UDC 620.92:330.332
DOI: 10.18524/2413-9998.2022.3(52).275807

Dmytro Podolchuk
PhD student,
Taras Shevchenko National University of Kyiv
60, Volodymyrska St., Kyiv, 01033, Ukraine
e-mail: dmytro.podolchuk@gmail.com
ORCID: https://orcid.org/ 0000-0001-7370-121X

THE ADVANCEMENT OF RENEWABLE ENERGY IN THE EUROPEAN UNION: AN EXAMINATION OF SUPPORT MEASURES

This study examines the development of renewable energy support mechanisms in the EU. It assesses the potential for their transformation in light of the formation of the European Energy Union in the context of the growing global energy crisis. As part of its long-term strategy to increase the share of renewable energy, the EU has set several ambitious targets, measures and legislative initiatives, such as Directive 2001/77/EC, which sets targets for 12% of energy and 22% of electricity from renewable sources by 2010, and the Renewable Energy Directive (RED II), which updates the RED I targets and provides for a share of renewable energy in final energy consumption of at least 32% by 2030. Various direct and indirect mechanisms to support renewable energy sources were analysed. It is concluded that the EU's commitment to increasing the share of renewable energy in the energy mix is consistent and ambitious. These initiatives demonstrate the EU's commitment to addressing the urgent need for a low-carbon economy.

Keywords: renewable energy resources, feed-in tariff, feed-in-premium, tradable green certificates, investment grants.

Problem statement. The fight against climate change and the necessary actions to decarbonise national energy systems is one of the most significant challenges to developing the global economy. In response to Russia's military aggression against Ukraine and the current energy crisis in the world, countries are more and more determined at each successive summit to set new climate targets and plans for their

achievement. In the 2018 IPCC report [13], it was noted that to reduce global warming by 1.5°C above the pre-industrial level, it is necessary by 2030 to reduce emissions of greenhouse gases (GHG) in the world by approximately 45% and to achieve zero level by 2050. Setting trajectories of GHG reduction was planned through accelerating the gradual withdrawal from coal use and further use of renewable energy sources (RES) with a transition to natural gas. This option was considered one of the most economically efficient ways to achieve climate neutrality. In addition, using other types of RES – green hydrogen, electric vehicles, and green energy storage can also improve the opportunities for decarbonisation through intersectoral cooperation.

RES are becoming increasingly popular at all levels – from home use to commercial power generation. The European Union is no exception and takes a leading position worldwide in developing renewable energy. The EU has a long-term strategy with clear goals and approaches for achieving them. By the end of 2021, global RES capacity, including hydropower, had reached 3061 GW. As of early 2022, the EU has a total RES capacity of 647 GW and plans to achieve a 55% reduction in emissions by its Member States and a 40% share of renewable energy sources in its energy mix by 2030 [14]. The EU's targets for zero emissions by 2050 and current RES capacities indicate the scale of the tasks ahead. The EU uses various support instruments to help develop technologies and attract investment to achieve this goal.

Literature review. The literature on the progress of renewable energy support in the EU has been growing in recent years, with various studies and reports providing insights into the effectiveness of EU policy measures and incentives in promoting the deployment of renewable energy technologies.

One of the main findings in the literature is that EU policy measures and incentives have been effective in promoting the deployment of renewable energy technologies. For example, a study by the European

Commission [3] found that EU member states have been successful in meeting their renewable energy targets set under the Renewable Energy Directive (RED) and the Energy Efficiency Directive (EED). The study also found that EU member states have been implementing various policy measures and incentives, such as feed-in tariffs, quotas, and tenders, to support the deployment of renewable energy technologies.

Another study by the International Energy Agency [12] found that the EU has been a leader in deploying renewable energy technologies, particularly in the solar and wind energy fields. The study also found that the share of renewable energy in the EU's overall energy consumption has been increasing steadily. The EU is on track to meet its 2020 total of 20% renewable energy consumption.

