



Environmental sustainability for traditional energy small and medium enterprises

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Abstract

The improvement of production processes, the development and use of new technologies, materials and energy infrastructure, the transition to new fuels, and the growth of energy consumption—all gives impetus to the advancement and continuous modernization of the energy sector. Hence, the transition to the concept of sustainable development poses new challenges to the energy sector: meeting the increasing demand for energy should occur while reducing the sector's anthropogenic impact on the environment. The energy sector must meet the requirements of sustainable development, for this, it needs to carry out a large-scale eco-modernization of the energy infrastructure, when the environmental component comes to the fore when developing long-term development programs for individual enterprises. Although the introduction of the principles of sustainable development may become one of the drivers for improving the efficiency of energy enterprises and achieving environmental sustainability, they have been introduced in a small part of enterprises. The purpose of this study is to define key principles and factors that should be included in the concept of environmental sustainability in traditional energy SMEs. Based on the results of the study, a list of factors that have a direct impact on the environmental sustainability of traditional energy facilities has been formed.

Keywords Sustainability · Environmental sustainability · Energy sector · Energy enterprises · SME · Traditional energy

Introduction and literature review

The achievement of the sustainable development goals (SDGs) and the transition to a low-carbon economy have become the main directions of many economic and industrial sectors development in the upcoming years (Hafner

et al. 2020; Cao et al. 2022). Nowadays, many countries are implementing large-scale eco-modernization programs to reduce CO₂ emissions generated mainly by industrial enterprises and automotive industry (Pandey et al. 2022; Tsai and Chen 2020; Cioca et al. 2016; Golubeva and Magaril 2013). The key tools for stimulating the transition of business to more environmentally friendly ways of its development are the tightening of environmental legislation, the allocation of

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subsidies to enterprises implementing environmental measures, and introduction of sustainable development principles (Wang and Zhang 2022; Xu and Xu 2022; Dzikuć et al. 2021; Rada et al. 2021; Marrucci et al. 2021; Frondel et al. 2011).

The energy industry is considered the largest polluter of the environment and consumer of natural resources and it is the sector most acutely aware of the transition to a new type of economic development (Rezazadeh et al. 2022; Al-Shetwi 2022; Karaeva et al. 2021; Marques and Caetano 2020; Gitelman et al. 2019; Ragazzi et al. 2011; Ahmad et al. 2021). The achievement of SDGs on national level is directly depended on the energy industry as it is the largest polluter (SDGs ...); it would provide access to the clean energy in the near future (SDG). Simultaneously with achieving the SDGs and significantly reducing emissions of toxic substances and greenhouse gasses, the energy sector must meet the ever-growing energy demand worldwide. According to 2021 data, more than 48% of global CO₂ emissions are accounted for energy sector, while in 1990 its share was only 41% as can be seen from Fig. 1 (IEA 2022). The trend indicates that to achieve the set goals for climate and environmental conservation, the sector will need to carry out a large-scale eco-modernization.

One of the directions of energy sector eco-modernization may be the transition to renewable energy sources, the abandonment of the use of coal as fuel, the implementation of efficient environmental technologies to operating energy facilities, and the development of nuclear energy. However, to make the transition to green energy, it is necessary to replace the existing energy infrastructure with a new one, since currently more than 61% of all electricity in the world is produced from non-renewable resources: natural gas, coal, or oil as reported in Fig. 2 (Statistical Review on World Energy 2021).

The development of green energy gives impetus to the modernization of the energy sector. Already, the energy sector attracts huge volumes of research and development (R&D) investments. It is expected that by 2025–2030, the inflow of energy investments in advanced economies

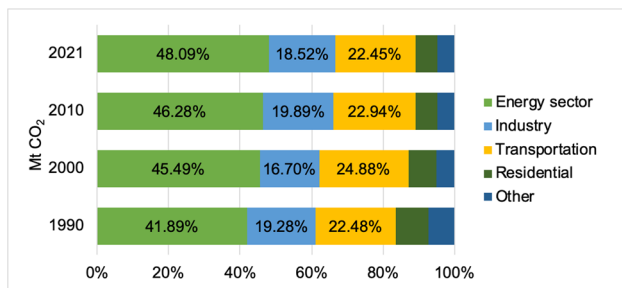


Fig. 1 Global CO₂ emissions by sector, 1990–2021, Mt CO₂ (made by authors using data from IEA 2022)

