УДК 341+349.6+502/504+947.71
DOI https://doi.org/10.24144/2307-3322.2025.90.5.25

THE LEGAL DEVELOPMENT OF ENTSO-E AS A TOOL FOR ENERGY SECURITY AND DECARBONIZATION OF THE EUROPEAN UNION

Matiushyna O.V.
PhD student, International Law Chair,
Educational and Scientific Institute of International Relations,
Taras Shevchenko National University of Kyiv.
ORCID: 0009-0002-8462-8825
e-mail: radiola112@hotmail.com

Matiushyna O.V. The legal development of ENTSO-E as a tool for energy security and decarbonization of the European Union.

The article examines the institutional and legal evolution of the European Network of Transmission System Operators for Electricity (ENTSO-E) within the broader framework of the European Union's climate policy and its strategic vision of a climate-neutral Europe by 2050. It explores how key legislative instruments – including Regulation (EU) 2019/943, Directive (EU) 2019/944, the network codes, and the Third Energy Package – have progressively transformed ENTSO-E from a primarily technical coordination platform into a central institutional actor in the EU's green energy transition. Particular attention is paid to the legal framework that governs the integration of renewable energy sources into the grid, the phase-out of fossil fuel-based generation, the development of advanced balancing mechanisms, and the expansion of regional coordination centers (RCCs). These developments reflect the EU's commitment to a decarbonized, interconnected, and resilient energy system.

The article further examines the impact of the legal principle of unbundling, which aims to ensure non-discriminatory access to energy networks and promote competitive electricity markets. In addition, the study addresses the external and geopolitical dimension of ENTSO-E's role, notably the emergency synchronization of Ukraine and Moldova with the Continental European electricity grid in March 2022. This synchronization is presented as both a technical and political milestone that strengthened the EU's energy resilience and reinforced its strategic neighborhood policy.

Ultimately, the article argues that ENTSO-E plays a pivotal legal and operational role in implementing the European Green Deal and advancing the EU's dual objectives of climate neutrality and energy security. It concludes by emphasizing the need for deeper legal harmonization, accelerated deployment of interconnectors, and more effective multilevel coordination to fully realize the ambitions of a climate-neutral and integrated European energy market.

Key words: International law, climate change, Paris Agreement, Green Deal, climate neutrality, decarbonization, ENTSO-E.

Матюшина О.В. Правове становлення ENTSO-E як інструменту енергетичної безпеки та декарбонізації Європейського Союзу.

У статті досліджується інституційна та правова еволюція Європейської мережі операторів систем передачі електроенергії (ENTSO-E) в ширшому контексті кліматичної політики Європейського Союзу та його стратегічного бачення кліматично нейтральної Європи до 2050 року. Аналізується, яким чином ключові законодавчі акти – зокрема Регламент (ЄС) 2019/943, Директива (ЄС) 2019/944, мережеві кодекси та Третій енергетичний пакет – поступово трансформували ENTSO-E з технічної координаційної платформи на одного з центральних суб'єктів «зеленої» енергетичної трансформації ЄС. Особливу увагу приділено правовим механізмам інтеграції відновлюваних джерел енергії до енергосистеми, поступовій відмові від викопного палива, розвитку механізмів балансування та розширенню повноважень регіональних координаційних центрів (РКЦ). Ці процеси відображають прагнення ЄС до створення децентралізованої, інтегрованої та стійкої енергосистеми з низьким рівнем викидів.

У статті також розглядається вплив правового принципу анбандлінгу, який забезпечує недискримінаційний доступ до мереж і сприяє розвитку конкурентного ринку електроенергії. Окрему увагу приділено зовнішньому та геополітичному виміру діяльності ENTSO-E, зокрема екстреній синхронізації енергосистем України та Молдови з континентальною європейською мережею у березні 2022 року. Ця подія розглядається як технічний і політичний прорив, що посилив енергетичну стійкість ЄС і зміцнив його політику добросусідства.

Зрештою, автор стверджує, що ENTSO-E нині відіграє ключову правову й операційну роль у реалізації Європейського зеленого курсу та просуванні подвійної цілі ЄС – кліматичної нейтральності й енергетичної безпеки. У підсумку наголошується на необхідності глибшої правової гармонізації, активнішого розвитку транскордонної енергетичної інфраструктури та ефективнішої координації між державами-членами для досягнення цілей кліматично нейтрального, інтегрованого енергетичного ринку Європи.

Ключові слова: міжнародне право, зміна клімату, Паризька угода, Зелений курс, кліматична нейтральність, декарбонізація, ENTSO-E.

