

ЕКОНОМІКА ТА ЕФЕКТИВНІСТЬ ВИРОБНИЧО-ГОСПОДАРСЬКОЇ ДІЯЛЬНОСТІ ПІДПРИЄМСТВ

УДК: 338.433:005.591.6

DOI: 10.37128/2411-4413-2020-4-6

CURRENT TRENDS AND PROSPECTS FOR THE DEVELOPMENT OF RENEWABLE ENERGY IN TERMS OF COVID - 19

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Crisis related to distribution of COVID-19 requires significant state involvement in the response, which includes the definition of strategies formation and direct intervention in to the socio-economic processes. Governments of countries are addressing the development of stimulus and recovery packages strategies what have a goal to form in the future necessary potential for society and economy on the whole. In given environment, stable assets are needed, including an inclusive energy system capable of supporting energy development in accordance with the United Nations Sustainable Development Program and the 2016 Paris Agreement, this requires further research of the prospects for innovative development of renewable energy sector in the crisis of COVID-19 in the transition from the use of fossil fuels to the use of renewable energy sources.

Global forecasts from the International Renewable Energy Agency, the International Energy Agency, and the US Energy Information Administration have suggested ways to transform the global energy system. China's hybrid energy market is showing an increase in wind and solar energy production. Reduced costs in the United States have stimulated an increase in renewable energy capacity. In Ukraine, the important role of alternative energy can be identified in the stabilization of Ukraine's agro-industrial complex.

In the article reviews current trends and conditions in the development of the energy sector in the transition from the use of fossil fuels to the use of renewable sources in China, United States and Ukraine in terms of forecasting generation and justification of investment directions. A number of technical challenges and problematic aspects of management in the renewable energy sector in Ukraine are highlighted. Long-term goals are proposed for all stakeholders of the energy system in the transition from the use of traditional fuel to the use of biopropellant. The conceptual principles and prospects of scientific research in the formation of the National Renewable Energy Development Plan until 2030 are also outlined.

Key words: refurbishable energy, global system, world crisis, economic development, COVID - 19, state stimulation.

Fig.: 6. Tabl.: 1. Lit.: 20

СОВРЕМЕННЫЕ ТЕНДЕНЦИИ И ПЕРСПЕКТИВЫ РАЗВИТИЯ ВОЗОБНОВЛЯЕМОЙ ЭНЕРГЕТИКИ В УСЛОВИЯХ COVID - 19

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Кризис, связанный с распространением COVID-19 требует значительного привлечения государства к реагированию, что предусматривает определение стратегий и осуществление прямого вмешательства в социально-экономические процессы. Правительства стран решают вопрос по разработке пакетов стимулирования и восстановления стратегий, которые имеют цель сформировать в будущем необходимый потенциал для общества и экономики в целом. В таких условиях необходимы стабильные активы, включая инклюзивное энергетическую систему, которая способна поддерживать развитие энергетики в соответствии с Программой Устойчивого развития Организации Объединенных Наций и Парижским соглашением 2016 года, поэтому необходимы дальнейшие исследования перспектив инновационного развития возобновляемой энергетики в кризисных условиях COVID-19 при переходе от использования ископаемого топлива к использованию возобновляемых источников энергии.

Глобальные прогнозы Международного агентства по возобновляемой энергетике, Международного энергетического агентства, Управления энергетической информации США по вопросам энергетического анализа предлагали пути трансформации глобальной энергетической системы. Гибридный энергетический рынок Китая демонстрирует увеличение производства энергии ветра и солнечной энергии. Снижение расходов в США стимулировало увеличение мощности возобновляемых источников энергии. В Украине важную роль альтернативной энергетики можно определить в стабилизации агропромышленного комплекса Украины.

В статье сделан обзор современных тенденций и условий развития энергетического сектора при переходе от использования ископаемого топлива к использованию возобновляемых источников в Китае, США и Украине с точки зрения прогноза генерации и обоснования направлений инвестирования. Выделен ряд технических вызовов и проблемных аспектов управления в секторе возобновляемой энергетики в Украине. Предложенные долгосрочные цели для всех заинтересованных сторон энергетической системы при переходе от использования традиционного топлива к использованию биотоплива. Также определены концептуальные основы и перспективы исследований при формировании Национального плана развития возобновляемой энергетики до 2030 г.

***Ключевые слова:** возобновляемая энергетика, глобальная система, мировой кризис, экономическое развитие, COVID-19, государственное стимулирование.*

Рис.: 6. Табл.: 1. Лит.: 20.

СУЧАСНІ ТЕНДЕНЦІЇ ТА ПЕРСПЕКТИВИ РОЗВИТКУ ВІДНОВЛЮВАНОЇ ЕНЕРГЕТИКИ В УМОВАХ COVID-19

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Криза, пов'язана з поширенням COVID-19 вимагає значного залучення держави до реагування що передбачає визначення стратегій та здійснення прямого втручання в

соціально-економічні процеси. Уряди країн вирішують питання із розробки пакетів стимулювання та відновлення стратегій, які мають мету сформувати у майбутньому необхідний потенціал для суспільства та економіки в цілому. В таких умовах необхідними є стабільні активи, включаючи інклюзивну енергетичну систему, що здатна підтримувати розвиток енергетики у відповідності до Програми Сталого розвитку Організації Об'єднаних Націй та Паризької угоди 2016 року, тому необхідними є подальші дослідження перспектив інноваційного розвитку відновлюваної енергетики в кризових умовах COVID-19 при переході від використання викопного палива до використання відновлюваних джерел енергії.

