Energy security of the country: case for Ukraine and EU

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Abstract: The core goal Green Deal Policy is providing energy security for countries' green growth. Moreover, the ongoing political crisis and countries' energy dependence necessitate the development of effective instruments for providing energy security. The paper aimed to estimate the countries' energy security to identify energy security's core drivers and bottlenecks in the EU and Ukraine. The study contained two main stages: 1) bibliometric analysis – to identify the scientific background on the abovementioned issues and develop the theoretical framework of the investigation; 2) to estimate the energy security of the country. The findings of bibliometric analysis (co-occurrence criteria) confirmed the growth of the papers' number, which focused on the investigation of energy security. Thus, the papers' number has increased 2.5 times over the past five years. The results allowed to identify the three core triggers that affect energy security: environmental (greenhouse gas emissions, environmental quality, etc.), institutional (efficiency of public administration, infrastructure development, etc.) and behavioural (society willingness to adopt energy and resource-saving lifestyles, considering environmental factors in decision-making, etc.). The objects of the investigation are the EU countries and Ukraine (as the potential EU member). The data for the years 2000-2020 were obtained from Eurostat, World Data Bank, Ukrstat, OECD. The study applied the method based on the MARKAL model to estimate the energy security of the countries, as well as Godric-Prescott and Butterworth filters to consider the indicators' fluctuation of energy security. The findings concluded that Ukraine (as the potential EU member) should converge with EU policies in the energy sector to increase energy security. Moreover, Ukraine should adopt EU practices to extend green energy technologies, promote a green mind and lifestyle among society, and create supporting instruments for developing alternative energy.

Keywords: energy policy, energy efficiency, green growth, green deal, renewable energy, sustainable development.

JEL: P18; P28; P48; Q43; Q48

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Introduction

Energy security is one of the milestones of a country's sustainable development. Considering the International Energy Agency (IEA), energy security is access to the energy sources with affordable prices on the regular base without disruptions [IEA, 2022]. In this case, all European Union countries try to change the energy balance structure on the way to increase the share of renewable energy in total energy consumption. Thus, the electricity power stations which used the coal, nuclear and hydro are in the decline from year to year.

At the same time, the effective policy and institutional regulations could provide reliable energy access during the transformation of country's energy balance. The energy issues are being intensified by the political conflicts. There is a need for relevant instruments to identify the bottlenecks in energy system and policy, and mechanisms to overcome them. In this direction, the EU countries have accepted the European Green Policy, which declared the step-by-step decarbonisation of EU economy. Thus, they are going to decline greenhouse gas emissions by 55% by 2030 [A European Green Deal, 2022]. At the same time, there is a need for empirical justification of rational balance between traditional and renewable energies in the country's energy balance structure. In this case, it is actual to develop appropriate approaches to forecasting the country's energy balance structure with the purpose to define an effective way of changing it and guaranteeing energy security.

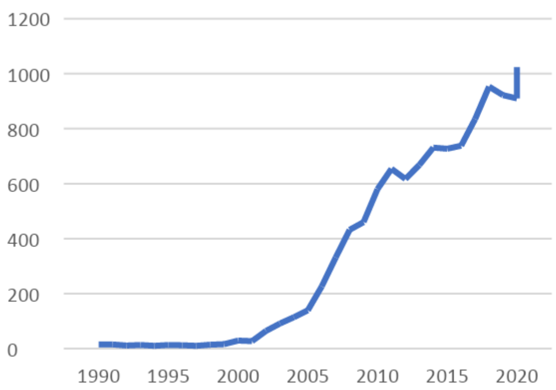
Theoretical premises

Energy security is well investigated and widely used, however, the there are no unified approaches to defining it [Kruyt et al., 2009; Ellabban et al., 2014; Goldthau & Sovacool, 2012]. It could be explained that energy security depends on the country's location, available resources, and vast range of dimensions (ecological, technical rediness of the energy system, economy development, social progress, institutional efficiency, etc.). A study by Ang et al. [2015] based on 83 definitions concluded that meaning of energy security depends on the context. Thus, the study by Ang et al. [2015] defined energy security through seven core dimensions: energy availability; energy infrastructure; energy price; social consequences; environment; energy management and energy efficiency. Winzer C. (2012) defined energy security considering the group of risk sources: technical, human, and natural. The paper by Kruyt et al. [2009] highlighted that it is security from the access to supply of energy.

