov, 2020; Alwaelya et al., 2021; Yumashev & Mikhaylov, 2020; Yumashev et al., 2020; Mutalimov et al., 2021; An & Mikhaylov, 2021).

In fact, when calculated at current prices, the energy intensity of Russia's GDP for the period 2012–2017 decreased by 34%. The significant lag in the actual values of indicators in the field of energy saving and energy efficiency from the target values was largely compounded in 2014–2017, when the Russian Federation was faced with foreign policy factors and economic instability. At the same time, the situation was characterized by a sharp decline in prices for oil and other export goods. Russian organizations were restricted access to international financial markets and access to modern technologies (An et al., 2019a, 2019b; An et al., 2020a, 2020b, 2020c; Moiseev et al., 2020, 2021; Gura et al., 2022; Dooyum et al., 2020; Mikhaylov et al., 2020; Mikhaylov & Tarakanov, 2020 Mikhaylov, 2020a, 2020b, 2020c).

That is why many researchers believe that the main impetus for the development of a systematic approach in the field of energy saving is various kinds of crises, as a result of which competition between enterprises in various industries becomes more

acute (Yuan et al., 2021; Fang et al., 2021; Kayacık et al., 2022). Assessment of the potential for energy saving in industry, both in developed and developing countries, can become the basis for developing an effective organizational and economic mechanism for managing savings at the regional and individual enterprise levels. To assess the potential, it is necessary to analyze the directions and structure of energy consumption. In the coming years, the world's total energy consumption in industrial production is expected to grow by 75% from the level of 2012 (3115 million tons of conventional fuel) and amount to about 5300 million tons. Today, the most popular fuel and energy resource for metallurgical enterprises is electric energy. According to statistics, its consumption accounts for about 20% of the total global energy consumption, and in forecasts until the 50s, the share of electricity in the total structure of energy consumption is expected to grow to values of 25–27% in total consumption. This situation, according to scientists, will lead to a reduction in the consumption of petroleum products and coal relative to electric energy. In this regard, the list of priority tasks aimed at improving energy efficiency should include the development of renewable energy sources, as well as alternative energy resources, such as hydrogen. The target for the share of alternative energy sources is between 10 and 15% of all energy by 2050) (Dayong et al., 2020; Mikhaylov et al., 2018; Nyangarika et al., 2018; Danish et al., 2020, 2021; An et al., 2021, 2022; Uyeh et al., 2021; Tamashiro et al., 2021, 2023; Shaikh et al., 2021).

2.3 The Creation of Concept of Energy Efficiency

The metallurgical industry is one of the most conservative in terms of using alternative energy sources, since it is highly likely that changes in the technological processes of steel production are not expected in the near future, as well as fluctuations in the structure of steel production. The analysis and evaluation carried out showed that the share of energy consumption in the production cost of domestic industrial enterprises is too high even by Russian standards. In metallurgy, it reaches 20%, petrochemicals-more than 40%, and the copper industry-about 80%. It is possible to increase the energy efficiency of metallurgical enterprises primarily through large-scale modernization of production facilities and energy facilities (with the replacement or decommissioning of obsolete equipment), as well as the development of alternative energy (Martínez et al., 2022; Sun et al., 2022; Kafka et al., 2022).

In many industries (electric power, metallurgy, oil refining, and petrochemicals), enterprises continue to operate outdated, inefficient equipment and technologies, many of which have not been updated (at best) since the late 1980s. Despite the fact that modernization should take place every 15 years.

The results of the study show that in general, industrial production has a significant potential for energy saving. Based on experts' estimates, in modern conditions, about 40% of this potential is accounted for by ferrous and non-ferrous metallurgy.

To solve the problems of energy saving in the metallurgical industry, it is necessary to use the potential contained in the main technological processes, including through the use of recyclable materials and deep processing of waste (Mukhtarov et al., 2022; Dong et al., 2022; Dinçer et al., 2022a, 2022b, 2022d). So, for example, there is a four-fold reduction in energy consumption in steelmaking when processing scrap metal in electric steelmaking furnaces compared to outdated open-hearth and converter production (Bhuiyan et al., 2022a; Kou et al., 2022). In addition, deep processing of carbon-containing waste generated at the enterprise can not only meet the need of individual consumers for energy resources, but also reduce the impact of enterprises on the environment in the region of their presence (Eti et al., 2022; Dinçer et al., 2023; Xu et al., 2022).

The problems of management formation at Russian industrial enterprises are entirely related to the peculiarities of the current stage of socio-economic development, characterized by the formation of private ownership in the industrial sector and the transition to decentralized planning. Some authors believe that the emerging energy crisis negatively affected the formation of domestic approaches to energy conservation, opening up export channels for local energy carriers. A number of researchers note that the actualization of energy conservation problems in Russia is associated with the transition to a market economy in the early 1990s: energy prices in the conditions of competitive operation of private industrial enterprises, natural prices increased by an average of 15–20 percentage points, while maintaining the overall level of energy intensity of industrial products.

On the scale of the global economic system, the increase in prices for basic energy resources has a stimulating effect on the development of renewable and alternative energy sources, largely due to the investment attractiveness of these projects. However, for this reason, there is a deterioration in the socio-economic indicators of the state, associated with an increase in the specific cost of energy resources for the population, since the industrial group of consumers spends them most efficiently, with the least losses. Moreover, the increase in prices for energy resources is one of the most significant factors for increasing inflation, as practice shows, an increase in their cost by two times leads to an increase in the prices of consumer goods and services by 15–20%. It is obvious that the development of energy efficiency management systems at enterprises and the updating of energy saving issues are impossible without the participation of the state in the processes of tariff regulation.

2.4 Conclusion

The peculiarities of the national investment policy in the energy infrastructure during the 90s of the last millennium, aimed mainly at maintaining the technical condition, led to the moral and physical obsolescence of the vast majority of energy facilities by 2000. To a greater extent, the degradation affected information technology and monitoring support that supports the analysis of the current and future state of the

elements of the energy sector. As a result, some manufacturers in the market operate with low efficiency, and their tariffs are not competitive in international comparison.

Based on the reviewed scientific works, it can be concluded that the management mechanism is a set of economic, social, legal, financial and managerial tools aimed at improving the efficiency of the enterprise's functioning. On the other hand, energy conservation is a set of implemented organizational, legal, technical, technological, and economic measures that are aimed at reducing the amount of energy resources used while maintaining the corresponding beneficial effect from their use. Obviously, energy conservation can be considered as a particular example of an energy efficiency management mechanism. This makes it possible to establish a clear link between the two concepts discussed in the first question.

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