Глобальні прогнози Міжнародної агенції з відновлюваної енергетики, Міжнародної енергетичної агенції, Управління енергетичної інформації США з питань енергетичного аналізу пропонували шляхи трансформації глобальної енергетичної системи. Гібридний енергетичний ринок Китаю демонструє збільшення виробництва енергії вітру та сонячної енергії. Зниження витрат в США стимулювало збільшення потужності відновлюваних джерел енергії. В Україні важливу роль альтернативної енергетики можна визначити у стабілізації агропромислового комплексу України.

В статті здійснено огляд сучасних тенденцій та умов розвитку енергетичного сектору при переході від використання викопного палива до використання відновлюваних джерел у Китаї, США та Україні з точок зору прогнозу генерації та обґрунтування напрямів інвестування. Виділено ряд технічних викликів та проблемних аспектів управління в секторі відновлюваної енергетики в Україні. Запропоновані довгострокові цілі для всіх зацікавлених сторін енергетичної системи при переході від використання традиційного палива до використання біопалива. Також окреслено концептуальні засади та перспективи досліджень при формуванні Національного плану розвитку відновлюваної енергетики до 2030 р.

Ключові слова: відновлювана енергетика, глобальна система, світова криза, економічний розвиток, COVID-19, державне стимулювання.

Рис.: 6. Табл.: 1. Літ.: 20.

Problem statement in general and its connection with important scientific or practical tasks. The COVID-19 pandemic is characterized by a significant number of infected people, a growing number of fatal cases, social and economic fails in regions, in countries and in separate societies. Crisis in the context of COVID-19 requires significant government involvement in the response, which includes the development of certain strategies and direct intervention in socio-economic processes. Governments of countries are addressing the development of stimulus and recovery packages strategies what have a goal to form in the future necessary potential for society and economy on the whole.

Economic systems in today's crisis need more than a new incitement. There are stable assets are needed at present, including an inclusive energy system capable to support the development of low-carbon energy. Even with the current global economic slowdown, which can only temporarily reduce carbon emissions (CO²), it is possible to recover rapidly, return to pre-crisis levels of development and strengthen long-term development trends.

Identifying current trends and prospects for the development of renewable energy can be a guide to creating a sustainable energy system and achieving interconnected energy and climate goals. In this sense, it is important to determine safe areas of investment based on the study of political and economic factors in transition period.

It is known that the vast majority of electricity generated in the world is generated by burning fossil fuels, which in the context of the COVID-19 pandemic and OPEC (Organization of the Petroleum Exporting Countries) restrictions is becoming less available, and its use has a negative impact on the environment. The results of recent research in the field of fossil fuel reserves show that if the level of consumption remains as it is today, the world's reserves will be depleted in 50-60 years. Energy consumers require more reliable and cost-effective energy. The United Nations Sustainable Development Program and the 2016 Paris Agreement should form the basis of a modern stimulus program in the energy sector [2].

To meet the growing demand for energy, reduce environmental pollution and achieve socio-economic benefits for sustainable development, further research is needed on the prospects for innovative development of renewable energy in conditions of COVID-19 in the transition from fossil fuels to renewable energy sources use.

Recent researches and publications analysis. The global crisis associated with the spread of COVID-19 has become a harbinger of a climate emergency. Modern conditions have created an opportune moment to re-evaluate outdated assumptions, traditionally accepted barriers and decisions. It is now becoming clear how and where to invest and what policies to implement to ensure energy reform to strengthen economic recovery and support sustainable development.

Global renewable energy forecasts issued in the second quarter of 2020 by the International Renewable Energy Agency (IRENA), the International Energy Agency (IEA) and the US Energy Information Administration (US EIAO EA) [9, 11, 16], proposed ways to transform the global energy system in accordance with the Paris Agreement and were aimed at ensuring socio-economic benefits and well-being. The benefits of renewable energy in the context of the growing economic crisis were obvious even then. Today, their resilience compared to traditional fossil fuel energy has become even more apparent.

According to research by the Oxford Institute for Energy Studies, China continues to lead the world in increasing the production of wind and solar energy [8, p. 2]. The Chinese energy market is a hybrid, with both market and administrative measures, including administrative planning. China has introduced green certificates and commitments on renewable energy to support the consumption of renewable energy. According to the 12th Five-Year Plan, the National Energy Administration of China (NEA) has set ambitious targets for subsidized wind and solar energy, but the local market is often ahead of them [8, p. 3]. COVID-19 has a significant impact on clean energy trends, which requires more detailed analysis.

The COVID-19 pandemic hit the United States in March 2020. According to Deloitte Development, reducing costs and increasing the capacity of renewable energy sources, as well as increasing the competitiveness of batteries created the basis for long-term and rapid development of renewable energy [16, p. 3]. But declining housing orders, job cuts and disruptions in value chains have slowed expectations in the short term. The response of the renewable energy sector to the existing uncertainty is observed in three key trends: market transformation, network resilience, innovation and cooperation. Despite the significant short-term effects of the crisis, the long-term

outlook for the renewable energy sector remains positive, as it based on the scale-effect achieved over the past few years.