However, the literature also highlights the EU's challenges in integrating renewable energy into its existing energy systems. A European Commission [3] study found that the integration of renewable energy technologies can lead to various technical and economic challenges, such as the variability of renewable energy sources, the need for new transmission and distribution infrastructure, and the need for flexible power generation.

Another study by the Fraunhofer Institute for Solar Energy Systems [10] found that integrating renewable energy into existing energy systems requires the development of new technologies and solutions, such as energy storage systems and demand response measures, to ensure the stability and reliability of the energy systems. The study also found that integrating renewable energy into the existing energy systems requires cooperation and coordination between different actors, such as grid operators and renewable energy generators.

Kurbatova T. [16] studied the experience of stimulating RES in the EU and characterised the long-term energy policies of Member States regarding the "green" energy sector. Ziabina et al. [20] systematised the potentials and barriers to the proliferation of alternative energy sources

in Ukraine and EU countries. They attempted to forecast the results of the National Action Plan on RES to 2020 and the Energy Strategy of Ukraine for the period up to 2035. In [11], these mechanisms were analysed in terms of their efficacy in attracting investments in RES technology production and efficiency. Nonetheless, research on particular aspects of RES development in the EU and Ukraine does not include an exhaustive analysis of stimulation mechanisms as an object of state regulation, considering global trends in green energy and present geopolitical realities.

In summary, the literature on the progress of renewable energy support in the EU has shown that EU policy measures and incentives have effectively promoted the deployment of renewable energy technologies. However, the literature also highlights the EU's challenges in integrating renewable energy into its existing energy systems, such as technical and economic challenges and the need for new technologies and solutions.

This study **aims** to examine the progression of RES support mechanisms within the European Union and evaluate the potential for their transformation in light of the formation of the European Energy Union amidst the intensifying global energy crisis.

Results and discussion. The European Union has been committed to increasing the share of renewable energy in its energy mix for decades. Beginning in the 1990s, the EU set a series of targets and implemented measures and legislative initiatives as part of its long-term strategy. One of the critical milestones in this effort was Directive 2001/77/EC [4], which set targets for achieving 12% of energy and 22% of electricity from renewable sources by 2010.

The Renewable Energy Directive (RED) I [5], adopted in 2009, set even more ambitious goals, aiming for 20% of renewable energy in the EU's total energy consumption by 2020. This directive included provisions and support mechanisms, such as feed-in tariffs, grid

reinforcement, and capacity expansion mechanisms, to encourage renewable energy production in the EU's 28 member states.

In 2019, the EU Clean Energy Package [8] was introduced, including four directives and regulations. One of these, the National Energy and Climate Plan, aimed to ensure that the Energy Union's objectives – energy security, internal energy market, energy efficiency, decarbonisation and research, innovation and competitiveness – were taken into account by the Member States.

The next major initiative, the Renewable Energy Directive II (RED II) [6], was adopted in 2018 and sets even more ambitious goals for renewable energy, with a target of at least 32% of renewable energy in final energy consumption by 2030. Additionally, RED II includes provisions for more competitive and cost-effective support mechanisms for renewable energy, such as market-based support mechanisms, legislation on promoters and energy communities, and changes to sustainability and greenhouse gas emission reduction criteria for biofuels and biomass.

The EU's most recent major initiative is the Green Deal, first proposed in 2019, which aims for net-zero greenhouse gas emissions by 2050 [7]. This includes new strategies for integrating energy systems, including hydrogen. The European Green Deal Investment Plan and the Just Transition Mechanism were created as the investment framework to support the implementation of the Green Deal.

The EU's RePowerEU plan [9], announced in May 2022, aims to achieve the goals of the Green Deal and address geopolitical energy security issues by accelerating investment in renewable electricity generation. The EU's commitment to increasing the share of renewable energy in its energy mix has been consistent and ambitious. These initiatives demonstrate the EU's commitment to addressing the urgent need to transition to a low-carbon economy.