Problem Statement. As the European Union advances its commitment to climate neutrality by 2050, the legal framework governing the integration of renewable energy sources and the balancing of power systems has become increasingly important. The European Network of Transmission System Operators for Electricity (ENTSO-E) plays a central role in this transformation, operating at the intersection of technical coordination and EU legal regulation. Despite the existence of a robust legal foundation – including Regulation (EU) 2019/943, Directive 2019/944, and the European Climate Law (Regulation (EU) 2021/1119) – the legal doctrine lacks a comprehensive analysis of ENTSO-E's role within the EU legal order, particularly regarding its function in achieving a unified energy market and the legal conditions for the integration of third countries into EU energy governance mechanisms.

The Purpose of the Paper. This paper examines the legal and institutional development of ENTSO-E in the context of the EU's climate neutrality goals. It analyzes ENTSO-E's legal functions in supporting RES integration, regulating grid stability, and ensuring compliance with EU cross-border electricity law. The study highlights key legal instruments and challenges related to decarbonization, renewable energy deployment, and energy security within the European framework.

Review of Scientific Research on the Issue. Recent research has addressed key aspects of RES integration into the EU energy system. Scholars have analyzed the alignment of climate and energy policy (Kettner & Kletzan-Slamanig, 2020), interregional coordination (Andriopoulos et al., 2022), the institutional role of ENTSO-E (Homeyer et al., 2022), market flexibility via aggregators (Kercher & Arboleya, 2022), and energy security under net-zero goals (Roggenkamp, 2024). Ukrainian authors have contributed to the study of sustainable energy governance.

Main research results. The EU has formally established the objective of reaching net-zero emissions by 2050. Achieving climate neutrality and zero emissions in the current context has a transformative impact on all sectors of the economy, especially the energy sector, where one of the key means of reducing emissions is the gradual replacement of fossil sources with renewable ones (Roggenkamp, 2024). This includes comprehensive sectoral regulatory reforms, in which the European Network of Transmission System Operators for Electricity (ENTSO-E) plays a central role in the integration of renewable energy sources (RES), regulating system balance alongside enhancing regional electricity market integration. According to researchers such as Kettner and Kletzan-Slamanig [1] and Andriopoulos et al. [2], the current EU legal acts aimed at ensuring energy efficiency and the integration of renewable energy sources definitely transform ENTSO-E into an important element of the European Union's climate policy. This underlines the importance of effective international cooperation to achieve global climate goals and ensuring the success of the energy transition.

As part of the ambitious goal of achieving climate neutrality by 2050, legal acts such as Regulation (EU) 2019/943, Directive 2019/944 and relevant grid codes have played an important role in transforming ENTSO-E from a conventional coordination platform into the EU's overall energy system, although, according to a study by Kettner and Kletzan-Slamanig, these energy efficiency and renewable energy policies do not always achieve full coherence with EU climate policies due to restrictions on the implementation of carbon reduction targets, as these policies may reinforce each other at certain levels, but their integration within the overall climate strategy is often incomplete [3], since, as noted by Medvedeva and Smirnova, «effective governance at all levels – global, regional and national – is critical to achieving the Sustainable Development Goals in energy policy»[4].

The outbreak of a full-scale war in Ukraine due to Russian aggression has actualized for the European Union the strategic need for energy independence, which requires not only an increase in the share of renewable energy sources in the energy mix, but also the modernization of electricity networks [5]. The goals to achieve zero emissions transform the functioning of the energy sector, in particular the electricity sector, which needs to adapt to a new generation structure based mainly on RES, ensuring stability of supply and energy security [6].

The integration of a large share of renewable energy sources into the energy systems of the European Union requires a radical transformation of their infrastructure and principles of operation. Traditionally, power systems were designed for centralized electricity production based on fossil fuels with a one-way flow of energy – from large power plants to consumers. This approach does not take into account the modern requirements for the decentralization of generation, the growth of dynamic and distributed RES capacities, as well as the active role of consumers, who can themselves act as producers, the so-called «prosumers», who supply electricity to the grid when production exceeds consumption, and can, if necessary, consume it from the grid.

In this context, there is a need for a bilateral, flexible and fluctuation-resistant mode of operation of power grids, which provides for the effective integration of fluctuations in the production of RES, in particular solar and wind energy. This is possible only if an adaptive network infrastructure is functioning, capable of prompt balancing of supply and demand in real time, which requires digitalization, investment in smart grids, as well as the introduction of new energy storage technologies.