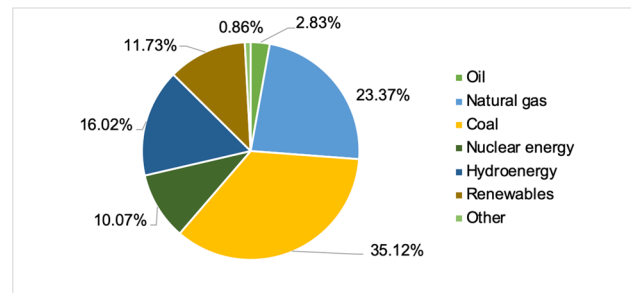


Fig. 2 Global electricity generation by fuel in 2020, % (made by author using data from Statistical Review on World Energy 2021)

and emerging markets will increase by 48.1% and 50.27% respectively compared to 2014–2019 (IEA 2022).

Most of the investments will be directed to the development of green energy, energy infrastructure, eco-modernization of existing energy facilities, and the implementation of environmental protection measures to reduce the negative impact on the environment. In addition, an important aspect of the transition to a new low-carbon and sustainable development vector may be the introduction of the principles of circular economy (CE) and sustainable development at individual energy enterprises (Su and Urban 2021; Karaeva et al. 2022; Garrido-Prada et al. 2021; Gitelman et al. 2019).

In 1987, the UN report “Our Common Future” defined sustainable development as “development that meets the needs of current generations without compromising the ability of future generations to meet their needs and aspirations” (Brundtland Report 1987). Achieving sustainable development involves maintaining a balance between the economic, social, and environmental aspects of human activity, while the concept can be applied both to the whole of humanity and to a single subject of economic relations.

Many authors note that without economic prosperity, social well-being, provided to a greater extent by local enterprises, and high-quality environment, it is impossible to achieve an increase in the welfare of the population (Shen et al. 2016; Boons et al. 2013). Therefore, achieving the sustainability of local enterprises plays an important role in achieving sustainable development goals at the local level (Morioka et al. 2016). If the economic and social sustainability of SMEs is achieved by improving the performance and social activity of enterprises, then to achieve environmental sustainability, it is necessary to implement a significant amount of various practices.

Nowadays most of SME owners do not believe that their activities can have a serious environmental impact. According to the results of the survey conducted in Australia and in which participated 233 regional SMEs, 65.3% of respondents do not believe that they harm the environment and that they need to implement environmental protection practices (Artin 2022). Incorrect perception by

owners and managers of the impact of SMEs on the environment deters the implementation of the principles of sustainable development at their enterprises (Artin 2022; Hillary 1999; Gadenne et al. 2009). Despite the fact that individual SMEs might have limited impact on the environment, their combined impact might exceed the environmental footprint of large enterprises (Smith et al. 2022). This is most relevant for the energy sector that contributes to the largest environmental impact. In this regard, the global agenda in the field of climate and environmental conservation is increasingly bringing environmental sustainability of SMEs (especially in the energy sector) to the fore (Gadenne et al. 2009; Prashar 2019; Udayasankar 2008).

The topic of environmental sustainability of industrial SMEs is becoming more relevant among scientists every year. For the first time, the concept of environmental sustainability was formed by Goodland (1995): “environmental sustainability is the maintenance of natural capital assets (i.e. soil, atmosphere, forests, water, etc.)” It can already be concluded that the achievement of environmental sustainability for local enterprises should consist not only in reducing anthropogenic impact, but also in increasing the efficiency of using natural resources, introducing the principles of circular economy and an effective environmental management system (Xiang et al. 2022; Nulkar 2019; Cariola et al. 2020). The process of transition of SMEs to a new development concept is much more complicated than for large enterprises due to lack of financial resources and strong dependence on economic performance indicators (Ghazilla et al. 2015). The implementation of environmental measures, the introduction of changes in the operational and production process requires a lot of time, financial, and labor costs, while not all owners of SMEs realize their need, which further slows down the process of transition to a new sustainable vector of development.