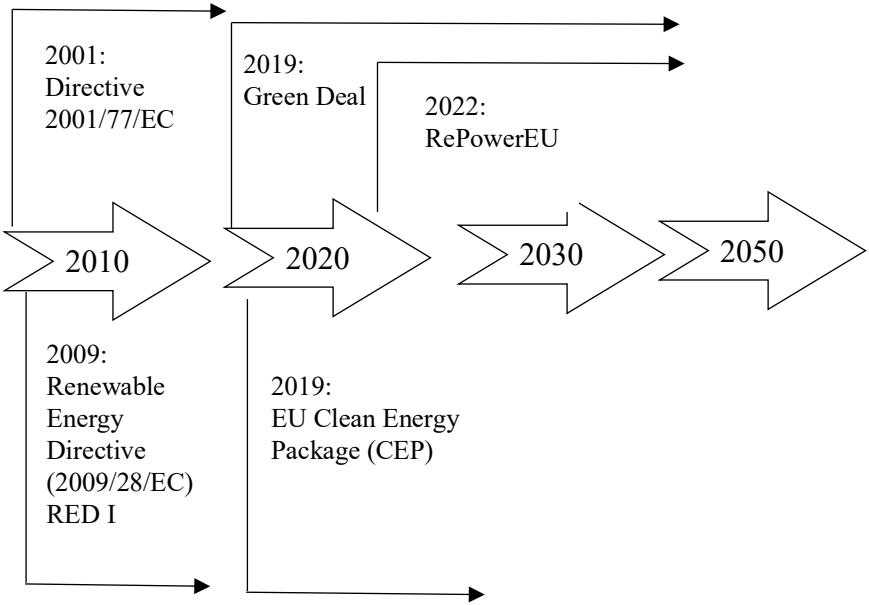

Fig. 1. Evolution of EU measures and goals

Source: developed by the author.

As we can see from Fig. 1, over the past few decades, the EU has set several ambitious targets, measures, and legislative initiatives to increase the share of renewable energy. From Directive 2001/77/EC, which set targets for achieving 12% of energy and 22% of electricity from renewable sources by 2010, to the more recent Renewable Energy Directive (RED) II, which updates the goals of RED I and provides for a share of renewable energy in final energy consumption of at least 32% by 2030, the EU has been a leader in the transition to a clean energy future.

However, different technologies are used to generate "green" energy from other sources, and the maturity of the respective market differs. As a result, generation efficiency varies, and the required support in terms of cost structure also differs accordingly. Support mechanisms

for RES depend, among other things, on energy policy goals and market failures, technology readiness, and the dynamics of market requirements.

In terms of direct support mechanisms, we see examples such as investment grants, feed-in tariffs (FiT), and tenders. For example, direct voluntary generation-based schemes, such as feed-in tariffs, are based on the willingness of consumers to pay premium prices for electricity from renewable sources. On the other hand, direct voluntary capacity-based schemes, such as shareholder programs, are based on the willingness of designated companies or investors to receive a limited or zero return on their capital invested in RES generation. Shareholder programs are initiatives in which owns stakes in renewable energy plants are offered to the public (e.g., customers of the energy company itself). In the case of donation, the RES developer asks the public for cost-free financing [11].

Indirect forms of support include environmental taxes, such as fees on hydrocarbon emissions, taxation of electricity generated from non-renewable sources, and the elimination of fossil fuel subsidies. These mechanisms create a level playing field for clean energy sources and help promote their growth and development.

The support mechanisms for RES have evolved, with the FiT being one of the most widely used in the industry's early days. Germany was one of the first countries to introduce this system in 1990, followed by Switzerland and Italy in 1991 and 1992, respectively. Other countries, such as Denmark, Spain, Greece, Sweden, and Portugal, adopted this approach.

The FiT system guarantees producers a fixed fee for the electricity they generate, regardless of the market price. This approach is highly efficient and relatively low-risk for producers, which explains its early popularity. However, the fixed FiT does not respond to changes in production costs, which can lead to inefficient use of funds and is

inconsistent with free market principles. As a result, it is being phased out in favour of the feed-in premium (FiP) system.

