frontiers | Frontiers in Environmental Science

TYPE Opinion
PUBLISHED 15 December 2022
DOI 10.3389/fenvs.2022.1090110

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Environmental Economics and Management, a section of the journal Frontiers in Environmental Science

RECEIVED 04 November 2022
ACCEPTED 28 November 2022
PUBLISHED 15 December 2022

CITATION
Krupnov YA, Krasilnikova VG, Kiselev V and Yashchenko AV (2022), The contribution of sustainable and clean energy to the strengthening of energy security.
Front. Environ. Sci. 10:1090110.
doi: 10.3389/fenvs.2022.1090110

The contribution of sustainable and clean energy to the strengthening of energy security

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KEYWORDS

sustainable and clean energy, fuel and energy complex, sustainable development goals (SDGs), environmental economy, energy security

Introduction

The motivation for this research was the large importance of the development of clean energy for environmental protection and the uncertainty about the impacts of clean energy on energy security. Sustainable and clean energy includes clean and alternative energy, which is renewable and whose production does not lead to the depletion of natural resources. Although sustainable and clean energy has been in existence for a long time, its positions have significantly strengthened and it received a new impulse for development after the adoption of the Paris Agreement (the United Nations Framework Convention on Climate Change (UNFCCC), 2022) at the global level and green agendas and strategies of decarbonization at the national level.

Both existing alternatives—sustainable and clean energy (e.g., solar, wind, and water) and fossil fuel energy (e.g., oil, natural gas, and coal)—have advantages and disadvantages. A choice in favor of a certain alternative is made, given the specifics of the needs of the sectors and economies. During decision-making on the management of the fuel and energy complex, it is necessary to be guided by the interests of energy security provision.

The institutional foundations of energy security were set by international regulatory acts. The International Energy Agency treats energy security as "reliable, affordable access to all fuels and energy sources" (IEA, 2022). Sustainability, here, is treated as the stability and reliability of energy.

The UN (2022) supplements this treatment with the priority connected with the implementation of SDG 7 in the aspect of "ensuring access to affordable, reliable, sustainable, and modern energy." Here, sustainability is closer to environmental performance and is treated as energy's friendliness toward the environment. The goal of this paper is to study the contribution of sustainable and clean energy to the strengthening of energy security.

Literature review

This paper uses the scientific provisions of the concept of energy security. General issues of clean energy were studied in detail in Chen (2022), Jia et al. (2022), and Khalfaoui et al. (2022). However, the consequences of the transition to sustainable and clean energy for energy security remain insufficiently studied and unclear, which is a literature gap. According to the concept of energy security, the fuel and energy complex is a part of the core of the environmental economy. Thus, this complex is assigned two strategic functions in modern economic systems.

The first function is traditional and the most obvious function—the provision of stability (continuous work and absence of crises) and high effectiveness of the energy system (Ragulina et al., 2022). Since energy is an essential resource, which is necessary for the normal implementation of most economic processes, a deficit of energy is unacceptable because it brings the risks of a reduction in the population's living standards and quality of life and a slowdown of the economic growth rate (Chutcheva et al., 2022).

The second function is more modern and is becoming more significant due to support around the world—the protection of the environment (Vorozheykina, 2022). In the past, this function was considered additional, but today, it is the main function, together with the first function, and equally significant (Kukushkina et al., 2022). The fuel and energy complex determines natural resource rent in GDP and preservation of natural heritage for future generations. Being a part of the industry, this complex forms a substantial part of production waste and consumption in the economy. Modernization of the fuel and energy complex facilitates the implementation of the climate agenda (Yankovskaya et al., 2022).

The leading trend of the development of the fuel and energy complex, conducted by the most progressive countries of the world, consists in the transition to sustainable and environmental (i.e., clean and renewable) energy (Hongsuchon et al., 2022). The initial accumulated experience of this transition in recent decades has been contradictory. Thus, the problem consists in the uncertainty of the consequences and prospects for the fuel and energy complex, executing its two described functions with the dominance of sustainable and clean energy (Malhotra et al., 2022).

