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Editorial

Transformation of Energy Markets: Description, Modeling of Functioning Mechanisms and Determining Development Trends

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1. Introduction

One of the key contemporary economic and social issues today is the global energy transition [1–3]. Energy transition processes are having a significant impact on the development of world economies, increasing their TFP and leading to an increase in their level of innovation through the transfer of myriad new technologies [4,5]. These processes also contribute to an increase in foreign direct investment and, consequently, an increase in the level of business investment, the competitiveness of economies and changes in the labor market [6,7]. Additionally, contributing to the systematic and dynamic development of the energy transition are the significant increase in the wealth of the population, the change in the degree of social and income inequality, the change in consumption patterns and the significantly increased consumption of energy by households, which until recently relied exclusively on the use of energy from conventional sources [8–12].

It should be noted that the ongoing energy transition processes most strongly affect the development of energy markets, the largest of which are the electricity primary fuel markets. Currently, energy markets represent an increasingly significant aspect of modern economies in terms of business investment, the share of the sector's output in GDP, as well as research and development. In recent years, the renewable energy sector has also been gaining importance as a natural complement to the two aforementioned markets [13–15]. Undoubtedly, the development of the renewable energy sector is linked to the goals of sustainable development [16–19], where the greatest emphasis is placed on caring for the environment and transitioning from classical energy sources to renewable and non-carbon sources. In addition, it is assumed that entrepreneurship is to take on a new meaning and is to be implemented as part of the emergence of sustainable start-ups and the transition of businesses to meet sustainable goals and increase the use of renewable energy [20–22].

All the above-mentioned aspects of the development of modern economies point to the need to take a fresh look at the development and functioning of energy markets. Of particular importance seems to be the analysis of changes in the prices of electricity and primary fuels and the relationship between these markets and the renewable energy market. Equally important are analyses to identify development trends already occurring in the energy markets and to make predictions about the formation of these trends in the future. Such identified studies should provide valuable guidance for the purposes of conducting current energy policy and creating institutional and legal conditions for the development of energy markets. Conclusions from research on energy markets also provide substantive arguments for the assumptions of global energy strategies, as well as the energy strategy of individual countries.

2. A Short Review of the Contributions in This Special Issue

Dynamically developing energy transition processes and their increasingly stronger links with the electricity market, the primary fuels market and the RES sector are an

Citation: Pietrzak, M.B.; Kuc-Czarnecka, M. Transformation of Energy Markets: Description, Modeling of Functioning Mechanisms and Determining Development Trends. *Energies* **2022**, *15*, 5493. https://doi.org/10.3390/en15155493

Received: 14 July 2022
Accepted: 26 July 2022
Published: 29 July 2022

important argument for the creation of a Special Issue under the title of "Transformation of energy markets: Description, modeling of functioning mechanisms and determining development trends", in which 12 research papers were published.

The paper [23] presents a new approach to the evaluation of the energy transformation process in the Member States of the European Union. In their study, the authors used the variables describing SDGs 7, 8, 10, 11 and 12 to assess the economic potential and current energy consumption patterns. Using an innovative set of diagnostic features and applying taxonomic methods, the authors grouped the EU countries according to the emissivity of their economies and the potential to fulfil the assumptions of the energy transition process. The authors note that there is a systemic problem with the implementation of energy transition and that not all countries will be able to meet the goals set by the EU. For many countries, this process can be demanding and backbreaking. The countries included in this group contain Bulgaria, Croatia, Greece, Latvia, Lithuania, Portugal, and Romania, as they are high-emission economies with relatively poor populations. At the other extreme, i.e., characterized by the tremendous potential for a smooth transition in the energy transformation process, there are countries with a high share of renewable energy sources, namely, the Nordic countries and Estonia. The authors emphasize the importance of a harmonized energy transition process, noting that the suspension of energy transformation processes may move from one region to the entire member state, or that it is possible for the economy of one of the countries, or a group of countries, to undergo a serious economic crisis. Thus, such eventualities would bring some countries back to the starting point and jeopardize the future of the entire EU energy project [24].