At the same time, a critical prerequisite is a clear legal delineation of the functions of market participants. In particular, it is necessary to guarantee the independence of transmission system operators (TSO) and distribution systems (DSOs) from electricity producers and suppliers in order to prevent conflicts of interest. This provides transparent and non-discriminatory access to networks for new market entrants, stimulates competition and increases the overall reliability of energy supply. Accordingly, legal regulation should play a key role in establishing clear balancing procedures, access to networks and the responsibility of the parties for the uninterrupted supply of electricity.

The first steps towards the liberalization of the energy market of the European Union were taken within the framework of Directive 96/92/EC, which initiated the process of opening national markets to competition through gradual access of third parties to networks. However, this directive only partially outlined the need for functional separation of activities related to the production, supply and transmission of electricity, without providing for a mandatory legal distinction.

Only with the adoption of Directive 2009/72/EC, which became part of the Third Energy Package, the requirement for legal, organizational and functional separation of TSOs and DSOs from entities engaged in the supply or production of electricity was clearly enshrined. These requirements were a response to the threat of conflicts of interest arising in vertically integrated utilities, where control over infrastructure can be used to unfair competition or restrict market access for new entrants.

Unbundling has become a critical condition for creating an efficient, transparent and competitive energy market in the EU. It provides a level playing field for access to grid infrastructure, which is especially important in the context of the growing role of decentralized generation based on renewable energy sources. It is the separation of functions between infrastructure operators and commercial structures that avoids bias, ensures transparency of balancing supply and demand, and also creates prerequisites for innovation and attracting investment in the modernization of power grids.

The concept of «balancing» has received an official legal definition in Regulation (EU) 2019/943, which has become a key tool of the new EU electricity market focused on decarbonization [7]. According to it, balancing covers all actions and processes carried out by TSOs to constantly maintain the frequency within the established range and ensure the necessary amount of reserves (Regulation (EU) 2019/943, art. 2(10)). In addition, Directive 2019/944 clarified the concept of «balancing markets» by including them in the broader category of electricity markets that also cover ancillary services (Directive 2019/944, art. 2(45)) [8].

The development of balancing mechanisms for the integration of renewable energy sources is a key element of new European legislative initiatives aimed at ensuring energy stability [9]. In this context, TSOs play a key role in ensuring system balance, which is of particular importance given the rapid growth of the share of renewable energy sources (RES) in the electricity generation structure. A characteristic feature of RES, in particular wind and solar energy, is high variability and dependence on weather conditions, which complicates forecasting and increases the frequency of imbalances. are

obliged to intervene in the event of a violation of the balance between production and consumption, in particular by rapidly procuring electricity from designated suppliers to reestablish system stability (Regulation (EU) 2019/943, art. 40).

These measures are intrinsically connected to the EU's overarching climate objectives, particularly its legally binding commitment to achieve climate neutrality by 2050 under the European Climate Law, as ensuring effective balancing is becoming critical for integrating the growing volumes of variable renewable generation and achieving the energy transition based on stability, security of supply and environmental sustainability [10].

A key role in this process is played by the transnational synchronization of power systems, which allows for joint management of reserves, frequency and volumes of electricity flows between countries. The rules on balancing and the functioning of balancing markets are enshrined in the technical codes of networks and governing documents developed by the European Network of Transmission System Operators for Electricity (ENTSO-E).

The European Network of Transmission System Operators for Electricity (ENTSO-E) serves as the central institution for the technical and operational integration of Europe's energy systems. Established under Regulation (EC) No 714/2009, it brings together transmission system operators from EU member states, the European Economic Area – including Norway, Iceland, and Liechtenstein – as well as from several partner countries such as Switzerland, the United Kingdom, Turkey, Ukraine, and Moldova [11]. The created system plays a central role in harmonizing the technical and market conditions for the functioning of the single European energy system [12].

The process of joining the European Network of Transmission System Operators includes not only the technical synchronization of power systems with the continental European grid, but also integration into the legal and market field of the European Union. In this context, candidate countries must ensure compliance with a range of regulatory and legal obligations, covering both technical and environmental, market and regulatory aspects.

The basic rules for the functioning of the EU internal electricity market are defined by Directive 2009/72/EC, which establishes general principles for the organization of the electricity market, in particular the requirements for the separation of transmission activities from generation and supply (unbundling), the creation of independent national regulators, compliance with the principles of transparency and non-discriminatory access to networks, as well as the functioning of balancing systems [13]. These provisions form the basis for harmonization of national legislation of member states and countries seeking integration into ENTSO-E.