The FiP system allows producers to sell electricity on the market and receive an additional payment for generation from renewable energy sources. The premium can be fixed or determined as the difference between the market price and the feed-in tariff for a particular generation type. This approach still reduces financial risks for producers while allowing them to participate in a competitive electricity market and preventing excessively high profits. By 2017, 16 EU countries, including Germany, France, the UK, and Poland, had adopted this system.

In addition to FiPs, many countries have begun to use "green" auctions or tenders to determine support levels and financial incentives for RES producers. These auctions encourage cost-effective production and disclose the actual cost of RES generation, ultimately reducing the price of electricity [19].

While FiTs and FiPs remain the most common forms of RES producer support in the EU, other options, such as investment grant programs and green certificates, are also being introduced. For example, Austria and Finland offer investment grants for constructing solar or hydroelectric power plants, and Spain provides grants for any RES. Green certificates, awarded to producers for energy generated from renewable sources and sold to companies required to meet certain quota obligations for green energy, are used in Belgium, Ireland, Norway, Romania, and Sweden.

It is important to note that different countries have different schemes and efficiency. The FiT system in Germany, from its launch in 1991 to 2019, helped to install about 25 GW of offshore wind farms, 12 GW of photovoltaic capacity outside cities, and 23 GW of rooftop photovoltaic capacity. However, after the introduction of capacity regulation in 2014 and 2016, the number of new plants decreased for photovoltaic and onshore wind installations. Support schemes in Italy were differentiated

for photovoltaic and non-photovoltaic technologies. In particular, all types of PV installations are supported by feed-in tariffs, while onshore wind installations are backed by tradable green certificates and two types of feed-in tariffs (FiTs and FiPs).

As a result, while the FiT system has been instrumental in the early stages of the RES industry, it has been replaced by more market-oriented approaches such as FiPs and auctions in many countries. The choice of support mechanism depends on the generation type and the plant size, but the overall trend is towards greater competition and economic feasibility.

As Europe prioritises the transition to renewable energy, some countries have begun discussing the potential implementation of a tax on "dirty" electricity imported from neighbouring nations. Additionally, governments such as Germany and the UK have announced plans to phase out certain forms of traditional energy generation, replacing them with renewable alternatives.

In the face of these changes, it's worth noting that 2021 has seen the emergence of a new market segment in the solar energy industry, one that is based on the economic model of projects without a feed-in tariff and driven by the rising cost of electricity for both commercial and private consumers. This industry will likely continue to proliferate in the coming years, mainly as new EU requirements for producing goods using green energy come into effect in 2023. These requirements will force industrial companies to either build their renewable energy sources or risk shutting down their operations.

This is just the beginning of the EU's push towards a greener economy, and we expect to see more and more of these requirements in the future. For example, in Ukraine, Ferrexpo has already commissioned a 5 MW solar power plant to meet the energy needs of its industrial enterprises, with plans to build an additional 20 MW by the end of 2021.

Other large industrial companies follow suit to remain compliant with these regulations and maintain their export-dependent economies [17].

By the end of 2022, it is projected that approximately 4.5 GW of new solar power plant capacity will be built in the Central and Eastern European (CEE) region for self-consumption by industrial companies without utilising the feed-in tariff model [10]. In particular, over 1.1 GW of new solar power plant capacity in Ukraine may be constructed within the industrial consumption segment during this period [18].

According to the feed-in tariff model, by the end of 2022, solar power plants with a total capacity of more than 700 MW could be built in Ukraine, with most of these distributed among residential installations [17].

Like many European countries, Ukraine has set goals to transition to renewable energy sources. Since 2008, the primary form of support for developing the renewable energy industry has been through implementing feed-in tariffs. However, in 2019, the administratively set tax was intended to be replaced by auctions to distribute support quotas [2]. However, the crisis in the Ukrainian energy sector led to non-payment of the feed-in tariffs and subsequently to its retroactive reduction [15]. The launch of the first auction to allocate quotas was later postponed [18]. This situation fails to stimulate renewable energy deve-lopment in the country but also suspends it for a certain period [1].