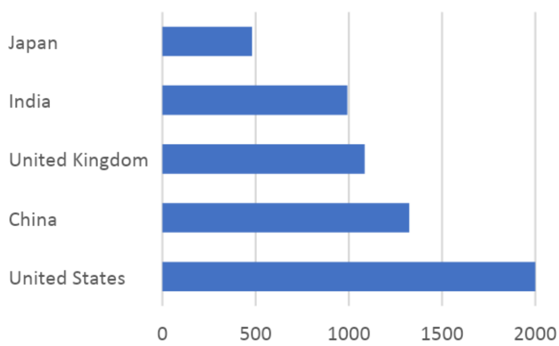
To identify the core factors that influence energy security, the study applied the bibliometric analysis using the benchmarks Scopus and Web of Science Tools Analysis. The methodology of analyses was based on the studies by Lyulyov et al. [2020]; Ziabina et al. [2020]; Soliman et al. [2021]; Us et al. [2020]. The following thresholds were chosen: keywords – energy, environment, energy security, institutions, infrastructure, greenhouse gas emissions, green mind, green lifestyle; boolean operators – or, and in different combinations; time – 1990-2021; language – English.

At the first stage, all publications were published to exclude the duplicates from Scopus and Web of Science. Afterwards, 11 401 publications were included in the analysis. The findings confirmed that the number of publications on energy security have been increasing for the past five years (figure 1a). In 2021, 1024 papers were published, which is higher by 40% compared to the year 2015. It has been noted that the scientists from the United States of America published the highest number of the papers – 2063, from China – 1324 papers, and from the United Kingdom – 1085 papers (Figure 1b). Sovacool B. K. has the most powerful scientific background in the investigations on energy security – 83 papers for the years 1990-2021. Thus, the most cited studies by Köhler et al. [2019]; Sovacool [2016, 2008, 2014]; Sovacool et al. [2018, 2019] focused on the analysis of the ways to overcome energy issues in countries. It should be noted that Chinese Academy of Science is prolific among institutions which focused research on energy security (Fig. 1d).

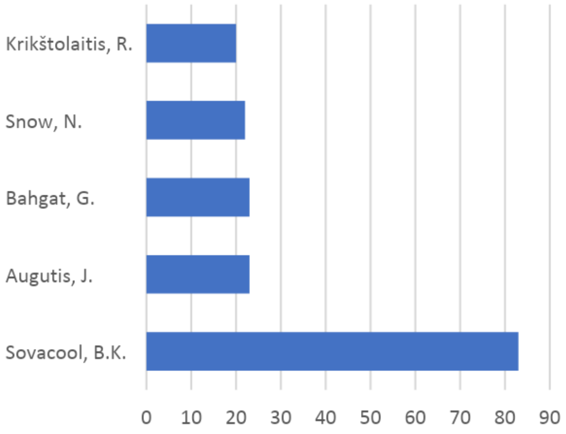
Figure 1. The visualisation of publication activity on energy security for 1991-2021



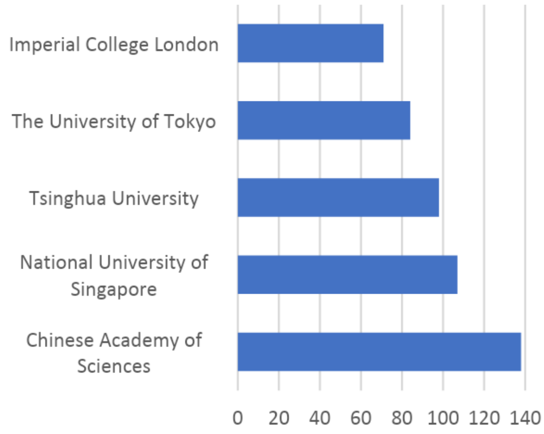
(a) – number of publications on energy security for 1990-2021