According to the International Energy Agency (IEA), India has made great progress in the energy sector in recent years. The country has provided energy to more than 700 million people since 2000. In India, there is an ambitious introduction of renewable energy sources. Energy efficiency is increased mainly due to innovative development programs [12, p. 47]. It also addresses serious public health problems caused by air pollution in large cities by providing 80 million households with liquefied petroleum gas. The country is taking significant steps to improve energy security by promoting domestic production [12, p. 3].

The main vector of development of energy sectors of Ukraine, in particular renewable energy, which is consistent with the goals and objectives of the fuel and energy sector is defined in the Energy Strategy of Ukraine (Energy Strategy), to 2035 [2, p. 5-6]. Among the goals of the Energy Strategy, the goals of improving the investment attractiveness of the industry and the development of a conscious energy-efficient society are important. At the first stage of the Energy Strategy implementation by 2020, it was expected to achieve 11% of the final electricity consumption (8% of the total primary supply) of energy generated from renewable energy sources. The Report of the Ministry of Energy of Ukraine on the implementation of the first stage of the Energy Strategy of Ukraine until 2035 states the need to update the Action Plan for the implementation of the Energy Strategy in terms of updating certain measures of the Plan, as well as terms and indicators of their implementation [3, p. 43].

The problems of renewable energy and the potential for their solution in Ukraine are widely studied in the domestic scientific literature. In [1] Goncharuk I.V. reveals the evolution of the theoretical foundations of positioning energy independence as a social and economic phenomenon, establishes the features of economic relations and the use of energy potential of the state as a starting point for scientific and technological progress. In labour Tomashuk I.V. poses a question of necessity of increase of level of society ecological consciousness; implementation of measures to ensure environmental safety and reduce the man-made load on the environment [7, p. 45].

In the scientific works of domestic scientists, such as Kaletnik G.M., Pryshliak V., Pryshliak N. the role of alternative energy in the stabilization of the agro-industrial complex of Ukraine is widely studied. In particular, in Kaletnik G.M. discuss about increasing gross production, creating new jobs and reducing energy dependence, the feasibility study of energy developments for the agro-industrial complex of Ukraine was carried out, the impact of state policy in the field of energy on the environment and food security of the state is studied and the resource potential of clean energy production in Ukraine is assessed by Kaletnik G.M., Pryshliak V., Pryshliak N., the issues of environmentally friendly technologies, clean and renewable energy sources and efficient energy use are studied. The impact of state policy on energy, environment and food security of the state is determined. In [4] the advantages, problems and prospects of using wind and solar energy technologies at the enterprises of the agro-industrial complex of Ukraine are considered and the creation of an autonomous power

generation system based on stochastic solar and wind energy is proposed by Kaletnik G.M. [4, 5, 6, 14, 15, 17].

Formulation of the goals of the article (task statement). The aim of this article is a review of essence of nature and efficiency of refurbishable energy, finding out of them sources power potential and lineation of ways of increase of practice of the use of refurbishable energy sources in economic turnover of country. The outlined aim stipulated the further decision of row of tasks, namely to ensure the implementation of the priorities of the United Nations Sustainable Development Program and the Paris Agreement of 2016 in the energy sector, it is necessary to set long-term goals for all stakeholders in the energy system in the transition from fossil fuels to renewables in the context of conceptual frameworks formation of the National Renewable Energy Development Plan until 2030, it is therefore needed to define modern to identify current trends and conditions of energy sector development in the transition from fossil fuels to renewable sources in developed economies and Ukraine; highlight technical challenges and problematic aspects of management in the renewable energy sector in Ukraine.

Presentation of the main material of the study with a full justification of scientific results. The energy sector, one of the central sectors of the world economy, is playing a crucial role in the context of the coronavirus crisis (COVID-19). Responses, including social constraints, have disrupted value chains, reduced demand for goods and services, lowered commodity prices, and caused a significant economic downturn worldwide. With the health crisis, hundreds of millions of people have lost their jobs or livelihoods.

Political incentives and investments aimed at recovery and development can initiate much broader structural changes than those needed for economies to reach pre-crisis levels. This can be achieved by providing the necessary conditions for the development of national and regional strategies for the development of the energy system in the direction of increasing the importance of renewable sources, which is a crucial step in building a sustainable economy and society. The energy sector should be seen as an integral part of the global economic system. This will make possible to understand the socio-economic impact of the transition from fossil energy to renewable energy.

Renewable energy sector has suffered along with the rest of the world economy, but has proved more resilient than other components of the energy sector. With the decline in energy demand to meet the needs of transport and industry, demand for fossil fuels has declined significantly. Oil prices have fallen sharply, which could increase further instability and pose risks to the viability of the entire oil industry in the long run, even with some signs of recovery in the short term. Meanwhile, renewable energy networks based on the use of renewable energy sources continue to operate efficiently.

According to research summarized in [10] (Fig. 1), the global share of renewable energy in total final energy consumption in the year to 2050 will be 25%, in conditions of current trends development associated with the economic downturn.