The suggested concept of environmental sustainability can be adapted also for local industrial enterprises. The factors highlighted in the work of Hurreeram et al. (2014) and allowing to achieve environmental sustainability in large industrial enterprises can be applicable for SMEs. The list of factors includes the use of energy obtained from renewable energy sources, minimization of waste generation, waste recycling, eco-design, and rational use of raw materials and energy resources. In general, the achievement of environmental sustainability by local enterprises in most of the studied models represents a reduction in anthropogenic impact on the environment: a control (Priyadarshini and Abhilash 2020) and reduction in emissions of greenhouse gasses and toxic substances (Prashar 2019; Kuckertz and Wagner 2010; Vikhorev et al. 2013; Ngai et al. 2013), improving the energy efficiency of production process (Prashar 2019; Joung et al. 2013; Kristensen and Mosgaard 2020), and minimizing the

generation of production waste (Vikhorev et al. 2013; Ngai et al. 2013; Joung et al. 2013; Nudurupati et al. 2022).

A number of studies point out the introduction of the principles of the circular economy (CE), i.e., “take-make-consume-reuse-recycle” in SMEs as one of the fundamental factors for achieving sustainable development (Kristensen and Mosgaard 2020; Nudurupati et al. 2022; Bocken et al. 2016). CE principles make it possible not only to reduce the negative impact of an industrial enterprise on the environment, but also to increase the efficiency of resource use. Despite the broad prospects, the use of CE principles within the framework of achieving environmental sustainability in SMEs is partially represented by several studies (Liakos et al. 2019; Tsai and Chou 2009).

Baumgartner (2014) considers the achievement of environmental sustainability in a broader way: in addition to reducing the direct anthropogenic impact, large and small enterprises need to implement responsible environmental management programs that include cultural, educational, and social activities. According to Choudhary et al. (2018), environmental sustainability of enterprises includes environmental education, corporate social responsibility, environmentally friendly production, environmental impact assessment, sustainable consumption, etc. Thus, the concept of environmental sustainability for SMEs, in addition to environmental factors, should include socio-educational aspects of activities. The speed of achieving environmental sustainability of SMEs in the future may be influenced by sustainable policies implemented at the state level (Xiang et al. 2022). Hughes and Troy (2020) observed that now it is easier for large players to adapt to new requirements and realities in the field of environmental protection, since they have the necessary amount of financial resources and have access to innovations. SMEs in the industrial sector most often do not have the extra resources and capabilities to implement environmental sustainability practices. Gherghina (2020) argues that if governments develop and implement additional tools to support SMEs as part of the implementation of environmental measures and principles of sustainable development, the situation may change dramatically.

The conducted literature review demonstrated high scientific interest in the topic of achieving environmental sustainability of SMEs. However, in order to design efficient tools and working concept, it is necessary to develop adapted concepts of achieving environmental sustainability for SMEs in different economy sectors. Each sector has its own specific environmental impact that should be reflected in it. At present, the implementation of the principles of sustainable development and environmental sustainability in the energy sector in most cases is considered at the state level, the level of a separate energy sector or a large industrial corporation. At the level of energy SMEs, the

introduction of the concept of sustainable development is only beginning to be considered in the scientific research (Pylaeva et al. 2022). SMEs play a key role in the functioning of the energy industry and the regional economy. As they usually form the regional energy structure, supply electricity to remote regions, or even engage in innovative developments (Smallbone et al. 2022; Chatterjee et al. 2022; Codini et al. 2022). Their successful activities have a positive impact on the macroeconomic indicators of the regions; they create jobs and improve the quality of life of the population. In the energy sector, most of the SMEs are state-owned enterprises of traditional energy. Traditional energy enterprises most often use traditional energy sources as coal and natural gas to generate electricity on thermal power plants. However, hydropower plants and nuclear power plants might be also attributed to traditional energy objects (Liu et al. 2020). These SMEs often operate completely autonomously and independently develop their strategic development programs.