(b) – the TOP-5 countries in the investigation of energy security



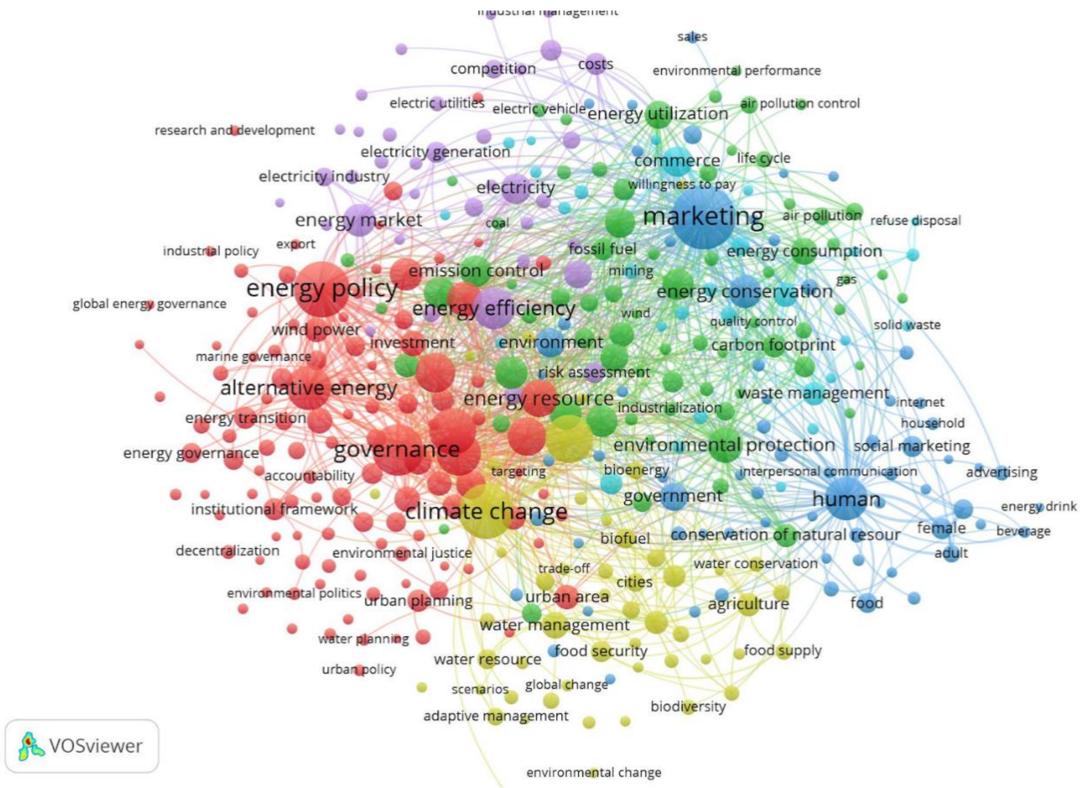
(c) – the TOP-5 authors in the investigation of energy security



(d) – the TOP-5 institutions in the investigation of energy security

Using VOSviewer version 1.6.18 allowed conducting the co-occurrence analysis of the selected papers. Figure 2 visualises the findings of co-occurrence analysis by country for the years 1991-2021.

Figure 2. The visualisation of co-occurrence analysis by country for 1991-2021



The findings of the co-occurrence analysis allocated five core clusters in the investigation of energy security. **The biggest was red cluster, which merged the following**

keywords: energy governance, institutional framework, infrastructure development, etc.
Thus, Sovacool & Mukherjee [2011] confirmes that providing energy security could be realised without relevant infrastructure and effective government management. At the same time, Correljé & van der Linde [2006] highlighted that the EU should reorient and update its energy policy, rebuild its structure, and reinforce the energy governance. Furthermore, the study by Goldthau & Sovacool [2012] identified that limitation in the provision of energy security was due to the complexity of energy governance (vertical and horizontal complexity) and the lowest level of the energy system's resilience. They confirmed the necessity to update and reorient the energy policy, considering new issues related to the decarbonization of the economic development. The studies by Szulecki et al. [2016], Alagpuria [2021], Dzwigol et al. [2021], Kharazishvili et al. [2021] highlighted that energy security of the EU countries depended on efficiency of national and common EU governance. Thus, they allocated the key issues in providing energy security and mechanism to overcame them.

The purple cluster focused on the analysis of electricity generation and technical issues of the energy system. Thus, most EU countries try to change the energy structure, eliminating traditional sources and enlarging the scope of renewable energy in the country's energy balance. The study by Wang et al. [2011] confirmed that energy security in Pakistan is related to the affordability of renewable energy in the country. Thus, they justified that the countries with developed infrastructure for renewable energy had the higher level of the energy security. However, based on the interview in Finland, France and the United Kingdom, the study by Teräväinen et al. [2011] justified the necessity to develop nuclear energy and new nuclear power stations. Daniel Yergin [2006] concluded that energy security required the diversification of energy sources. Furthermore, he confirmed the necessity of changes in the energy balance structure through developing the "clean coal", and a new generation of nuclear power and renewable energy, as they become more competitive. Yergin [2006] highlighted that it required the relevant energy infrastructure and investment. The paper by Ellabban et al. [2014] confirmed that high price of traditional energy recourse had the negative impact on the country's energy security. In this case, the scientists proved the necessity of alternative energy development. The paper by Ellabban et al. [2014] highlighted the advantages and disadvantages of renewable energy under the types (solar, wind, hydro and etc.). Moreover, they concluded that enlarging the scope of renewable energy could not be effective without the development of smart grid technologies. The scientists Asif & Muneer [2007] analysed five countries that have an impact the world energy market (the USA, India, China, Russia, the United Kingdom) and confirmed that alternative energy (solar, wind, biomass, etc.) could satisfy the ongoing and future energy demand without declining of energy security.

