Here, we seek to review the relevant literature and published articles on the subjects of electricity markets, electricity prices and green energy transition. While volatilities in prices in electricity markets are regular phenomena, these markets have seen even greater volatility during 2022. This has been the case as Europe in particular faces an energy crisis with relatively high oscillations in energy prices and occasional disruptions in energy supply [1].

Electricity markets and electricity prices are important, both for supply and demand of electricity, in decentralized electricity generation markets and relevant prices. During the last two decades energy markets have seen a series of trade-offs between privatization, restructuring and regulation vs. deregulation [2]. These approaches have seen mixed results in terms of the development of retail electricity markets in European Union (EU) countries [3]. The integration of EU markets is still limited due to a variety of factors diminishing the role of cross-border flows in inducing greater competition in the electricity markets, a development which would lower electricity prices for end-consumers [4]. Transmission capacity expansion needed is not the only reason to decarbonize the electricity sector efficiently [5] and to assure market integration and competitive market prices between the EU countries. Other incentives include persistent country-specific differences, barriers and shortcomings preventing the functioning of the single or common European energy as well as electricity markets [4,6].

Different pricing models, depending on different market structures in the electricity market, can be applied to increase market competitiveness. According to [7], uniform marginal pricing, zonal marginal pricing, and nodal marginal pricing methods are commonly used market structures. To move from a uniform pricing structure to a more competitive zonal pricing structure, the determination of price zones is critical for achieving a competitive market that generates accurate price signals. The paper [7] analyzed pricing zone detection algorithms, focusing on the k-means clustering and queen/rook spatially constraint clustering while using the Turkish electricity system as a case study.

Few articles presenting green energy transition choose Poland as a case study. The article [8] investigated energy transition in terms of an assessment of the functioning of the renewable energy sector in the context of the energy green transition in Poland. This can be important for upgrading technologies, boosting global competitiveness and maximizing innovation activities with social and economic implications. The research recommended improvements in legal, physical and mental determinants of the renewable energy sector. Among them are a necessity to improve and simplify relevant pieces of legislation, including the Distance Act. Solar, wind and biomass energy production techniques were found to have the largest opportunities for development. It is important to raise awareness on the need to educate the public about using and obtaining renewable energy within a low-emission economy. A robust decarbonization strategy can contribute new jobs and reduce the emissions of harmful substances to the environment.

The article [9] argues that Poland faces electricity and heating demand challenges if it is to achieve a sustainable energy mix, especially considering economic investment and operational costs. The article [9] proposed an optimization model based on the grey wolf
optimizer meta-heuristic methodology, allowing the identification of the most convenient energy mix for Poland by 2040. Assuming cost optimization energy efficiency with the decrease in the global cost of renewables-based sources, the same levels of CO\textsubscript{2} emissions and the energy import and export balance suggest that the expected financial savings and reduction in CO\textsubscript{2} emissions.

Different sources of electrical energy on the supply side can be important for electricity prices and for development of electrical energy exchange with foreign countries. The Polish power exchange is analyzed by [10], providing specific information about the Polish electrical energy system and its installed capacity, achievable capacity, production and consumption of electric power, electricity market and its nature, in addition to the prices and functioning of the day-ahead Polish market.

The energy transition in the Visegrad (V4) countries (the Czech Republic, Hungary, Poland, and Slovakia) was analyzed by [11]. The combustion of fossil fuels is the primary source of energy production in these societies, and the energy transformation represents a challenging issue for the implementation of the European Green Deal programme. This manifests practically in the share of renewable energy sources (RES) in final energy consumption, a reduction in the CO\textsubscript{2} emissions of the non-Emissions Trading System (ETS) sector, a date of withdrawal of coal from the economy, and general energy efficiency. The V4 countries have different approaches and levels of energy transformation. Poland is the most dependent on the production of electricity from coal with the largest number of employees in the coal and coal linked sectors. The other V3 countries have, to date, based their transformation on nuclear energy and the potential use of biomass.

In some countries, such as in Turkey, there is long-standing conflict between the governments, the civil society and different stakeholders on the construction of a nuclear power plant in Turkey. Among concerns are potential problems and impacts on the environment and health, waste management, and risk of nuclear accidents [12].