Further regulatory improvements in the functioning of the European energy system were largely due to previous crisis situations, which revealed weaknesses in the technical coordination and balancing of power grids. One of the most serious incidents occurred on November 4, 2006, when a major blackout affected 15 European countries. The outage was triggered by a scheduled shutdown of a 380 kV ultra-high voltage transmission line over the Ems River in Lower Saxony, Germany. The shutdown was initiated by the German TSO E.ON Netz to allow the passage of the cruise ship *Norwegian Pearl*, which was under construction at a nearby shipyard [14]. The outage was carried out without proper coordination with other transmission system operators (TSOs), resulting in network congestion in neighboring regions, cascading disconnection of lines and the breakdown of the network into three parts, followed by the cessation of power supply to more than 15 million consumers in France, Italy, Spain, Austria and other countries [15].

A similar incident occurred on March 31, 2015 in Turkey, when most regions of the country were left without electricity [16]. The reason was the lack of reserve capacities, excessive interregional flows and insufficient operational coordination. Despite the fact that Turkey was only partially synchronized with ENTSO-E, the incident revealed serious risks to stability even in countries with limited integration. ENTSO-E, in cooperation with the Turkish operator TEİAŞ, assessed the incident and strengthened the requirements for the technical readiness of potential participants in the interconnected power grid [17].

Additionally, on April 28, 2025, a large-scale power outage affected Spain and Portugal due to a sudden imbalance in the power system and insufficient network inertia, highlighting ongoing challenges of synchronous coordination amid the growing share of renewables.

In response to these systemic challenges, the European Union has adopted a number of secondary law regulations that provide unified technical regulation of the operation of power systems, in particular Regulation (EU) 2017/1485 sets out comprehensive rules for the secure and coordinated operation of

power systems, covering aspects such as frequency regulation, system security, emergency and restoration procedures, and the real-time exchange of operational data among transmission system operators (TSOs) [18]. As a complement to the existing legal framework, Regulation (EU) 2017/2195 lays down detailed provisions for the functioning of the balancing market, covering access criteria, selection processes, and capacity procurement mechanisms, the efficient allocation of balancing resources, and the principles governing remuneration for balancing services [19], and Regulation (EU) 2019/943 establishes the core principles governing the internal electricity market, regulates cross-border electricity flows and network access, and mandates the creation of Regional Coordination Centers to enhance intersystem coordination and monitor system stability [20].

According to the European Climate Law (Regulation (EU) 2021/1119), achieving climate neutrality by 2050 requires a significant reduction in the use of fossil fuels in all sectors of the economy, which necessitates large-scale electrification of transport, heating, industry and other sectors to improve energy efficiency and reduce CO_2 emissions per unit of energy [21]. However, for its successful implementation, high flexibility and resilience of the energy system is required, which is why effective balancing, supported by uniform ENTSO-E rules, is a key condition for a climate-oriented transformation of the energy sector.

Austria, Sweden, Norway and Iceland already provide more than 95% of electricity production from renewable sources, mainly from hydropower and wind [22]. Although Belgium had previously committed to a nuclear phase-out, it has postponed the shutdown of two reactors until 2035, while continuing its coal phase-out strategy [23]. Finland closed the last coal-fired power plant in Helsinki in 2025 and announced a complete phase-out of coal by 2029 [24]. Denmark has declared its political intention to fully discontinue coal-based electricity generation by 2028 [25]. Germany has set a legally endorsed coal phase-out deadline for 2038, with the possibility of accelerating this timeline to 2030 [26]. Portugal, meanwhile, became the fourth EU Member State to eliminate coal from its energy mix entirely, decommissioning its final coal-fired power plant in 2021 [27]. France, according to the Energy and Climate Law of 2019, completed the use of coal capacity in 2022 [28].

These developments underscore the increasing significance of electrification and decarbonization in shaping the internal energy market, where system stability is maintained through coordinated balancing operations, shared reserve management, and the harmonization of technical standards.

The role of trans-European coordination in ensuring security of supply became particularly prominent after the emergency disconnection of Ukraine and Moldova in 2022 from the post-Soviet IPS/UPS energy system and the synchronization of Ukrainian and Moldovan power systems with ENTSO-E in March 2022, shortly after the start of the full-scale war. This extraordinary technical and political decision made it possible to integrate the two countries into the continental European grid on a permanent basis, providing emergency flows, cross-border support, and maintaining grid stability during hostilities. In 2023, ENTSO-E confirmed further deepening cooperation with both countries, including admission to trade mechanisms and the system services market; this integration solution was not only technical, but there is a strategic step that ensured the resilience of Ukraine's energy system amid deliberate infrastructure damage and marked the beginning of its operational alignment with the EU electricity market [29].