According to the International Renewable Energy Agency's (IRENA) Renewable Energy Roadmap, renewable energy can account for 60% or more of the total final energy consumption of many countries. For example, China may increase

the share of renewable energy in its energy consumption from 7% in 2015 to 67% in 2050. In the European Union, this share could increase from around 17% to over 70%. India and the United States can show an increase in renewable energy consumption to two-thirds or more of total energy consumption [20, p. 19].

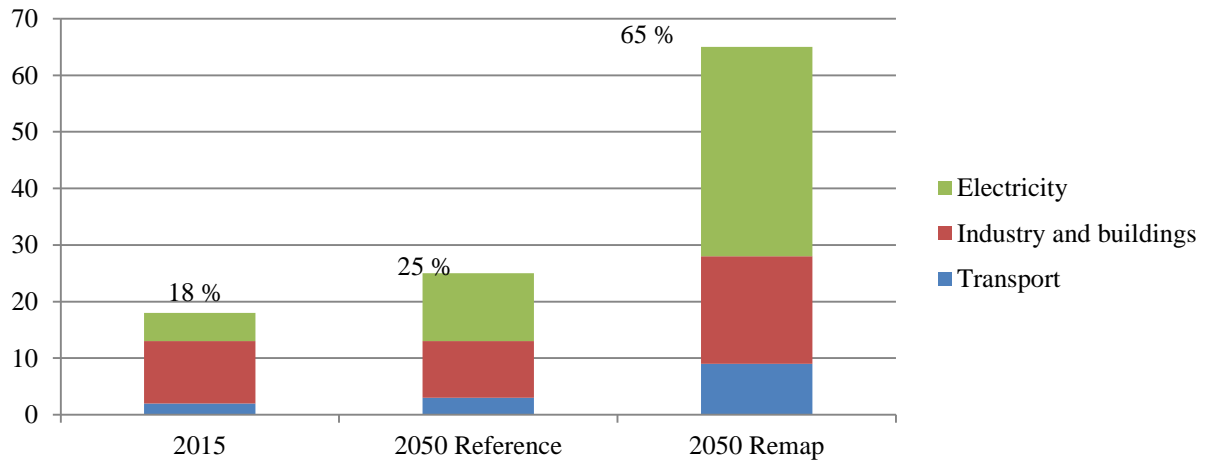


Fig. 1. Share of renewable energy in total final energy consumption, %

Source: compiled by the author according to [20].

Global energy transformation has sufficient economic preconditions and is economically feasible. The additional costs for a comprehensive, long-term transition to the use of renewable energy sources will amount to 1.7 trillion US dollars annually by 2050. However, the savings by reducing air pollution, improving health of population and reducing environmental damage far outweigh these costs. According to IRENA, the savings in these three areas alone will amount to 6 trillion US dollars annually by 2050. In addition, the transition to the use of renewable energy sources will significantly improve the global socio-economic climate, improve global welfare, and will be the basis for GDP growth (gross domestic product) and employment compared to the use of fossil fuels. The shift to renewable energy stimulates economic activity much more than would be expected with continued use of fossil fuels.

For example, the current work plan of the Chinese government in the field of energy is aimed at “stable growth” of the share of renewable energy sources in the overall structure of the energy balance, and the policy announced in 2020 supports this direction. China's draft energy law clearly states that renewable energy will have priority in development. The project deals in detail with renewable energy in all its forms more than with any other type of energy (Fig. 2).

Another area of developments in the energy sector is aimed at increasing the demand for clean energy in industry. In March 2020, the National Commission for Development and Reform (NCRC) issued an Opinion on the development of a regulatory and policy system for green production and consumption, emphasizing the promotion of various green industries, technologies, goods and services. This development involves “increasing political support for clean energy distribution, smart distribution, energy storage technologies and multi-energy complementarity”. The

complementarity of several types of energy means the use of several types of energy sources, energy storage and flexible consumption, which aims to reduce overall costs and increase the reliability of clean energy.

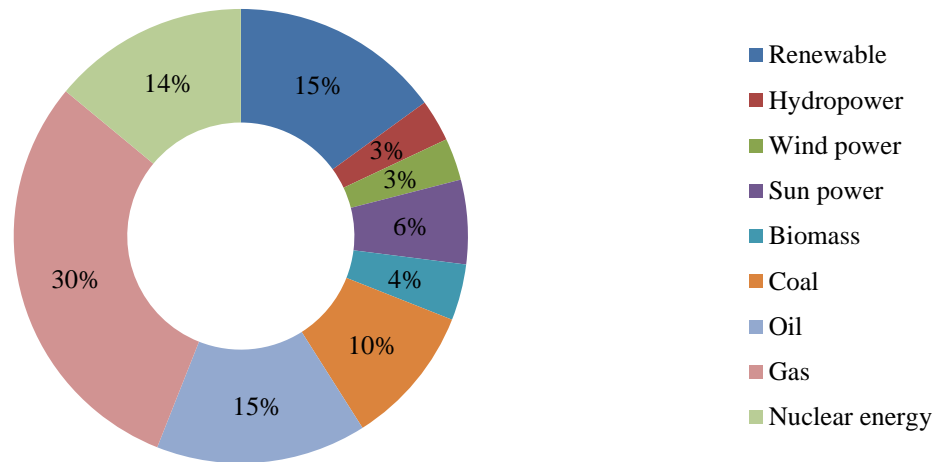


Fig. 2. The structure of energy sources in 2020 in China, %
 Source: [8, p. 5].