Conclusion. The European Union has implemented a comprehensive strategy to increase the share of RES in its energy mix. In 2019, the EU introduced the Green Deal, a roadmap for achieving net-zero greenhouse gas emissions by 2050, which includes strategies for integrating energy systems and increasing the use of hydrogen. To support the implementation of the Green Deal, the EU created the European Green Deal Investment Plan and the Just Transition Mechanism as the investment framework for the initiative. In 2022, the EU further developed the RePowerEU plan, which aims to address geopolitical energy

security issues by accelerating investment in renewable energy generation. These program documents and directives provide appropriate mechanisms to support "green" energy, and EU member states are transitioning from a fixed tariff and administrative support system to a system of surcharges and auctions. As a result, several renewable energy sectors are adapting to function without active support.

References

1. Energize Ukraine (2020). Ukraine's Renewable Energy Sector: Challenges and Opportunities. Retrieved from https://www.energize-ukraine.com/ukraines-renewable-energy-sector-challenges-and-opportunities.
2. European Bank for Reconstruction and Development. (2019). Renewable Energy in Ukraine. Retrieved from https://www.ebrd.com/news/2019/renewable-energy-in-ukraine.html.
3. European Commission. (2018). Renewable Energy Progress Report. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/2018-renewable-energy-progress-report_en.pdf.
4. European Union. (2001). Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market. *Official Journal of the European Communities*, L 283, 33–39.
5. European Union. (2009). 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, 16–62.
6. European Union. (2018). Directive 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. *Official Journal of the European Union*, L 328, 81–119.
7. European Union. (2019). A Clean Planet for All: A European Strategic Long-Term Vision for a Prosperous, Modern, Competitive and Climate-Neutral Economy. Retrieved from https://ec.europa.eu/info/publications/clean-planet-all-european-strategic-long-term-vision-prosperous-modern-competitive-and-climate-neutral-economy_en.
8. European Union. (2019). Clean Energy Package. Retrieved from https://ec.europa.eu/energy/en/topics/renewable-energies/clean-energy-package.

9. European Union. (2022). RePowerEU: An Investment Plan for Renewable Energy. Retrieved from https://ec.europa.eu/info/strategy/investment-plan-renewable-energy-repower-eu_en.
10. Fraunhofer Institute for Solar Energy Systems. (2020). Energy System Integration of Renewable Energy Sources. Retrieved from https://www.ise.fraunhofer.de/content/dam/ise/en/documents/publications/studies/Energy-System-Integration-of-Renewable-Energy-Sources.pdf.
11. Golnoush, S., et al. (2022/3). Review of different national approaches to supporting renewable energy development. EUI. 164 p. doi: 10.2870/627847.
12. International Energy Agency. (2019). Renewable Energy in the EU: Past, Present and Future. Retrieved from https://www.iea.org/reports/renewable-energy-in-the-eu-past-present-and-future.
13. IPCC. (2018). Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C. Retrieved from https://www.ipcc.ch/sr15/.
14. IRENA. (2022). Renewable capacity highlights 2022. Retrieved from https://irena.org/-/media/Files/IRENA/Agency/Publiction/2022/Apr/IRENA_-RE_Capacity_Higlights_2022.pdf?la=en&hash=6122BF5666A36BECD5AAA2050B011ECE255B3BC7.
15. KPMG Ukraine (2019). Ukraine: Renewable Energy Sector Update. Retrieved from https://home.kpmg/content/dam/kpmg/ua/pdf/2019/12/renewable-energy-sector-update-2019.pdf.
16. Kurbatova, T. O. (2014). Economic mechanisms to stimulate the development of renewable energy in the European Union. Mechanism of regulation of economy. 4 (66). 139-148 [in Ukrainian].
17. Ukraine Ministry of Energy and Environmental Protection. (n.d.). Renewable Energy. Retrieved from https://www.me.gov.ua/en/portal/renewable-energy.
18. Ukraine's State Agency of Energy Efficiency and Energy Saving. (2019). Feed-in Tariffs for Renewable Energy Sources in Ukraine. Retrieved from http://www.saee.gov.ua/en/content/feed-tariffs-renewable-energy-sources-ukraine.
19. Verbruggen, A., & Laes, E. (2021). Early European experience with tradable green certificates neglected by EU ETS architects. *Environmental Science & Policy,* 119, 66-71. https://doi.org/10.1016/j.envsci.2021.02.013.
20. Zyabina, E. A., Lyuliev, O. V., & Pimonenko, T. V. (2019). Development of green energy as a way to energy independence of the national economy: the experience of EU countries. *Scientific Herald of Polissya*, 3 (19), 39-48. DOI: 10.25140/2410-9576-2019-3(19)-39-48. [in Ukrainian].