The integration of Ukraine and Moldova into ENTSO-E is an important component of the EU's broader climate and energy policy on the external circuit, in particular the implementation of the European Green Deal. This process is in line with the EU's strategic course to form a common «green energy space» with its eastern neighbors through the development of common infrastructures, harmonization of market rules and synchronization of technical standards. Coordinated real-time electricity balancing, coordination between transmission system operators, reserve management and frequency regulation are all prerequisites not only for energy security, but also for the effective functioning of a carbon-neutral energy market.

It is also worth considering the complex regional specifics. For example, although Moldova is already part of ENTSO-E, it continues to provide a significant amount of electricity to Transnistria, an unrecognized entity that is outside the control of the central government and receives electricity from the Moldovan power plant, which operates on Russian gas. This situation creates both technical and geopolitical challenges for regional integration and achieving decarbonization goals. At the same time, it is precisely such examples that prove the importance of a systematic approach to balancing, which allows maintaining the stability of the network even in conditions of political instability and high

security risks. Thus, the integration of the Eastern Partnership countries into ENTSO-E is not only a technical extension of the European network, but also a tool for the implementation of the EU's climate policy, which integrates the objectives of decarbonization, energy security, and political solidarity.

A significant advancement was the introduction of the concept of aggregation in Directive 2019/944, recognizing it as a novel flexibility tool within the internal electricity market [30]. Aggregation is defined as the activity of pooling loads or volumes of electricity produced by a natural or legal person for the purpose of participating in electricity markets (Art. 2(18)), and the aggregator is recognized as a person, which performs such a function and is not a supplier of the relevant consumer (Art. 2(19)). This concept paved the way for the emergence of independent aggregators that can combine loads from different sources – including RES and storage – and operate in the balancing market, reducing systemic imbalances. The directive also allows consumers to enter into contracts with aggregators without the consent of their supplier (art. 13), which creates preconditions for the development of flexible models of participation in the electricity market, in line with the EU's climate goals [31].

Finally, the environmental component of integration was enshrined in the European Climate Law (Regulation (EU) 2021/1119), which sets the goal of achieving climate neutrality by 2050 and requires the transition to environmentally sustainable generation, which directly affects the balancing market due to the need to integrate unsustainable renewable energy sources.

Thus, the modern ENTSO-E balancing and regulation system is the result of a gradual evolution, taking into account both internal market reforms and the lessons of large-scale incidents, as well as climate commitments at the EU level.

Although the principle of non-discrimination is the cornerstone of European energy legislation, it does not require absolutely equal treatment of all users of the system. European law allows a distinction to be made between different categories of consumers, provided that equal treatment is maintained within each category [32]. Until 2018, producers of electricity from renewable sources were considered a separate class of users for whom guaranteed or even priority access to the grid was provided [33].

With the entry into force of Directive (EU) 2018/2001 on renewable energy sources, RES electricity is increasingly seen as competing on an equal footing with conventional generation. However, according to paragraph 60 of the preamble to this Directive, Member States may continue to apply priority dispatching for RES if this does not contradict market principles [34], and national governments can legally oblige system DSOs to give preference to generation from renewable sources during dispatching (Directive (EU) 2018/2001, art. 12).

Traditionally, national electricity transmission systems have been designed with a sufficient level of capacity to meet the needs of end users within their own jurisdiction. At the same time, with the deepening integration of EU markets and the growth of cross-border electricity flows, the problem of structural overloads is becoming more and more relevant. They most often occur at the points of interconnectors – interstate power lines, which were mainly built before market liberalization in order to guarantee energy security without the primary aim of promoting market competition or operational efficiency (Regulation (EU) 2019/943, art. 2(1)) [35].

European legislation in the field of interconnectors began to take shape in 2003 with the adoption of Regulation (EC) No. 1228/2003 [36], which was subsequently superseded by Regulation (EU) 714/2009 [37] and, in its latest form, by Regulation (EU) 2019/943.

To address the issue of limited cross-border transmission capacity, one of the key concepts introduced was that of the bidding zone – a market zone enabling unrestricted electricity trade among participants, without the obligation of prior capacity reservation (Regulation (EU) No 543/2013; Annex I to Regulation (EC) No 714/2009, art. 2) [38].