The world community's largest concerns are connected with the risks associated with the first function—energy security. Thus, it is important to study the contribution of sustainable and clean energy to the strengthening of energy security (Abotaleb et al., 2022). Considering energy security in the context of the described functions of the fuel and energy complex, this paper raises the two following research questions (RQs).

RQ1: What is the contribution of sustainable and clean energy to the provision of affordability and sufficiency of energy? Eales et al. (2020), Rybak et al. (2021), and Villavicencio Calzadilla and Mauger (2018) provide legitimate concerns regarding the transfer to clean energy, reducing the affordability of energy in the economy. This allows formulating hypothesis H1: sustainable and clean energy has a negative impact on the stability and effectiveness of the energy system. However, the existing arguments are based mainly on theoretical assumptions and general regularities and thus need rechecking.

RQ2: What is the contribution of sustainable and clean energy to the reduction of production waste and consumption and the fight against climate change? The existing literature notes that this contribution is significant since clean energy facilitates the reduction of CO_2 emissions (Ajagekar and You, 2022; Qamar et al., 2022) and is climate friendly (Chen and You, 2022; Matak et al., 2022). This allows formulating hypothesis H2: sustainable and clean energy makes a significant positive contribution to the reduction of production and consumption waste and the fight against climate change. However, here, the reasoning is also fragmented and based on separate data; thus, it needs to be strengthened.

To fill the discovered gap in the literature and ensure reliable reasoning for the answers to the raised research questions, we systemically study the contribution of sustainable and clean energy to the strengthening of energy security, taking into account both designated functions.

Results

A systemic approach to the contribution of sustainable and clean energy to the strengthening of energy security

In most of the existing sources, the two designated functions of the fuel and energy complex are acknowledged, but they are differentiated. Energy security is associated with the first function (Popkova et al., 2019; Popkova and Sergi, 2021; Wang et al., 2022), while the second function belongs to the green economy (Fouladvand, 2022; Oladeji et al., 2022).

A systemic view of these two functions in the Decade of Action shows that energy security is inextricably linked to the green economy. From the position of sustainable development of energy security, this is not just sufficiency but also environmental friendliness of energy. This is why this paper proposes a clarified treatment of energy security in the unity of the results of the fuel and energy complex executing its two functions.

It is suggested to treat energy security as the stability and high effectiveness of the energy system and its correspondence to the interest of environmental protection. The advantage of the new definition is that it allows for a comprehensive and reliable assessment of the prospects for the provision of energy security—from the position of the consequences for energy security to the position of the consequences for the environmental security of energy.

TABLE 1 Comparison of the results obtained and the literature.

Objects of comparison		Contribution of sustainable and clean energy		
		RQ1	RQ2	
		To provision of accessibility and sufficiency of energy	To the reduction of production and consumption waste	To the fight against climate change
Relevant SDG		SDG 7	SDG 12	SDG 13
Existing literature	Functions of sustainable and clean energy	Provision of stability and high effectiveness of the energy system	Environmental protection	
	Treatment	Hypothesis H1: negative impact	Hypothesis H2: significant positive contribution	
	Sources	Eales et al. (2020), Rybak et al. (2021), and Villavicencio Calzadilla and Mauger (2018)	Ajagekar and You (2022) and Qamar et al. (2022)	Chen and You (2022) and Matak et al. (2022)
Results obtained	Functions of sustainable and clean energy	Authors' specified interpretation of the unity of two functions: simultaneous provision of stability, high effectiveness of the energy system, and protection of the environment		
	Treatment	Description of the weakness of hypothesis H1 (the influence is absent or weak)	Description of the strengths of hypothesis H2, which is supported with proof	
	Considered case experience	BRICS	G7	

Source: authors.

International case experience of the contribution of sustainable and clean energy to the strengthening of energy security

Using the formed systemic view of the contribution of sustainable and clean energy to the strengthening of energy security, given both designated functions, we perform a case overview of the international experience of the execution of these functions in practice. To strengthen the evidence base of hypothesis H1, we use the experience of the countries of BRICS, all of which ratified the Paris Agreement and adopted national strategies on economic decarbonization.