In the United States, the production of electricity from natural gas and renewable sources is growing (Fig. 3, Fig 4) due to lower natural gas prices and reduced costs for solar and wind power, which makes these types of energy more and more competitive.

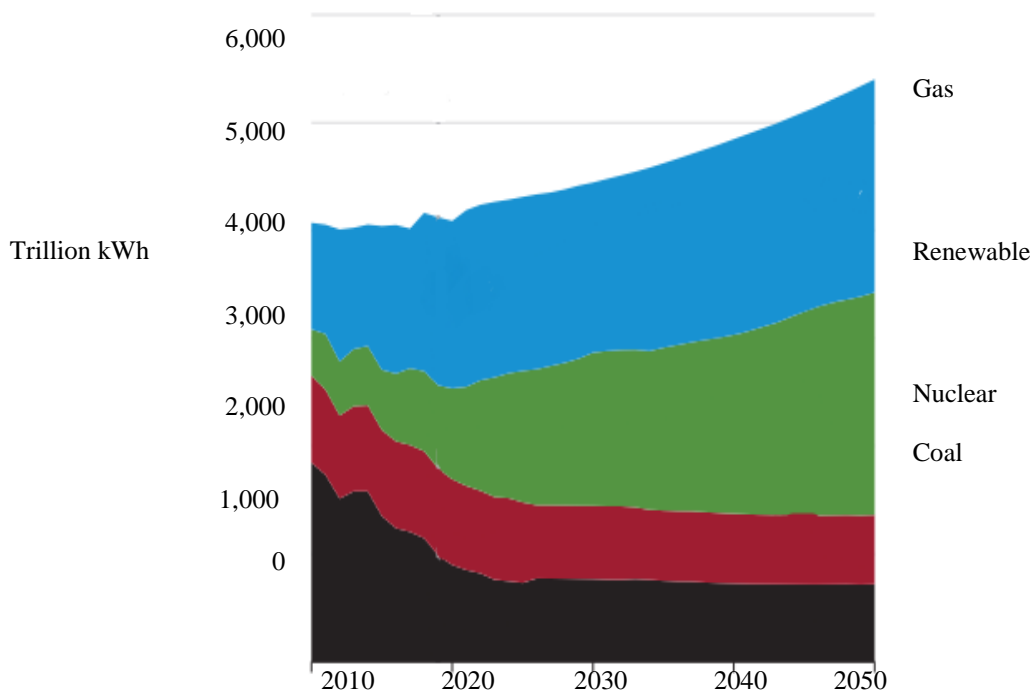


Fig. 3. Electricity generation by types of sources in the United States 2010-2050 (trillion kWh)

Source: adapted by the author according to the data [9, p. 63].

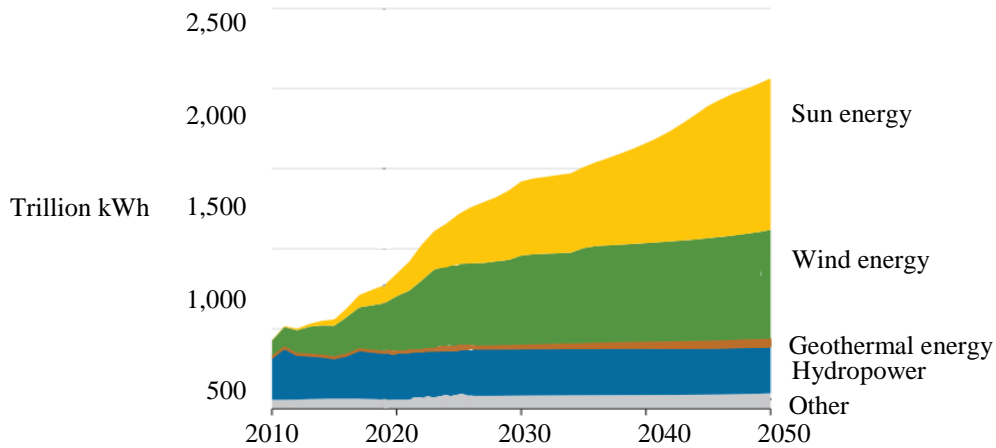


Fig. 4. Generation of electricity from renewable sources by type in the United States 2010-2050 (trillion kWh)

Source: adapted by the author according to the data [9, p. 63].

Short-term demand for electricity fluctuates due to seasonality, long-term demand trends are usually due to economic growth and energy efficiency. Annual growth in electricity demand in the forecast period until 2050 in the United States makes in average about 1%. Historically, with the development of the economy, the growth rate of demand for electricity has slowed down. The reason for this is that more efficient devices and production processes (appliances, heating systems, ventilation, cooling and equipment) require less electricity. Electricity consumption in the case of rapid economic development will grow on 0.3% faster than the average, and electricity consumption in the case of slow economic growth will grow by 0.2% slower than average (Fig. 5).