Exceptions are countries that, due to technical features or geographical conditions, have several internal trade zones. For example, Italy is divided into several zones, reflecting regional imbalances of production and consumption; Norway has five zones (NO1–NO5), taking into account the specifics of hydropower generation and limited interregional connections; due to constrained interregional transmission capacity, Sweden and Denmark have implemented zonal divisions—SE1 to SE4 and DK1 to DK2 respectively – based on the topology of their electricity grids and the historical structure of their energy systems [39]. These countries are integrated into the European ENTSO-E network, participate in the internal energy market and are able to carry out cross-border electricity trade both among themselves and with other EU states. This is especially true for Norway, which, although not a member of the EU, is part of the European Economic Area and is an active exporter of electricity through interconnectors, in

particular NordLink, NorNed and Skagerrak [40]. It is important to note that the structure of Norway's electricity exports is almost entirely based on renewable sources, primarily hydropower, which accounts for more than 90% of the country's production balance.

In the context of the European Green Deal and the 2050 climate neutrality goal, Norway's role as a clean electricity exporter is strategic. It contributes to the decarbonization of the EU energy sector by allowing other countries to reduce the use of fossil fuels, in particular during peak load hours or RES shortages (Regulation (EU) 2021/1119). Owing to its well-established hydropower infrastructure and interconnection networks, Norway plays a key role in the European balancing mechanism, serving as a flexible reserve for variable renewable energy generation. [40].

As for Ukraine and Moldova, their energy systems have a high level of interconnection through common infrastructure, in particular the interconnector Isaccea (Romania) – Vulcanesti (Moldova) – Odesa region (Ukraine), which is part of the route for electricity imports from the EU. Within the framework of ENTSO-E, a joint import capacity quota of 2100 MW has been established for both countries [41]. In addition to the existing infrastructure, two more new interconnectors are currently being designed, which will strengthen the technical resilience of the region and increase export and import opportunities in both directions. These steps are part of a broader strategy to integrate with the European electricity market and strengthen the region's energy security [42].

The development of energy infrastructure, in particular the expansion of transmission and distribution networks, is a key element in achieving the EU's climate goals. According to Directive 2019/944, transmission and distribution system operators are obliged to develop national or regional network development plans, which are submitted to national regulators at least once every 5-10 years (Directive (EU) 2019/944, art. 32) [43]. These plans should take into account not only the traditional criteria for the development of networks, but also the technical integration of new energy sources, primarily RES, and the use of storage systems as an alternative to the physical expansion of infrastructure (Directive (EU) 2019/944, art. 32(3)).

The development of offshore wind energy in the North Sea plays an important role in achieving the EU's climate goals, in particular within the framework of the 2050 climate neutrality commitment. Restrictions on onshore deployment of RES encourage states with access to the sea coast to develop offshore generation in exclusive economic zones, where they have functional jurisdiction under international and European law [44].

Although there is not a separate EU directive governing offshore generation, a number of provisions of Directive 2019/944 and Directive 2018/2001 on RES also apply to marine energy. Individual states – including Belgium, Denmark, Germany, and the Netherlands – oblige national TSOs to connect wind farms to the transmission system, while the United Kingdom allows connections through private companies [45].

Despite the successes, a complete transition to a sustainable energy future depends not only on an increase in the share of RES, but also on a parallel reduction in the use of fossil fuels. As noted by renowned Ukrainian scientists Medvedieva, Yedeliev, Reznikova, Nanavov, and Grydasova [46], although the EU's climate policy functions harmoniously, it jeopardizes the further development of climate neutrality policies in Europe due to rapid political and economic fluctuations. the importance of effective international cooperation and courage from states on their climate commitments. Achieving global climate goals requires effective international cooperation and determination on their commitments from states [47].

Conclusions. The evolution of ENTSO-E and the regulation of the European energy system are important milestones towards achieving Europe's climate neutrality by 2050. Within the framework of the Paris Agreement and the European Climate Law, the EU has assumed the role of a global leader in climate policy, actively implementing measures to decarbonize and integrate renewable energy sources. co-financing of emission containment infrastructure projects, while permitting extraction remains a national issue, limiting the EU's powers to enforce network expansion.

The process of abandoning fossil fuels in EU countries, in particular in Germany, France, Portugal and Finland, indicates the intentions of the irreversibility of the course towards decarbonization. ENTSO-E plays a pivotal role in this transition by coordinating the activities of transmission system operators, advancing the development of interconnectors and regional planning, thereby enhancing system stability and supporting the integration of a unified European energy market. The example of Norway as a supplier of clean hydroelectricity and the synchronization of the energy systems of Ukraine and Moldova confirm the potential for expanding this «green energy space» beyond the EU.