Стаття надійшла 29.11.2022 р.

Д. В. Подольчук,
аспірант,
Київський національний університет імені Тараса Шевченка
вул. Володимирська, 60, Київ, 01033, Україна
e-mail: dmytro.podolchuk@gmail.com
ORCID: https://orcid.org/ 0000-0001-7370-121X

РОЗВИТОК ВІДНОВЛЮВАНОЇ ЕНЕРГЕТИКИ В ЄВРОПЕЙСЬКОМУ СОЮЗІ: АНАЛІЗ ЗАХОДІВ З ПІДТРИМКИ

У цьому дослідженні розглядається розвиток механізмів підтримки відновлюваної енергетики в ЄС та оцінюється потенціал їх трансформації у світлі формування Європейського енергетичного союзу в умовах посилення глобальної енергетичної кризи. У рамках довгострокової стратегії збільшення частки відновлюваної енергетики ЄС визначив низку амбітних цілей, заходів та законодавчих ініціатив, таких як Директива 2001/77/ЄС, яка встановлює цілі щодо досягнення
12% енергії та 22% електроенергії з відновлюваних джерел до 2010 року, а також Директива з відновлюваної енергетики (RED II), яка оновлює цілі RED I та передбачає частку відновлюваної енергії у кінцевому енергоспоживанні на рівні не менше 32% до 2030 року. У дослідженні також розглядаються різні види прямих і непрямих механізмів підтримки відновлюваних джерел енергії, включаючи «зелені» тарифи, зміцнення мереж і механізми розширення потужностей, а також екологічні податки і скасування субсидій на викопне паливо. Впровадження та ефективність цих механізмів підтримки ВДЕ відрізняються в різних країнах-членах ЄС через такі фактори, як їхня індивідуальна енергетична політика, існуюча інфраструктура та ринкові умови. Крім того, вартість технологій відновлюваної енергетики продовжує знижуватися, що робить їх більш конкурентоспроможними порівняно з традиційними джерелами викопного палива. Це означає, що рівень підтримки, необхідний для ВДЕ, з часом також може зменшитися. Крім того, інтеграція відновлюваної енергії в енергосистему та розробка рішень для зберігання енергії матимуть вирішальне значення для досягнення амбітних цілей Крім того, ЄС стикається з геополітичними проблемами енергетичної безпеки, і план ЄС RePowerEU спрямований на вирішення цих проблем шляхом прискорення інвестицій у виробництво електроенергії з відновлюваних джерел. У дослідженні робиться висновок, що зобов'язання ЄС щодо збільшення частки відновлюваної енергії в енергетичному балансі є послідовним і амбітним, і ці ініціативи демонструють прихильність ЄС до вирішення нагальної потреби переходу до низьковуглецевої
економіки.

Ключові слова: відновлювальні джерела енергії, «зелений» тариф, контракти на різницю, товарні зелені сертифікати, інвестиційні гранти.