The green cluster penetrated all clusters and contained the following keywords: greenhouse gas emissions, environmental quality, protection, etc. Thus, the study by Owusu & Asumadu-Sarkodie [2016] defined energy security as uninterrupted energy supply for stable economy development. Besides, they confirmed that providing energy security requires extending the scope of renewable energy. Furthermore, other studies by Owusu & Asumadu-Sarkodie [2016]; Formankova et al. [2018]; Sotnyk et al. [2018]; Miskiewicz [2020]; Chygryn et al. [2015]; Fila et al. [2020] identified that renewable energy allowed to reduce greenhouse gas emissions and mitigate the climate changes. Jacobson M. [2009] highlighted that most environmental issues and global warming were caused by the exhaust from the combustion of solid, liquid, and gaseous substances during energy production and use. These issues could be overcome by introducing cardinal changes in the energy sector. Besides, as the demand and the price of fossil-fuels has been increasing from year to year, the government should develop new approaches to providing undisrupted energy supply, which is the basis of energy security. Jacobson M. [2009] found that developing green energy allowed to reduce the negative impact on the environment and people health. The study allocated the positive impact of green energy on health and environment by the types (solar, wind, hydro and etc.) and stages of the life circle (generation and use).

The blue cluster merged the following keywords: marketing, behaviour, green mind, etc. The study by Anable et al. [2012] emphasised the social and cultural gaps that restrict the spreading of renewable energy and reduce energy security. Taking the transport sector of the United Kingdom as an example, they explained that without relevant demand for renewable energy, the supply could not be increased. Using the logit model, the study by Zainudin et al. [2016] confirmed that behavioral (perceived of product advantages and control negative behaviour), social (household's size), and economic (household's income) dimensions have a significant impact on the consumers' willingness to pay for energy saving products. In this case, the authors Zainudin et al. [2016] highlighted the role of green marketing in promotion of green technologies, including green energy. Qian, L. and Yin, J. [2017] analysed the role of ethical value in spreading of renewable energy and energy-efficient technologies. With their findings, they confirmed that the green policy and social marketing should pay attention to cultural values to promote the energy efficiency technology and resource-saving lifestyles. Using the ptobit and tobit models, the Slovenian scientists analysed the willingness to pay for green electricity. Considering the findings, the age and household's size had a negative statistically significant impact on the willingness to pay for green electricity. However, income, education, and green awareness had a positive statistically significant impact on the willingness to pay for green electricity Zorić & Hrovatin [2012].

To sum up, the results allowed to identify the three core triggers that affect energy security and should involve due to the energy security assessment: institutional (efficiency of public administration, infrastructure development, etc.), environmental (greenhouse gas emissions, environmental quality, etc.), and behavioural (society's willingness to adopt energy and resource-saving lifestyles, considering environmental factors in decision-making, etc.).

Methodology

Ukraine identified the European vector of development. It necessitates the implementation of energy policy aimed at improving the energy efficiency of the national economy, as this not only corresponds to rapid integration with the EU in this area, but also, above all, reduces the destructive impact on the environment. It is the main condition for achieving the Sustainable Development Goals of the country. It should be noted that providing energy security allowed achieving sustainable energy supply, reducing greenhouse gas emissions, increasing security of supply, and reducing the cost of energy imports, but also has increased the competitiveness of the national economy. Table 1 contains the dimensions of the country's energy efficiency as a core indicator of energy security.

Table 1. The variables for the assessment of the country's energy efficiency

Variables	Symbols
The share of renewable energy sources in the power industry	x1e
The share of renewable energy in heating and cooling	x2e
The share of renewable energy sources in transport	x3e
Primary and final energy consumption (reduction)	x4e
Energy intensity per unit of GDP (decrease)	x5e
Fuel consumption for electricity and heat production (gradual reduction of coal use (both hard and brown))	x6e
Primary energy consumption	x7e
The share of renewable energy in final energy consumption	x8e
Coefficient of dependence of energy imports on solid fossil fuels	x9e

Source: own work.