As for sustainable and clean energy in Brazil, bioenergy and hydropower dominate. Among the largest economies in the world, the Russian fuel and energy balance is one of the most environmental friendly economies (low carbon): more than one-third of electric energy generation accounts for atomic energy, hydropower, and other renewable energy sources. In recent years, the share of sustainable and clean energy in India has increased, with the active development of solar and wind energy.

China became a country with the world's largest installed capacity of hydropower, wind energy, and solar energy. South Africa shows large potential for expanding the use of renewable energy sources since it possesses rich natural resources of sun and wind (BRICS Energy Research Cooperation Platform, 2022). As of now, all countries of BRICS have a high level of energy security. Therefore, sustainable and clean energy in BRICS countries strengthens the stability and raises the effectiveness of the energy system.

To strengthen the evidence base of hypothesis H2, we use the case experiences of countries in the G7, which demonstrate serious results in the development of sustainable and clean energy. The ongoing projects include forced decarbonization of sectors, systemic changes for environmental sustainability in all spheres of life, tackling extinction, and initiatives on ocean protection (SDG Knowledge Hub, 2022). Therefore, in countries of the G7, sustainable and clean energy makes a significant positive contribution to the reduction of production and consumption waste and the fight against climate change.

Discussion

This paper contributes to the literature through the development of the scientific provisions of the concept of energy security by its integration with environmental economics. The results obtained are compared to the existing literature in Table 1.

As shown in Table 1, unlike the division—which is present in the existing literature—between the function of provision of stability and high effectiveness of the energy system (Chutcheva et al., 2022; Ragulina et al., 2022) and the function of environmental protection (Kukushkina et al., 2022; Vorozheykina, 2022; Yankovskaya et al., 2022), this paper proposes addressing these functions in a comprehensive manner. Unlike Eales et al. (2020), Rybak et al. (2021), and Villavicencio Calzadilla and Mauger (2018), we determined a weakness of hypothesis H1. Using the example of the case

experience of the countries of BRICS, we did not discover the negative consequences of the development of clean energy with regard to the accessibility and sufficiency of energy in the society and the economy.

We also discovered the strengths of hypothesis H2 and supported it with proof based on the case experience of the G7. We demonstrated a positive contribution of sustainable and clean energy to the reduction of production waste, which strengthened the scientific evidence of the works of Ajagekar and You (2022) and Qamar et al. (2022). We also discovered the contribution of sustainable and clean energy to the fight against climate change, which strengthened the scientific evidence of the works of Chen and You (2022) and Matak et al. (2022). This is why the transition to sustainable and clean energy should be conducted in combination with other measures for implementing SDG 12 and SDG 13.

Conclusion

This paper proved a significant, but moderate, contribution of sustainable and clean energy to the strengthening of energy security, filling a literature gap and providing answers to both raised research questions. As an answer to RQ1, it was discovered that the function of provision of stability and high effectiveness of the energy system is further successfully performed by the fuel and energy complex with the development of sustainable and clean energy. As an answer to RQ2, it is determined that the function of environmental protection is performed more successfully by the fuel and energy complex with the development of clean energy.

The originality and theoretical significance of the paper consist in, first, clarification of the notion and essence of an economic system's energy security from the position of the sustainable development goals (SDGs) through consideration of not only the function of provision of stability and high effectiveness of the energy system but also the function of environmental protection and, second, rethinking the consequences of the transition to sustainable and clean energy from the position of the fuel and energy complex performing its two functions on the provision of energy security.

The practical significance of the authors' conclusions and recommendations is that they could be used during the development and implementation of programs and strategies for energy security provision since they suggest sustainable and clean energy as a prospective management tool. Energy policy implications consist in the expedience of including the indicators and plans for the development of sustainable and clean energy in the programs for achieving SDG 12 and SDG 1 and the necessity to reconsider the programs for achieving SDG 7, given the absence of a close connection between it and clean energy.

Author contributions

YK, VKr, VKi, and AY were responsible for writing the original draft, investigation, methodology, supervision, and writing and editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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