The authors of [25] investigated whether the COVID-19 pandemic had a noticeable effect on energy consumption and affected the business cycle. It turns out that socio-economic development and energy transformation processes may be hampered or even stopped by unforeseen events, an example of which undoubtedly being the outbreak of the coronavirus pandemic [26]. Two hypotheses were proposed: that energy consumption is the leading factor shaping the business cycle, and that there is a translation of the clock of energy consumption into business cycles. Using spectral analysis and the business cycle clock, the authors determined the phase spectrum between energy consumption (in GWh) and GDP. They confirmed that energy consumption can be used as a leading indicator of the business cycle, indicating that the largest decrease in energy consumption occurred during the first lockdown. Smaller declines during successive waves of the COVID-19 virus are mainly due to smaller restrictions and their weaker impact on economic activity. As for business clocks, the authors' research showed that only Sweden and Norway remained around their long-term trend, and in other cases, the business cycle phase shifted from deep recession to the middle level or to recovery.

The authors of [27] focus on the challenges and opportunities for the development of photovoltaics in Poland, taking into account the aspect of information asymmetry between energy source producers and consumers. The qualitative research conducted on Polish small- and medium-sized enterprises showed that the main source of information asymmetry is the operation of the regulator, the technological conditions related to the early stage of technology development and the lack of appropriate knowledge held by the end customer about the investment. The authors also pointed out that this highly dynamically developing sector in Poland suffers from a high rotation of employees, especially those with special technological competencies, and volatile political decisions.

In [28], the authors focus on energy consumption in health care facilities, trying to set the determinants of electricity and thermal energy costs in relation to the size and intensity of work in Polish clinics. Multivariate backward stepwise regression analysis was used to analyze financial and resource data of all Polish hospitals from 2010 to 2019. An interesting element was also the division of the country into four climatic zones. The obtained results showed that energy consumption not only depends on the operational activities of Polish hospitals but is also related to the geographical location. This was especially true for surgical hospitals; the warmer the climatic zones, the higher the EEC.

In the case of non-surgical hospitals, no influence of the climatic zone on the EEC was observed.

The authors of [29] deal with factors determining the demand for energy consumption from renewable sources in European countries. The study presents institutional, social, historical and economic factors shaping the demand for energy from renewable sources. Despite the general awareness of Europeans and a positive attitude towards green energy, these factors are not universal in all countries. Based on the BACE model methodology, the authors showed that there is a divergence concerning REC in Europe. Additionally, the lags are visible in the case of Croatia, Cyprus, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia, where GDP and FDI growth could help in a faster transition to less climate-damaging energy. The study also confirmed that global awareness of climate change increased after the Paris Agreement, creating room for changes in energy policy in both developed and developing countries in Europe.

As in the case of article [3,30] also refers to the process of energy transformation, with the difference being, however, that it focuses on this process only in Poland, taking into account international obligations and the current national policy. The author emphasizes that regardless of the scenario realized, the transition to green energy and the reduction in CO2 emissions will inevitably entail an increase in energy prices, thus possibly leading to energy poverty for some Poles. The author also emphasizes that Poland's lack of climate neutrality in 2050 will mean that it will not fully participate in the global technological revolution. As a remedy, he recommends a diversified scenario with natural gas, stressing that due to political and historical reasons, nuclear power has no real chance of being accepted in the country. The solution to the problems raised in the article [30] is undoubtedly the further development of the RES sector, which, as shown in articles [31,32], is able to meet in full, for the most part, the energy needs of the regions.

The author of the article [33] undertook the research topic of the relationships between crude oil prices and exchange rates. While this is a fairly popular issue, there is no one consistent answer regarding the shape and direction of this relationship. The author, basing his analysis on the nonlinear Granger causality tests and SVR models, showed the existence of stronger bidirectional causal relations between crude oil prices and exchange rates EUR/USD and GBP/USD, and weaker relations between crude oil prices and JPY/USD. The revealed existence of bidirectional causal relations between crude oil and exchange rates' returns implies the potential possibility of using lagged values of one of these variables as the regressor for the second one.