The country's import-export energy balance, which largely depends on the effectiveness of its international policy/relations, plays an important role in meeting demand and determining the structure of electricity production, as well as the electricity at the wholesale market. The following indicators were used to estimate "efficiency of international relations" of the integrated indicator of energy security: net balance of import-export of electricity (($x1f$); the dependence of the country on energy imports ($x2f$) (calculated as the total amount of energy imported from other countries to gross domestic energy consumption).

Stable and secure electricity supply depends on the development of the national energy system. In addition, its level determines the possibility of cross-border connections and entry into the unified European energy market. It allows attracting additional sources of energy supply. Furthermore, it catalyzes the internal market development, reduces energy prices, as well as limits the negative effects of threats and restrictions. Increasing the capacity of cross-border connections between member states of the single energy market should be done primarily through the optimal use of existing connections and the removal of barriers to market access. It should consider national systems, changing the rule of providing capacity between states, optimizing methods of providing with the capacity of market participants, etc. The key indicators of measuring the "internal energy market" of the integrated energy indicator are: System Average Interruption Duration Index, SAIDI *(*$x1in$*),* share of the energy losses ($x2in$).

Assumptions about the interdependence of macroeconomic and energy indicators, in particular the MARKAL-MACRO model, play an important role in the systemic approach to the study of a country's energy security. This model was developed to estimate the decarbonization impact on GDP growth in the United Kingdom [Manne & Wene, 1992]. The parameters in the model were capital, labour, and energy resources:

(1) $$Yt=Ct+It+ECt$$

where Yt, Ct, It, and ECt are the production, consumption, investment, and energy costs in period t.

The model contains the indicators of the energy system covering from the energy production, energy import / export, conversion, transmission, and distribution for final consumption. Thus, the energy forecasting depends on positive and negative fluctuations of labour forces, capital, and volume of output. At the same time, in contrast to the existing model, which allows, along with traditional indicators of energy system development, considering indicators of change in international and national social and economic development (efficiency of international relations and implementation of energy policy, human security). Thus, the assessment of energy security along with indicators of fuel and energy sector should consider economic, environmental, and resource constraints (labor, capital). Therefore, the integrated indicator of energy security considers the indicators of measurement "macroeconomics, health care, environment, employment and education, skills and social impact" (Table 2).

Table 2. The variables for the assessment of a country's energy security

Variables	Symbols
CO_2 emissions per capita	x1m
Ozone concentration	x2m
The waste generated	x3m
The average minimum wage	x4m
The current costs of environmental protection	x5m
The cost of electricity	x6m
The cost of natural gas	x7m
The share of household expenditures on housing and utilities	x8m

Source: own work.

The study applied the entropy method to determine the influence of the indicators of each of the vectors on the integrated energy security index. This approach allows to consider the maximum / minimum values of indicators of energy security vectors and to eliminate the subjective nature of its assessment.

Step 1: the normalization of initial parameters is carried out:

Positive indicator:

(2) xij*=xij-mjMj-mj

Negative indicator:

(3) xij*=Mj-xijMj-mj

where Mj=maxxij, mj=minxij.

Step 2: Calculate the indicator weight:

(4) pij=xij/i=1nxij

Step 3: Calculate the information entropy of each component based on the specific gravity:

(5) ej=-1ln n i=1mpijln pij

Step 4: Calculate the information entropy redundancy:

(6) dj=1-ej

Step 5: Calculate the weights of each indicator:

(7) wj=dji=1ndj

Step 6: The assessment of integrated energy security index using the taxonomic method:

(8) IEC=Ie+If+Iin+Im=j=1njxej*+i=1nixfj*+i=1nixinj*+i=1nixmj

where IEC – integrated energy security index; Ie, If, Iin, Im – sub-indexes' vectors of "energy efficiency", "efficiency of international relations", "internal energy market", "macroeconomics, health care, environment, employment and education, skills and social impact".

The IEC should be in neasure between 0-1 (Table 3). The lagest value of IEC indicates the higher level of energy security, and the lower value IEC – smaller level of energy security.

Table 3. The threshold of a country's energy security

Interval	Country's energy security
0,75 ≤ IEC< 1	High
0,5 ≤ IEC< 0,75	Average
0 ≤ IEC< 0,5	Low

Source: own work.