In general, the success of the climate transformation depends not only on an increase in the share of RES, but also on the complete abandonment of fossil fuels, which is possible only under the condition of legal, technical and institutional convergence provided by the ENTSO-E model.

REFERENCES:

1. Kettner, M., & Kletzan-Slamanig, D. (2020). Is there climate policy integration in European Union energy efficiency and renewable energy policies? Yes, no, maybe. *Environmental Policy and Governance, 30*(1), 1–12. URL: https://doi.org/10.1002/eet.1880.
2. Andriopoulos, N., Georgantas, I., Makrygiorgou, D. I., Skipis, D., Dikaiakos, C., Moraitis, I., … & Papadaskalopoulos, D. (2022). Coordinating capacity calculation via electricity market coupling: Insights from the H2020 CROSSBOW project. *Electricity, 3*(2), 182-201.URL: https://doi.org/10.3390/electricity3020011.
3. Kettner M., & Kletzan-Slamanig, D. (2020). Is there climate policy integration in European Union energy efficiency and renewable energy policies? Yes, no, maybe. *Environmental Policy and Governance, 30*(1), 1-12. URL: https://doi.org/10.1002/eet.1880.
4. Medvedieva M., & Smirnova X. (2019). Climate and energy governance at a crossroad: Global, regional and national dimensions. *EEA – Electrotehnica, Electronica, Automatica*. URL: http://www.scopus.com/inward/record.url?eid=2-s2.0-85063664802&partnerID=MN8TOARS.
5. European Council. (2022, October 5). *The time is now: The EU needs a genuine Energy Union*. URL: https://www.consilium.europa.eu/en/european-council/president/news/2022/10/10/ 20221005-pec-newsletter-energy-union.
6. Roggenkamp, M.M. (2024). How net zero goals impact electricity systems and supply security. In D.S. Olawuyi, J.J. González, H. Mostert, M.F. Montoya, & C. Banet (Eds.), *Net zero and natural resources law: Sovereignty, security, and solidarity in the clean energy transition* (pp. [243]). Oxford University Press. URL: https://doi.org/10.1093/9780198925033.003.0015
7. Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. *OJ* L 158/54.
8. Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU. *OJ* L 158.
9. Andriopoulos, N., Georgantas, I., Makrygiorgou, D. I., Skipis, D., Dikaiakos, C., Moraitis, I., … & Papadaskalopoulos, D. (2022). Coordinating capacity calculation via electricity market coupling: Insights from the H2020 CROSSBOW project. *Electricity, 3*(2), 182–201. URL: https://doi.org/10.3390/electricity3020011.
10. Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality (European Climate Law). *Official Journal of the European Union*, L 243, 9.7.2021, 1–17.
11. Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity. *Official Journal of the European Union*, L 211, 14.8.2009.
12. ENTSO-E. (n.d.). *Members*. URL: https://www.entsoe.eu/about/inside-entso-e/members.
13. Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC. *Official Journal of the European Union*, L 211, 14.8.2009, 55–93.
14. Wikipedia. (2023). *2006 European blackout*. Wikipedia. URL: https://en.wikipedia.org/wiki/2006_European_blackout.
15. Bundesnetzagentur. (2007). *Report by the Federal Network Agency on the disturbance in the German and European power system on the 4th of November 2006*. URL: https://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/Areas/ElectricityGas/Special%20Topics/Blackout2005/BerichtEnglischeVersionId3947pdf.pdf.
16. International Energy Agency (IEA). (2016). *Turkey's power blackout of March 2015*. International Energy Agency. URL: https://www.iea.org/reports/turkeys-power-blackout-of-march-2015.
17. ENTSO-E. (2016). *Turkey's blackout of 31 March 2015: Lessons learned and follow-up*. Internal Report. IEA. (2016). *Electricity security across borders: Case studies of cross-border electricity*