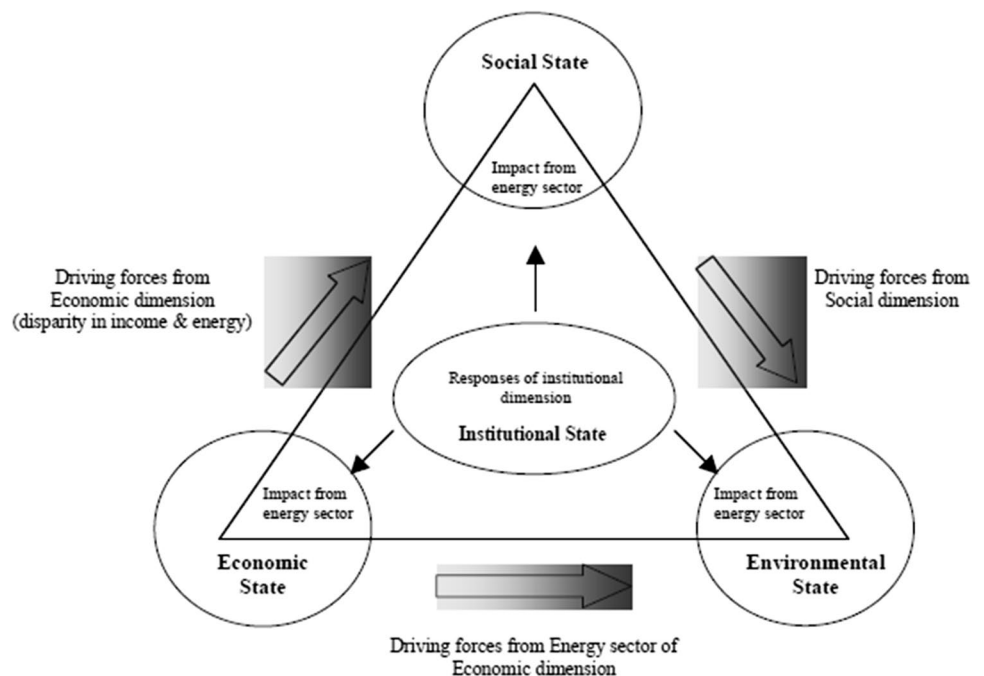
In this regard, the gradual introduction of the principles of sustainable development and environmental sustainability into the production and operational activities of traditional energy SMEs might contribute to a smooth and more efficient transition of the entire energy sector to a new “green” development paradigm (Garrido-Prada et al. 2021). This also contributes to the implementation of the principles in the territories where small energy enterprises are located: employees working on new principles and realizing the importance of preserving the environment for future generations are more likely to lead a more environmentally friendly lifestyle and bring new principles into everyday life.

In order to develop adapted concept of environmental sustainability for energy SMEs, the specifics of their environmental impact should be considered. Due to the specific and significant environmental impact of the energy sector, the research question is “what factors should be included in the developing concept of environmental sustainability of SMEs enterprises?.” Thus, the purpose of this study is to define key principles and factors that should be included in the concept of environmental sustainability in traditional energy SMEs. This work contains an overview of the research on the sustainable development and environmental sustainability of SMEs presented in the scientific literature, the proposed concept of sustainable development of energy enterprises taking into account their environmental impact and the list of factors that have a direct impact on the environmental sustainability of traditional energy facilities. As a research method, authors conducted in-depth analysis of scientific literature and evaluate performance based on annual reports of several local energy enterprises in order to define how they operate and affect the environment.

Results and discussion

Achieving environmental sustainability is a key strategic direction for the energy industry. As depicted from the review, there are currently no sustainable business models adapted for energy companies. Davidsdottir (2007) presented the most relevant scheme of sustainable development, taking into account the specifics of the energy industry; data are reported in Fig. 3.

Fig. 3 Sustainable development in the energy sector (adapted from Davidsdottir 2007)



According to Fig. 3, the economic dimension has an impact on both the social and environmental dimensions: on the one hand, energy companies provide stable access to electricity for the population, on the other hand, energy production, especially from fossil energy sources, leads to considerable environmental pollution. At the same time, electricity consumers also have a negative impact on the environment through their activities. Therefore, the environmental dimension comes to the fore when developing programs to achieve sustainable development of the energy industry.