Results

Table 4 contains the findings of the indicators' weights of the integrated energy security index.

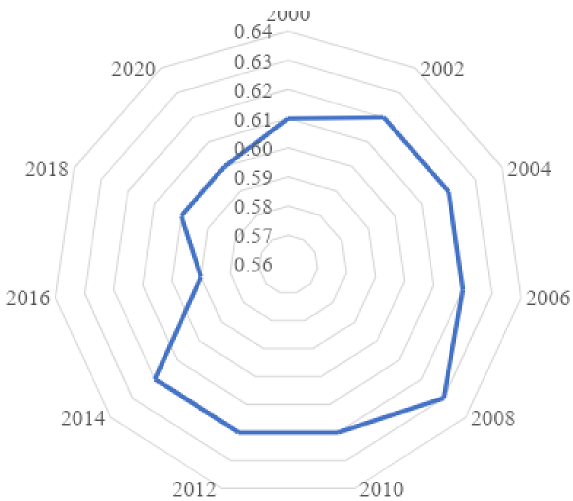
Table 4. The indicators' weights of a country's energy security

indicators	x1e	x2e	x3e	x4e	x5e	x6e	x7e	x8e	x9e	x1f	x2f
wj	0.058	0.056	0.045	0.065	0.062	0.066	0.062	0.097	0.058	0.056	0.045
	x1in	x2in	x1m	x2m	x3m	x4m	x5m	x16m	x7m	x8m	
wj	0.038	0.038	0.033	0.012	0.006	0.070	0.042	0.039	0.024	0.021	

Source: own work.

Empirical calculations of indicators' normalized values of energy security vectors considering their weighting factors allowed calculating their integral level, using the taxonomic method. Figure 3 contains the findings of integrated energy security index for Ukraine for the 2000–2020 years.

Figure 3. The findings of the country's energy security index for Ukraine for the 2000–2020 years.



The findings (Figure 4) confirmed the uneven fluctuations of the country's energy security index, which occured, in particular, in 2004-2008 and 2014-2018. Relevant negative changes occurred during the two political crises (2004 – Orange Revolution, 2014 – Revolution of Dignity), which led to economic downturns and the loss of part of Ukraine.

In the context of energy security, it is important to assess the level of asynchrony of state energy policy with European practices to implement the energy efficient component of the European Green Deal Policy and the speed of its response to exogenous and endogenous changes in the national economy. This approach is based on the theoretical principles of the σ- and β-convergence, considering the economic development of the country, its openness and involvement in globalization. Estimation of σ-convergence of vectors:

(9) $$\sigma_t^c = (1/n\sum_{i=1}^{n}\left(\ln x_{ij,t} - \ln\overline{x_{ij,t}}\right)^2)^{1/2}$$

where xij – the i-th indicator of the vector of the country's energy security in the t-th year; n – number of countries to calculate group convergence.

Estimation of β- convergence of vectors:

(10) $$\ln\,(x_{ij,t}/x_{ij,t-1}) = C + \beta\ln(x_{ij,t-1}) + \delta F_{it} + \varepsilon_{it}$$

where Fit – explanation variable of parameters' fluctuations of the country's energy security index (economy openness, involvement in globalization processes, the efficiency of public administration, etc.)

Summary, recommendations

The summarising of theoretical background on analysis of energy security allowed allocated five core scientific directions. Thus, it allowed to define the significant indicators that should be considered under energy security assessment. The study applied the MARKAL model for energy security assessment. It allows considering changes in the international and national conditions of a country's socio-economic development (efficiency of international relations and implementation of energy policy, human security).

According to the findings, the integrated energy security index had the highest value in 2008 – 0.628 points, and the lowest value in 2016 – 0.594 points. It was provoked by the military and political instability in Ukraine, which significantly slowed down the transformation of the country's transition from export-raw materials to resource-innovation models, as well as reforms to ensure a green structure of energy consumption. In addition, during the study period 2000–2020, the level of the integrated energy security index of the national economy was characterized by fluctuations that occured in 2004–2008 and 2014–2018.

The findings confirmed that Ukraine (as the potential EU member) should converge with the EU policies in the energy sector to increase energy security. Moreover, Ukraine should adopt EU practices to extend green energy technologies, promote green thinking and lifestyle among society, and develop supporting instruments for developing alternative energy.