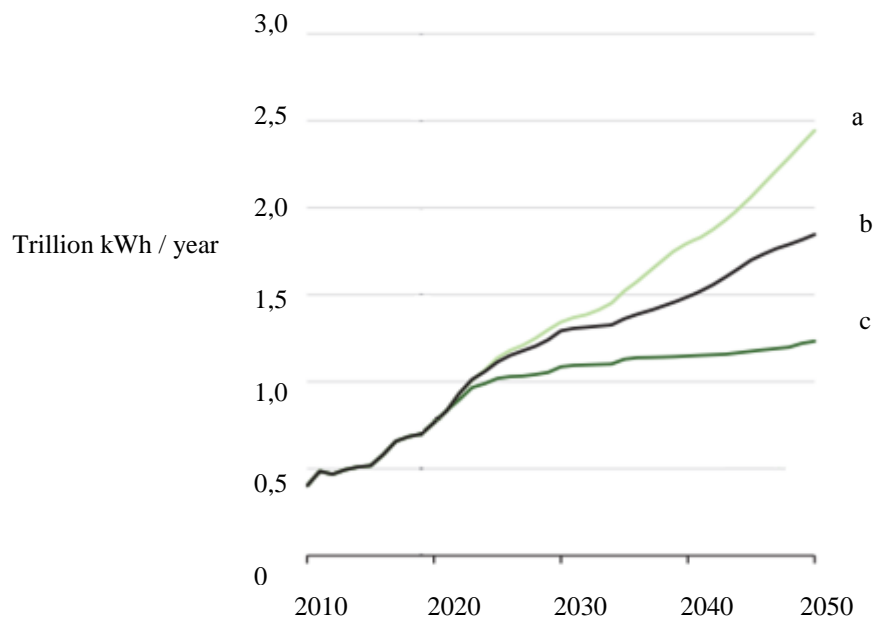


Fig. 5. Renewable energy generation forecasts in the USA, trillion kWh
a - small volumes of fossil fuel use; b - standard forecast; c - low volumes of fossil fuel.

Source: adapted by the author according to the data [9, p. 151].

The growth of projected electricity sales in the USA in the period up to 2050 would be faster if not for the significant development of photovoltaic systems for roofing in residential and commercial buildings, but for the spread of combined heat and power systems in industrial and some commercial buildings. By 2050, end-use photovoltaic batteries will account for 4% of total US production.

Demand for electricity in the US transportation sector is a middle percentage of the total, as electric vehicles still represent an emerging market. There is currently no scientific or practical evidence to suggest a significant increase in US consumer attention to electric vehicles. Both sales of electric cars and their use (mileage) must increase significantly in order to increase the growth rate of electricity demand within a percentage of the year.

In Ukraine in 2018, the share of energy supply from renewable sources was 4.6%. The dynamics of changes in the share of energy supply from renewable sources in the overall structure of energy supply indicates its growth by more than 3 times compared to 2007 (Fig. 6.) [10].

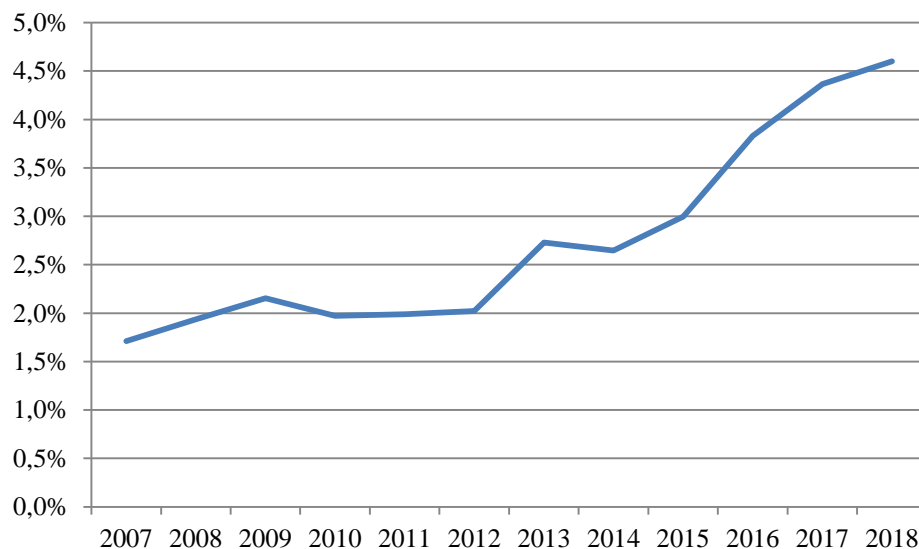


Fig. 6. The share of energy supply from renewable sources in Ukraine, 2007 – 2018

Source: compiled by the author [10, p. 151].

In 2019, the share of renewable energy sources in the structure of electricity production in Ukraine was about 3.3% (Fig. 7).

A significant shortcoming in the planning and development of measures for the development of renewable energy in Ukraine is the lack of actual results on the portal of the State Statistics Service of Ukraine on energy balance, energy supply, use and consumption of electricity from renewable energy sources. The latest official data are presented by the State Statistics Service of Ukraine only for 2018.