Список використаної літератури

1. Energize Ukraine (2020). Ukraine's Renewable Energy Sector: Challenges and Opportunities. Retrieved from https://www.energize-ukraine.com/ukraines-renewable-energy-sector-challenges-and-opportunities/.
2. European Bank for Reconstruction and Development. (2019). Renewable Energy in Ukraine. Retrieved from https://www.ebrd.com/news/2019/renewable-energy-in-ukraine.html.
3. European Commission. (2018). Renewable Energy Progress Report. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/2018-renewable-energy-progress-report_en.pdf.
4. European Union. (2001). Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market. *Official Journal of the European Communities*, L 283, 33–39.
5. European Union. (2009). 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, 16–62.
6. European Union. (2018). Directive 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. *Official Journal of the European Union*, L 328, 81–119.
7. European Union. (2019). A Clean Planet for All: A European Strategic Long-Term Vision for a Prosperous, Modern, Competitive and Climate-Neutral Economy. Retrieved from https://ec.europa.eu/info/publications/clean-planet-all-european-strategic-long-term-vision-prosperous-modern-competitive-and-climate-neutral-economy_en.
8. European Union. (2019). Clean Energy Package. Retrieved from https://ec.europa.eu/energy/en/topics/renewable-energies/clean-energy-package.
9. European Union. (2022). RePowerEU: An Investment Plan for Renewable Energy. Retrieved from https://ec.europa.eu/info/strategy/investment-plan-renewable-energy-repower-eu_en.
10. Fraunhofer Institute for Solar Energy Systems. (2020). Energy System Integration of Renewable Energy Sources. Retrieved from https://www.ise.fraunhofer.de/content/dam/ise/en/documents/publications/studies/Energy-System-Integration-of-Renewable-Energy-Sources.pdf.
11. Golnoush, S., et al. (2022/3). Review of different national approaches to supporting renewable energy development. EUI. 164 p. doi: 10.2870/627847.

12. International Energy Agency. (2019). Renewable Energy in the EU: Past, Present and Future. Retrieved from https://www.iea.org/reports/renewable-energy-in-the-eu-past-present-and-future.
13. IPCC. (2018). Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C. Retrieved from https://www.ipcc.ch/sr15/.
14. IRENA. (2022). Renewable capacity highlights 2022. Retrieved from https://irena.org/-/media/Files/IRENA/Agency/Publiction/2022/Apr/IRENA_-RE_Capacity_Higlights_2022.pdf?la=en&hash=6122BF5666A36BECD5AAA2050B011ECE255B3BC7.
15. KPMG Ukraine. (2019). Ukraine: Renewable Energy Sector Update. Retrieved from https://home.kpmg/content/dam/kpmg/ua/pdf/2019/12/renewable-energy-sector-update-2019.pdf
16. Курбатова, Т. О. (2014). Економічні механізми стимулювання розвитку відновлювальної енергетики в Європейському Союзі. *Механізм регулювання економіки.* 4 (66). 139–148.
17. Ukraine Ministry of Energy and Environmental Protection. (n.d.). Renewable Energy. Retrieved from https://www.me.gov.ua/en/portal/renewable-energy.
18. Ukraine's State Agency of Energy Efficiency and Energy Saving. (2019). Feed-in Tariffs for Renewable Energy Sources in Ukraine. Retrieved from http://www.saee.gov.ua/en/content/feed-tariffs-renewable-energy-sources-ukraine.
19. Verbruggen, A., & Laes, E. (2021). Early European experience with tradable green certificates neglected by EU ETS architects. *Environmental Science & Policy,* 119, 66–71. https://doi.org/10.1016/j.envsci.2021.02.013.
20. Зябіна, Є. А., Люльов, О. В., & Пімоненко, Т. В. (2019). Розвиток зеленої енергетики як шлях до енергетичної незалежності національної економіки: досвід країн ЄС. *Науковий вісник Полісся*, 3 (19), 39–48. DOI: 10.25140/2410-9576-2019-3(19)-39-48.