In [34], the author was devoted to the issue of energy poverty in households run by individuals aged 60 and older. The article uses the energy poverty index, which has not been used in Poland so far; the energy poverty index is a composite indicator containing both objective and subjective assessments of the housing situation of the elderly. Its values were then the basis for multidimensional statistical analyses of households, including cluster analysis. The results obtained by the author suggest that households consisting of elderly people are strongly diversified and that the energy deprivation of Polish households, of people aged 60 and older, seems to occur mainly among specific socio-professional clusters (living in the countryside, having low education and low income). The author points out that these are people whose apartments are, in most cases, heated with coal, and its rejection at the national level may deepen the energy exclusion of older people. To prevent this, it is suggested to expand gas pipelines to also connect households located in rural areas.

The authors of [35] refer to the spatial relationship of air pollution, economic growth, and renewable energy consumption. The authors of the study looked at the classical environmental Kuznets curve (EKC) and enriched it with spatial dependencies. A non-obvious solution was to create a neighborhood matrix not based on geographic location, but based on the values of the ecological footprint measure. The results of the spatio-temporal Durbin model determined the indirect effects, showing that the Kuznets curve has an inverse U-shaped relationship between the per capita GDP and CO_2 emission. It is worth noting that relatively highly developed countries were among those in which

the change in energy from renewable sources consumption had the greatest impact on the CO_2 emissions in other countries. The results of the research show the importance of pro-ecological activities not only within a given country. The spatial spillovers in this regard are also significant.

In [36], the author took a closer look at the impact of structural changes in the global market of crude oil and energy products after the outbreak of the COVID-19 pandemic on the competitiveness of the wholesale fuel market in Poland. The estimated NARDL model indicated a significant change in the short-run pass trough of inputs to wholesale prices in the first year of the COVID-19 pandemic.

Another article linking the impact of COVID-19 to the energy market is [37]. The authors set themselves the goal of assessing the similarity between the time series of energy commodity prices and the time series of daily COVID-19 cases using the DTW method (Dynamic Time Warping) and hierarchical clustering. The results of the conducted analyses showed that not all energy sources responded in the same way to the shock caused by the COVID-19 virus pandemic. It turned out that most similar to COVID-19 are the time-series for coal and palm oil. The smallest similarity was noted in the case of gasoline, ethanol, and ULSD. The taxonomic grouping made it possible to distinguish a group of raw materials depending on their degree of response to a pandemic in its three different sub-periods. Generally speaking, ULSD, heating oil, crude oil, and gasoline form a group weakly related to COVID-19, while coal, natural gas, palm oil, CO_2 allowances, and ethanol are strongly connected.

A recent paper [38] addressed the problem of analyzing oil consumption in Poland, which is one of the country's main sources of primary energy. Unfortunately, Poland covers only 3% of its oil consumption domestically, with the remaining demand met by foreign suppliers. Therefore, the article analyzes current oil consumption, taking into account political and economic conditions and the RES sector. The article proposes a model of oil consumption for the domestic market based on artificial neural networks, which was used to produce consumption forecasts of this primary fuel.

3. Conclusions

Having presented the content of all the articles that make up the Special Issue "Transformation of energy markets: Description, modeling of functioning mechanisms and determining development trends", it should be stated that the problem of development of energy markets is crucial within the framework of the ongoing energy transition. Certainly, the processes of energy transition will continue to develop dynamically, which will undoubtedly affect changes in energy markets, including the further systematic development of the RES sector. In this case, the institutional and legal regulation of the production and sale of renewable energy seems important. This is not an easy task, because in the case of the RES sector, the focus should not be on post-independent, renewable energy sources, but on the energy mix. Formal regulation of the sale of combined energy from different renewable sources seems to be the biggest challenge. However, the development of energy markets in this direction should raise the level of energy security both in selected countries and around the world.

Conflicts of Interest: The authors declare no conflict of interest.

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