Considering the concept of sustainable development of SMEs in the energy sector, we can conclude that the model is less focused on environmental aspects than on economic ones, namely, the financial stability of the enterprise and economic efficiency. At the same time, the social component of sustainability includes only political aspects, the social policy of the enterprise, and personnel policy.

The proposed scheme of sustainable development for traditional energy enterprises is presented in Fig. 4.

In order to take into account the specifics of the energy industry in addition to the main socio-economic and environmental indicators, it is necessary to consider:

- The dynamics of world energy prices: the economic efficiency of energy enterprises and potential profits directly depend on energy prices.
- The state of global energy markets: any change in the structure of global energy consumption, political upheavals, and a reduction in the production of natural energy

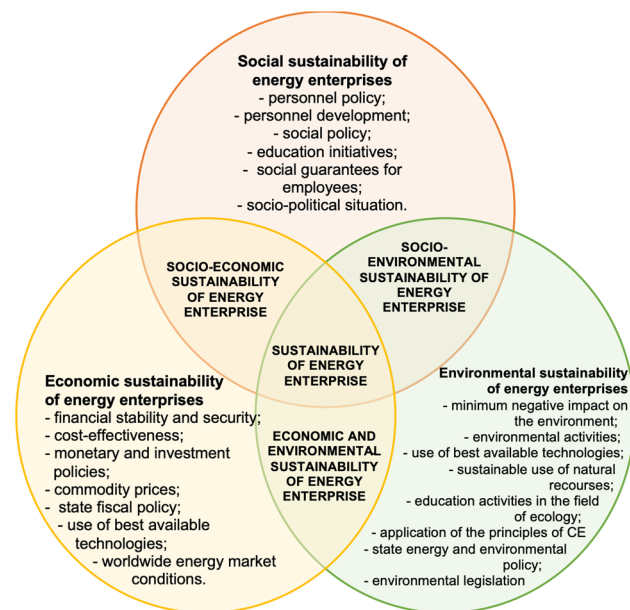


Fig. 4 Sustainable development of traditional energy enterprises (source: made by authors)

resources—all this can affect the current activities of energy enterprises.

- Use of the best available technologies: in addition to the obvious technological and economic advantages in the form of increasing the efficiency of production activities, modern technologies can significantly reduce the negative impact of an energy facility on the environment (for example, the use of the best technologies in the field of wastewater treatment or processing of industrial waste).
- Rational use of natural resources: 61% of all electricity is produced using non-renewable natural energy carriers; therefore, it is important to rationalize their consumption as much as possible, increasing the efficiency of production activities.
- Education activities in the field of ecology: an important component of achieving environmental sustainability at energy enterprises is to raise awareness of employees and management in matters of environmental management and environmental conservation. A high level of awareness can contribute to faster achievement of the SDGs (Karaeva et al. 2022).
- Application of the principles of circular economy: at SMEs, it is possible to achieve faster implementation of the principles of circular economy in comparison with large energy enterprises: rational use of natural resources, recycling of production waste and from operating activities—all this may increase the environmental efficiency of the traditional energy enterprise.
- State energy and environmental policy: energy is one of the central sectors of the economy, so any change in the energy policy of the state has a direct impact on the activities of local energy enterprises. Moreover, in recent decades, there has been a trend towards “greening” the energy sector by supporting renewable energy and tightening environmental legislation, which affects the sustainability of SMEs and stimulates their transition to a new vector of development.

In the concept of sustainable development, all three dimensions are closely interrelated. Without achieving a balance between environmental impact, financial performance, and social well-being of employees, it is impossible to achieve the sustainability of the enterprise. However, if the means to achieve economic and social sustainability in different sectors of the economy are relatively similar (effective capital management of the enterprise, effective investment activities, state support and subsidies, corporate social responsibility (CSR), improving the quality of working conditions, etc.), in order to achieve environmental sustainability, it is necessary to develop new approaches and tools that consider specificities of the industry.