Technical challenges in the field of renewable energy in Ukraine can be considered unbalanced generation structure, which is exacerbated by the lack of responsibility of renewable energy companies for imbalance and low quality of energy generation forecasting, as well as the historical problem of poor topology and technical infrastructure. According to the Ministry of Energy and of Ukraine, the development of renewable energy in Ukraine is characterized by the following problematic aspects:

imperfect regulatory capacity of public authorities to influence the development of renewable energy; lack of responsibility of energy generating enterprises with renewable energy sources for imbalance; imperfect regulatory framework and technical means of planning the development of networks governing the connection of facilities with renewable energy sources (indefinite specifications, imperfect modeling software, the presence of “white spots” at the level of the operator of distributive system); underdeveloped competitive electricity market, etc.

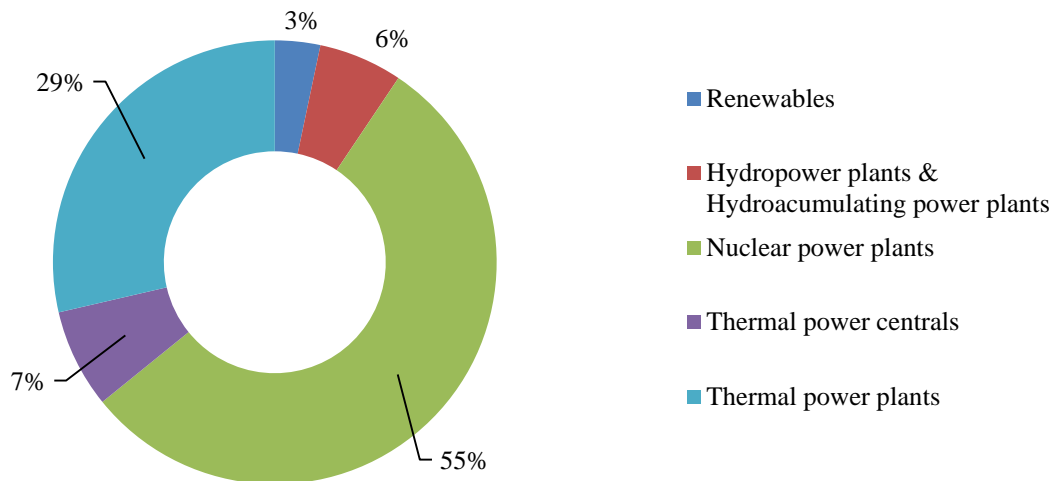


Fig.7. The share of renewable energy sources in electricity generation in Ukraine 2019, %

Source: adapted by the author according to the data [2,4,9,12].

Investments in the transition from the use of fossil fuels to the use of renewable energy sources can stimulate the economy in the recovery phase of 2021-23 and create a significant number of jobs. Increasing funding for renewable energy will provide relevance to the transition from fossil fuel employment and provide new opportunities for both skilled and unskilled workers in other industries.

Public policy should be aimed at attracting private investment, which should be used strategically to promote innovative solutions and financing in the direction of renewable energy development projects.

Renewable energy development projects – including existing power plants and power plants under construction, generation distribution and the development of network transmission infrastructure to ensure the supply of energy from renewable sources – must be protected by the government. In addition to renewable energy production, government measures can stimulate related industries in value chains (eg battery manufacturers), infrastructure development (smart grids, grid reinforcement, electric vehicle charging, district heating and cooling, hydrogen), energy efficiency and end-to-end electrification.

Investment decisions must go hand in hand with political ones, which will ensure that production and economic opportunities are consistent with the goals of post-crisis recovery and the transition from fossil fuels to renewable energy sources.

Careful attention is needed by governments to build up existing production capacity, build value chains and expand the skilled workforce in parallel with the development of investment.

To promote socially responsible energy reforms, labor and social protection policies need to be tailored to the specific needs of each region in the country. Interventions in the labor market can be carried out by employment services (comparison of competencies required in the workplace with the qualification of candidates; promotion of off-the-job training and in-service training). Government programs could also take into account the qualifications of workers in the fossil fuel energy sector, whose competencies could be refocused on the transition from fossil fuels to renewables.

Based on research by the International Energy Agency, the US Energy Information Administration, the International Renewable Energy Agency and taking into account current issues of renewable energy in Ukraine, we have proposed a number of measures to stimulate post-crisis energy recovery and accelerate the development of renewable energy till 2030 (table 1).

Table 1

Measures to stimulate post-crisis recovery and accelerate the development of renewable energy

General goals	Compliance with the terms of the 2016 Paris Convention. Development of a national plan for the development of renewable energy until 2030. Amendments to the Law of Ukraine “On the Electricity Market”. Establishment and coordination of goals for the development of renewable energy in all areas of end-use (electricity, heating and cooling, transport), infrastructure goals and goals for energy efficiency.
Public participation	Shifting the financial focus of the public from the use of fossil fuels to investing in the development of renewable energy. Develop and implement carbon tariff penalties that will help limit the economic growth of harmful industries in the post-crisis period of economic recovery after the COVID-19 pandemic. Mobilize public financial resources to invest in the development of renewable energy infrastructure. Identify criteria and constraints for meeting sustainable development goals for investors (risk analysis for climate change impacts).
Investment	Protection of renewable energy development projects from delays in time: extend deadlines, reduce fines, simplify contract conditions, simplify and speed up permitting procedures. Encouraging investment in planned projects (concluding preliminary agreements, ensuring transparency of procurement plans, identifying and distributing risks evenly among all participants). Adapt the goals of the National plan for the development of renewable energy until 2030 for use in construction and develop a number of specific solutions. Development of incentives to reduce carbon emissions in the production of building materials and the development of construction networks. Adapt the goals of the National plan for the development of renewable energy until 2030 for use in transport and develop a number of specific solutions. Development of incentives to reduce carbon emissions from public transport, implementation of urban infrastructure projects that provide comfortable conditions for cyclists and pedestrians.
Employment and job creation	Implementation of social protection measures for workers affected by COVID-19. Creating benefits for workers involved in renewable energy development projects. Creating new jobs using the potential of value chains in the field of renewable energy and transfer of transitional technologies. Introduction of advanced training and retraining for employees who are at risk of losing their jobs. Reconciliation of supply and demand in the labor market through an active marketing policy in the labor market.