markets. International Energy Agency. URL: https://www.iea.org/reports/electricity-security-across-borders.
18. Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation. *Official Journal of the European Union*, L 220, 25.8.2017, 1–120.
19. Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing. *Official Journal of the European Union*, L 312, 28.11.2017, 6–53.
20. Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. *Official Journal of the European Union*, L 158, 14.6.2019, 54–124.
21. Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality. *Official Journal of the European Union*, L 243, 9.7.2021.
22. European Commission. (2025). *Renewable energy statistics in the EU*. URL: https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20250221-3.
23. Enerdata. (2023). *Belgium approves bills to extend two reactors until 2035*. URL: https://www.enerdata.net/publications/daily-energy-news/belgium-approves-bills-extend-two-reactors-2-gw-until-2035.html.
24. Open Access Government. (2024). *Finland officially closes its last coal power plant*. URL: https://www.openaccessgovernment.org/finland-officially-closes-its-last-coal-power-plant/190753.
25. IEA. (2020). *Climate Act: Denmark's coal phase-out*. URL: https://www.iea.org/policies/18110-climate-act-denmarks-coal-phase-out.
26. Beyond Fossil Fuels. (2023). *Europe's coal exit*. URL: https://beyondfossilfuels.org/europes-coal-exit.
27. IEA. (2021). *Coal 2021: Analysis and forecast to 2024*. URL: https://www.iea.org/reports/coal-2021.
28. Beyond Fossil Fuels. (2023). *Europe's coal exit*. URL: https://beyondfossilfuels.org/europes-coal-exit.
29. ENTSO-E. (2023, March 23). *One year of synchronization: Ukraine and Moldova as part of the Continental European grid*. URL: https://www.entsoe.eu/news/2023/03/23/one-year-of-synchronization-ukraine-and-moldova-as-part-of-the-continental-european-grid.
30. Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU. (2019). *Official Journal of the European Union*, L 158, 125–199.
31. Kercher, S., & Arboleya, P. (2022). The key role of aggregators in the energy transition under the latest European regulatory framework. *International Journal of Electrical Power & Energy Systems, 134*, 107361. URL: https://doi.org/10.1016/j.ijepes.2021.107361.
32. Kruimer, H. (2014). *The Non-Discrimination Obligation of Energy Network Operators: European Rules and Regulatory Practice*. Cambridge–Antwerp–Portland: Intersentia.
33. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. *Official Journal of the European Union*, L 140, 5.6.2009.
34. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast). *Official Journal of the European Union*, L 328, 21.12.2018.
35. Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. *Official Journal of the European Union*, L 158, 54–124.
36. Regulation (EC) No 1228/2003 of the European Parliament and of the Council of 26 June 2003 on conditions for access to the network for cross-border exchanges in electricity. *OJ L 176*, 15.7.2003, 1–10.
37. Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity. *OJ L 211*, 14.8.2009.
38. Regulation (EU) No 543/2013 of the Commission of 14 June 2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009. *OJ L 163*, 15.6.2013.

39. Meeus, L. (2020). *The Evolution of Electricity Markets in Europe*. Cheltenham: Edward Elgar Publishing.
40. Statnett. (2024). Why we have bidding zones. URL: https://www.statnett.no/en/about-statnett/The-power-system/why-we-have-bidding-zones.
41. UA Energy. (2024, December 21). *ENTSO-E has increased the capacity of interconnectors for electricity imports to Ukraine and Moldova to 1200 MW*. URL: https://ua.energy/zagalni-novyny/entso-e-zbilshyla-obsyagy-propusknoyi-spromozhnosti.
42. ENTSO-E. (2023). *Continental Europe Operational Handbook: Synchronous area and interconnection data*. URL: https://www.entsoe.eu.
43. Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity. *Official Journal of the European Union*, L 158.
44. Müller, H.K. (2015). *A Legal Framework for a Transnational Offshore Grid in the North Sea*. Intersentia. Roggenkamp, M., & Diestelemeier, L. (2022). EU Climate Law and Energy Network Regulation. In E.
45. Nieuwhout, C.T. (2020). *Regulating Offshore Electricity Infrastructure in the North Sea: Towards a New Legal Framework* (PhD dissertation). University of Groningen. URL: https://www.rug.nl.
46. Medvedieva M., Yedeliev, R., Reznikova, N., Nanavov, A., & Grydasova, G. (2024). European strategy for achieving climate neutrality and analysis of legal instruments for its implementation. *Social Legal Studios*, 2024-06-04. URL: https://doi.org/10.32518/sals2.2024.64.
47. Matiushyna O. (2023). Становлення і розвиток кліматичної політики ЄС у контексті міжнародно-правового співробітництва держав з протидії змінам клімату [Establishment and development of EU climate policy in the context of international legal cooperation of states in combating climate change]. *Law Review of Kyiv University of Law*, (3), 245–250. URL: https://doi.org/10.36695/2219-5521.3.2023.46.