Thus, an important stage is the identification of factors that affect the environmental sustainability of large and

small enterprises in energetics. At the initial stages, in order to achieve environmental sustainability, energy companies need to implement an EMS, which will allow them to take into account the priorities of environmental activities of the enterprise and plan future environmental activities for the short and long term. Currently, EMS is more widely used in large enterprises, but their simplified introduction is also possible on SMEs. For example, the ISO 14000 family of standards “Environmental Management” (ISO 14000, 2022) can become the basis for the development of EMS at small and medium-sized energy enterprises: the standards contain the basic principles, criteria, and a flexible approach to the step-by-step implementation of the system.

In addition, the introduction of EMS will allow to conduct an annual environmental audit of the enterprise, monitor changes in environmental legislation, assess the compliance of the enterprise with modern requirements, and increase the awareness of employees in environmental issues. The main barrier to the introduction of EMS on SMEs is the unwillingness of owners and management to bear high financial costs for the implementation of the system and its support (Hughes and Troy 2020). This problem can be solved by co-financing the implementation of EMS by the state or by developing a simplified procedure for its implementation.

The specific of the energy industry is the high consumption of such non-renewable resources as natural gas, coal, and oil: in addition to depletion of natural resources, it leads to significant environmental pollution. In order to ensure environmental sustainability, it is necessary to carry out eco-modernization of energy facilities and abandon the use of coal in order to increase energy production efficiency (reduce resource consumption relative to the unit of energy produced) and reduce specific emissions of greenhouse gases and toxic substances into the atmosphere (Karaeva et al. 2021). The implementation of environmental protection measures and eco-modernization of the energy facility also requires large financial, material, and labor costs. However, SMEs, being an important element of the functioning of the economy, should receive financial support from the state for the implementation of the necessary measures. Moreover, reducing the anthropogenic load today can lead to significant benefits in the future: fees for environmental damage show an annual increase in many countries.

Efficient management of industrial waste, especially in enterprises where coal is used as the main fuel, is also an important component of environmental sustainability. In most cases, SMEs do not implement waste management systems: almost all waste is disposed of or stored on the territory of the enterprise, harming land and soil resources (Woodard 2020). The implementation of the industrial and solid waste management system is part of EMS and means the effective application of CE principles. For enterprises

using natural gas or fuel oil as fuel, it is possible to introduce a simplified waste management system.

Based on conducted review and analysis, five main groups of factors that affect the environmental sustainability of energy enterprises were defined (Table 1).

The factors listed above consider the specifics of the energy sector and have a direct impact on the environmental sustainability of SMEs in the energy sector. To achieve it, it is necessary not only to take into account all factors, but also to demonstrate positive dynamics in environmental performance, namely, increasing resource efficiency and reducing emissions/discharges of harmful substances. The most effective tool for achieving environmental sustainability for SMEs in the energy sector is the introduction of simplified EMS. According to Zorpas (2010), introduction of EMS might not only affect the environmental performance, but also positively impact financial results by reducing environmental contingencies and improving the company’s public image. EMSs also allow accounting and planning of environmental activities and encourage enterprises to implement the principles of sustainable development and CE (Rodríguez-Espíndola et al. 2022).

The important role of resource efficiency in environmental sustainability of SMEs is evidenced by Cunha et al. (2020) and Garrido-Prada et al. (2021). However, Chatzistamoulou and Tyllianakis (2022) point out that employing resource efficiency initiatives requires major changes in the business model of SME, introduction of new technologies, and staff training that implies high costs. Due to the frequent lack of financial resources and state support, many SMEs cannot provide resource efficiency even if they show a high interest in it. Therefore, such factors as collaboration of SMEs with public and private organization (Montalvo 2008) and awareness of available funding (Demirel and Danisman 2019) can complement the suggested list of factors after adjusting to energy sector specifics (group “external factors”). State support and financing is the only tool that will provide substantial support to SMEs in the energy sector and will allow individual enterprises to achieve environmental sustainability in a short time. Group of factors “Minimization of the adverse impact of energy SMEs on the environment” correspond to the results of other studies (Prashar 2019; Vikhorev et al. 2013; Karaeva et al. 2020) and fully consider the nature and the degree of energy sector’s environmental impact (Karaeva et al. 2020).