table 1

Development of the renewable energy industry	Reducing entry barriers for domestic enterprises seeking to enter value chains in the field of renewable energy. Development of the necessary production capacity for use in value chains in the field of renewable energy. Promoting integration into regional value chains in the field of renewable energy.
Priority	Implement renewable energy solutions to support recovery and crisis of COVID-19 recovery. Implement a cross-sectoral partnership to accelerate the recovery of the COVID-19 crisis. Ensuring the use of modern solutions to protect vulnerable populations when using traditional energy sources. Taking into account the financial needs of energy companies to reconcile debt obligations, working capital and grants. Creating conditions for solving problems in the field of energy supply to areas where there are no transitional networks.

Source: developed by the author based on data [8, 9, 11, 12, 16, 18, 19].

The proposed measures are designed to set long-term goals for all stakeholders in the energy system. The National Renewable Energy Development Plan to 2030 will also identify future investment needs in renewable energy infrastructure development and provide a comprehensive pricing approach using fossil fuels and renewable energy sources based on improved data collection process, its content, transparency and availability at the regional and state levels.

Conclusions and prospects for further research. The results of the analysis highlight some key policy priorities and measures that will help accelerate the recovery from the COVID-19 pandemic crisis and the transition from fossil fuels to renewables.

Achieving synergies in ensuring energy efficiency and renewable energy development can be possible through the renovation of existing assets using appropriate technologies. Planning of the energy sector with a high share of renewable energy should be carried out taking into account that innovative business models of renewable energy should include generation schedules taking into account peak loads and tariffs. It is also worth encouraging an increase in the use of electricity in transport, buildings and production, which will significantly accelerate the achievement of sustainable development goals and provide a number of other benefits, such as reducing CO² emissions in cities. The basis for the development of renewable energy is systemic innovations, among which solar and wind energy play a significant role. At the same time, such innovations should cover a range of issues not only related to technological research, they should take into account the life cycle of technology, at least in the format of presentation, implementation, study, dissemination and commercialization. Development-supporting innovations should be in the field of energy management, market development, formation of business models, development of related technologies that will contribute to the spread of renewable energy technologies. For systemic innovative development it is also necessary to harmonize the socio-economic system and investments with the stages of development of renewable energy. It is worth noting that the faster the development of renewable energy, then the smaller the losses from climate change and the less stress the socio-economic system experiences. The proposed ways of renewable energy development and measures that will promote this development are possible only if they are

transparently perceived, disseminated and implemented.

The results of such researches also depend significantly on the government's structural realities and intentions to introduce a carbon tax system. Meanwhile, the global analysis suggests that Ukraine's economy can receive significant GDP growth, increase welfare and employment while supporting the development of renewable energy.

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УДК 631.1

DOI: 10.37128/2411-4413-2020-4-7

**СУЧАСНІ
ЕНЕРГОЕФЕКТИВНІ
ТЕХНОЛОГІЇ В АПК
УКРАЇНИ**

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У статті аргументовано основні детермінанти розвитку енергоефективних технологій в АПК України. Розкрито основні проблеми, які перешкоджають досягненню енергетичної незалежності України. Викладено проблеми та перспективи на шляху адаптації нинішніх технологій у рослинництві, новітніх техніко-технологічних рішень в тваринництві та ресурсозберігаючих систем землеробства до існуючих умов вітчизняного сільськогосподарського виробництва.

Здійснено аналіз використання сучасних енергоефективних технологій у галузі рослинництва і обґрунтовано, що вони пов'язані з, використанням сучасної техніки та відновлюваних джерел енергії, космічними інформаційними технологіями. Розглянуто особливості інноваційних енерго- і ресурсозберігаючих технологій землеробства. Запропоновано новітні техніко-технологічні рішення в тваринництві, що сприяють енергозбереженню в розрізі сучасного техніко-технологічного забезпечення галузі, енерго- та ресурсозберігаючих технологій, виробництво біопалива (біогазу) з окресленням проблем та перспектив його розвитку.

Запропоновано заходи з подолання кризового стану інноваційно-технологічної активності сільськогосподарських підприємств, орієнтовані на зміцнення аграрної галузі та забезпечення її прогресивного розвитку. Обґрунтовано застосування перспективних енергоефективних технологій в АПК, як запоруки розвитку галузі на інноваційному підґрунті.

Узагальнено заходи щодо вдосконалення державного регулювання і стимулювання до переходу на енергоефективні технології, а саме: покращення іміджу держави на світовій арені для збільшення інвестиційної привабливості; розробка дієвої енергетичної політики, що