The article [13] determined the CO\textsubscript{2} emissions of European industrial sectors, such as those involved in the production of clinker, lime and ammonia, as well as those of blast furnace operations, refineries and others. Around one-third of these emissions could be avoided by 2030 with fuel switch measures towards biomass and electricity, but due to relatively high electricity prices, reaching deep decarbonisation targets will require innovative production processes in the long term.

The article [14] explained decentralized electricity generation using the multilevel perspective in the expansion of photovoltaics in German cities and tenants’ household buildings, with solar power produced on site. The barriers to and drivers of the diffusion of the tenant electricity model are analyzed using a qualitative document analysis and a range of semi-structured expert interviews based on the multi-level perspective. The restrictive legal framework on the regime level was found to be the main barrier for tenant electricity diffusion, leading to high transaction costs of implementing tenant electricity. A social barrier is the inertia concern of some residents with their electricity supply and switch to a tenant electricity contract. Among its drivers are long-term trends in the increasing electricity demand in urban areas, technical developments like blockchain technology and the increasing deployment of smart meters, as well as the EU Renewable Energy Directive.

As argued by [15], changes in public support for clean energy policies can be driven by a historical event. In 2022, this historical turning point was the Russia–Ukraine war, an event causing policymakers’ to give stronger support for cleaner energy, as well as electricity policy changes at the phase-out of fossil fuels and the phase-in of clean energy alternatives [16].

A comparative analysis [17] explains the decentralization and energy transformation of the large-scale energy sector in EU countries towards pro-ecological and dispersed production sources, as well as the consideration of a citizen dimension of the energy sector. Energy self-sufficiency at a local level, based on the concept of Energy Communities with energy clusters, has become more important than energy cooperatives to achieve common benefits in the economic dimension.
A significant transition towards renewable and carbon-free energy sources is observed as new challenges to the grid operation emerge in terms of intermittency and uncertainty [18]. Advanced policy strategies and technologies can help to provide flexible solutions to maintain the reliability of power systems. However, across European countries there is a diversity of legal and practical situations and a varying nature of distribution system operators. The best practices in deployment of demand side flexibility are identified, as well as the main barriers that leverage flexibility towards offering electricity grid services. Additionally, the diversity of electricity generation mix, market design, emerging market access of flexibility of resources and new approaches, facilitating the integration of flexible assets in the distribution grid, are reviewed for the United Kingdom, Belgium, Italy and Greece with country-specific recommendations.

The transformation of the global energy mix is driven by new energy resources, the diffusion of new and novel technologies, and climate change-related commitments [19]. Fossil fuel (coal, oil, and natural gas) trade patterns are still important for satisfying the energy needs in the international trade network of energy flows, a system with energy security implications. The focus is on the growth in the U.S. unconventional resources, EU renewable energy, China’s natural gas consumption, and changes in other country energy flows and renewable energy adoption. The article introduces a modified energy–security index to highlight the interplay between fuel type, trade partner diversification, domestic supply and consumption balance in the energy transition and the international network of energy flows and energy security.

During the year 2022, volatile energy prices in world markets were caused by an insecurity of supply. One source of instability in energy markets was crude oil market volatility, an issue which requires accurate monitoring and forecasting [20]. Energy prices, including electricity ones, can have important macroeconomic impacts on costs and can push inflationary pressures [21].

Therefore, the key questions raised regard the provision of affordable and stable electricity prices, the competitive electricity supply and efficient use of electrical energy for different segments of consumers and the acceleration of the green transition to greater production and use of renewable energy sources. The electricity prices, for example in the EU countries, are linked with the green transition from a fossil fuel-based energy production system to one with a greater role for renewable sources of energy, protected by regulatory electric market reforms [22]. However, some similar patterns in electricity market developments can be observed in some other countries, with electricity market liberalization and its adjustments to industrial, households and other final consumers [23] presenting challenging issues of renewable sources of energy to sustainable development [24]. The discussions in this Special Issue contribute to a better understanding of the electricity market’s functioning, the movement of electricity prices and the green transformation process in the energy sector, particularly in electricity markets, boosting discussions of important energy policy and practice.

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