Rodríguez-Espíndola et al. (2022) emphasize the influence of green innovations and circular economy principles on environmental and social sustainability of SMEs. In the suggested list of factors, CE is mostly presented in groups “Rational use of natural resources” and “Waste management system.” Including green innovation in the list of mandatory factors can have a negative effect as in order to create and

Table 1 The list of factors that influence the environmental sustainability of traditional energy enterprises

The group of factors	Factors
Effective functioning of SMEs' management	<ul style="list-style-type: none"> - Implementation of the environmental management system (EMS) at the enterprise - Annual environmental audit - Development of environmental policy for 1–2-5 years - Educational work in the field of ecology with the personnel of the enterprise
Rational use of natural resources	<ul style="list-style-type: none"> - Efficient use of fuel resources - Efficient use of water resources - Efficient use of other natural resources - Implementation of a resource and energy saving system
Minimization of the adverse impact of SMEs on the environment	<ul style="list-style-type: none"> - Using the best available treatment technologies - Use of modern technologies for production purposes - Use of more environmentally friendly fuels (for example, natural gas instead of coal) - Reduction of greenhouse gas emissions and toxic substances into the atmosphere - Reduction of wastewater emissions into water bodies - Implementation of the environmental management system at the enterprise
Waste management system	<ul style="list-style-type: none"> - Minimization of production waste generation - The share of waste reused in production - The share of waste sent for recycling - The share of waste sent for disposal
External factors	<ul style="list-style-type: none"> - Changes and/or stricter environmental legislation - Government directives on decarbonization of the economy - Financial support by the government of energy companies conducting eco-modernization - The global agenda in the field of climate and environmental conservation

innovate new green energy technologies, external funding is needed.

It should be noted that, being the most important branch of the economy, on which the stability of the work of other economy sectors depends, energy strongly depends on environmental factors. Adaptation to constantly changing environmental conditions can have a favorable effect for SMEs, but at the same time it can create an additional financial burden. The introduction and implementation of the principles and measures listed above can increase the resilience of SMEs in energetics to external changes, thereby ensuring a high level of environmental sustainability.

Conclusions

The concept of sustainable development adapted for energy companies was developed, with special attention paid to the environmental sustainability. The key factors that consider specifics of traditional energy SMEs and have a role to play in achieving environmental sustainability were defined. All factors were divided into 5 groups that form 5 main directions of SMEs' environmental development. The most significant factors include:

- The presence of EMS, which allows accounting and planning of environmental activities of the enterprise
- Resource efficiency of energy production: reduction of consumption of natural energy carriers with an increase in energy production
- Use of the best available technologies in the field of production and environmental protection; that factor may significantly reduce the anthropogenic impact on atmosphere, water, and soil resources made by the traditional energy facility
- The minimum impact of the energy facility on the environment

Following the long-term trends of SMEs in the energy sector to achieve environmental sustainability can contribute to obtaining additional benefits in the future: reducing fees for negative impacts, government support, competitive advantages, and improving the image of enterprises in the eyes of consumers. But despite the obvious benefits, the process of transition of SMEs to a new vector of development is rather slow due to serious financial and/or administrative barriers. To solve this problem, it is necessary to develop effective tools of state support: financial support for SMEs planning to implement EMS, a simplified procedure for its implementation, subsidies and benefits for enterprises

demonstrating a high level of environmental sustainability, etc.

It is important to note that the suggested concept of sustainable development and environmental sustainability for energy SMEs is only applicable for traditional energy enterprises that use fossil fuel for energy production. Factors of environmental sustainability of renewable energy facilities or nuclear power plants will differ because of the different nature of effects. The next step of the research will be the analysis of the specifics of the business models used at energy SMEs and the development of mechanisms for the phased implementation of the principles of sustainable development in order to reduce their environmental impact while maintaining steady economic performance.

Author contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Anzhelika Karaeva, Gabriela Ionescu, Lucian Ionel Cioca, Athanasia Tolkou, Ioannis Katsoyiannis, and George Kyzas. The first draft of the manuscript was written by Anzhelika Karaeva and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval Not applicable.

Consent to participate Not applicable.

Consent for publication We undertake and agree that the manuscript submitted to your journal has not been published elsewhere and has not been simultaneously submitted to other journals.

Competing interests The authors declare no competing interests.

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