References

A EUROPEAN GREEN DEAL. (2022). URL: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

ALAGPURIA, M. (2021). Sustainable Financing for the Entrepreneurship Continual Growth: A Gap Analysis on Small and Medium Enterprises in India. *Virtual Economics*, *4*(2), 105-119. https://doi.org/10.34021/ve.2021.04.02(6)

ANABLE, J., BRAND, C., TRAN, M., & EYRE, N. (2012). Modelling transport energy demand: A socio-technical approach. *Energy Policy, 41*, 125-138. doi:10.1016/j.enpol.2010.08.020

ANG, B. W., CHOONG, W. L., & NG, T. S. (2015). Energy security: Definitions, dimensions and indexes. *Renewable and Sustainable Energy Reviews*, 42, 1077–1093.doi:10.1016/j.rser.2014.10.064

ASIF, M., & MUNEER, T. (2007). Energy supply, its demand and security issues for developed and emerging economies. *Renewable and Sustainable Energy Reviews*, 11(7), 1388–1413. doi:10.1016/j.rser.2005.12.004

CHYGRYN, O., & KRASNIAK, V. (2015). Theoretical and applied aspects of the development of environmental investment in Ukraine. *Marketing and management of innovations (3)*, 226-234.

CORRELJÉ, A., & VAN DER LINDE, C. (2006). Energy supply security and geopolitics: A european perspective. *Energy Policy, 34*(5), 532-543. doi:10.1016/j.enpol.2005.11.008

DZWIGOL, H., TRUSHKINA, N., & KWILINSKI, A. (2021). The Organizational and Economic Mechanism of Implementing the Concept of Green Logistics. *Virtual Economics*, *4*(2), 41-75. https://doi.org/10.34021/ve.2021.04.02(3)

ELLABBAN, O., ABU-RUB, H., & BLAABJERG, F. (2014). Renewable energy resources: Current status, future prospects and their enabling technology. *Renewable and Sustainable Energy Reviews, 39*, 748-764. doi:10.1016/j.rser.2014.07.113

FILA, M., LEVICKY, M., MURA, L., MAROS, M., & KORENKOVA, M. (2020). Innovations for Business Management: Motivation and Barriers. *Marketing and Management of Innovations*, 4, 266-278. http://doi.org/10.21272/mmi.2020.4-22

FORMANKOVA, S., TRENZ, O., FALDIK, O., KOLOMAZNIK, J., & VANEK, P. (2018). The future of investing-sustainable and responsible investing. *Marketing and Management of Innovations,* 2, 94-102. http://doi.org/10.21272/mmi.2018.2-08

GOLDTHAU, A., & SOVACOOL, B. K. (2012). The uniqueness of the energy security, justice, and governance problem. *Energy Policy, 41*, 232-240. doi:10.1016/j.enpol.2011.10.042

IEA. (2022). International Energy Agency. URL: https://www.iea.org/topics/energy-security

JACOBSON, M. Z. (2009). *Review of solutions to global warming, air pollution, and energy security. Energy Environ. Sci., 2(2), 148–173.* doi:10.1039/b809990c

KHARAZISHVILI, Y., KWILINSKI, A., DZWIGOL, H., & LIASHENKO, V. (2021). Strategic European Integration Scenarios of Ukrainian and Polish Research, Education and Innovation Spaces. *Virtual Economics*, *4*(2), 7-40. https://doi.org/10.34021/ve.2021.04.02(1)

KÖHLER, J., GEELS, F. W., KERN, F., MARKARD, J., ONSONGO, E., WIECZOREK, A., . . . WELLS, P. (2019). An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions, 31*, 1-32. doi:10.1016/j.eist.2019.01.004

KRUYT, B., VAN VUUREN, D. P., DE VRIES, H. J. M., & GROENENBERG, H. (2009). *Indicators for energy security. Energy Policy, 37(6), 2166–2181.* doi:10.1016/j.enpol.2009.02.006

LYULYOV, O., & MOSKALENKO, B. (2020). Institutional Quality and Shadow Economy: An Investment Potential Evaluation Model. *Virtual Economics*, *3*(4), 131-146. https://doi.org/10.34021/ve.2020.03.04(7)

MISKIEWICZ, R. (2020). Internet of Things in Marketing: Bibliometric Analysis. *Marketing and Management of Innovations*, 3, 371-381. http://doi.org/10.21272/mmi.2020.3-27

OWUSU, P. A., & ASUMADU-SARKODIE, S. (2016). A review of renewable energy sources, sustainability issues and climate change mitigation. *Cogent Engineering*, *3*(1), 1167990.

QIAN, L., & YIN, J. (2017). Linking Chinese cultural values and the adoption of electric vehicles: The mediating role of ethical evaluation. *Transportation Research Part D: Transport and Environment*, *56*, 175-188.

SOLIMAN, M., LYULYOV, O., SHVINDINA, H., FIGUEIREDO, R., & PIMONENKO, T. (2021). Scientific output of the European Journal of Tourism Research: A bibliometric overview and visualization. *European Journal of Tourism Research*, *28*, 1-20.

SOTNYK, I., SHVETS, I., MOMOTIUK, L., & CHORTOK, Y. (2018). Management of Renewable Energy Innovative Development in Ukrainian Households: Problems of Financial Support. *Marketing and Management of Innovations*, 4, 150-160. http://doi.org/10.21272/mmi.2018.4-14

SOVACOOL, B. K. (2008). Valuing the greenhouse gas emissions from nuclear power: A critical survey. *Energy Policy, 36*(8), 2950-2963. doi:10.1016/j.enpol.2008.04.017

SOVACOOL, B. K. (2014). What are we doing here? analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Research and Social Science, 1*, 1-29. doi:10.1016/j.erss.2014.02.003

SOVACOOL, B. K. (2016). How long will it take? conceptualizing the temporal dynamics of energy transitions. *Energy Research and Social Science, 13*, 202-215. doi:10.1016/j.erss.2015.12.020

SOVACOOL, B. K., & HIRSH, R. F. (2009). Beyond batteries: An examination of the benefits and barriers to plug-in hybrid electric vehicles (PHEVs) and a vehicle-to-grid (V2G) transition. *Energy Policy, 37*(3), 1095-1103. doi:10.1016/j.enpol.2008.10.005

SOVACOOL, B. K., & MUKHERJEE, I. (2011). Conceptualizing and measuring energy security: A synthesized approach. *Energy, 36*(8), 5343-5355. doi:10.1016/j.energy.2011.06.043

SOVACOOL, B. K., AXSEN, J., & SORRELL, S. (2018). Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design. *Energy Research and Social Science, 45*, 12-42. doi:10.1016/j.erss.2018.07.007

SZULECKI, K., FISCHER, S., GULLBERG, A. T., & SARTOR, O. (2016). Shaping the 'Energy union': Between national positions and governance innovation in EU energy and climate policy. *Climate Policy, 16*(5), 548-567. doi:10.1080/14693062.2015.1135100

TERÄVÄINEN, T., LEHTONEN, M., & MARTISKAINEN, M. (2011). Climate change, energy security, and risk-debating nuclear new build in finland, france and the UK. *Energy Policy, 39*(6), 3434-3442. doi:10.1016/j.enpol.2011.03.041

US, Y., PIMONENKO, T., & LYULYOV, O. (2020). Energy efficiency profiles in developing the free-carbon economy: On the example of Ukraine and the V4 countries. *Polityka Energetyczna*, *23*

WANG, Y., XU, L., & SOLANGI, Y. A. (2020). Strategic renewable energy resources selection for pakistan: Based on SWOT-fuzzy AHP approach. *Sustainable Cities and Society, 52*. doi:10.1016/j.scs.2019.101861

WINZER, C. (2012). Conceptualizing energy security. *Energy Policy*, 46, 36–48.doi:10.1016/j.enpol.2012.02.067

YERGIN, D. (2006). *Ensuring Energy Security. Foreign Affairs, 85(2), 69.* doi:10.2307/20031912

ZAINUDIN, N., SIWAR, C., CHOY, E. A., & CHAMHURI, N. (2016). Low-hanging Fruits Impact of Socio-Economic and Behavioral Characteristics on Consumers' Willingness to Pay. *Malaysian Journal of Consumer and Family Economics*, *9*, 115-126.

ZIABINA, Y., & PIMONENKO, T. (2020). The Green Deal Policy for Renewable Energy: A Bibliometric Analysis. *Virtual Economics*, *3*(4), 147-168. https://doi.org/10.34021/ve.2020.03.04(8)

ZORIĆ, J., & HROVATIN, N. (2012). Household willingness to pay for green electricity in Slovenia*. Energy Policy, 47, 180–187.* doi:10.1016/j.enpol.2012.04.055

MANNE, A. S., & WENE, C. O. (1992). *MARKAL-MACRO: A linked model for energy-economy analysis* (No. BNL-47161). Brookhaven National Lab., Upton, NY (United States).