

Implementation of innovative projects using renewable energy sources in the fields of “future economy”

Svitlana Bondarenko ^A; Iryna Perevozova ^B; Tetiana Maksimenko ^C

Received: June 1, 2020 | Revised: June 20, 2020 | Accepted: June 30, 2020

DOI: 10.33445/sds.2020.10.3.13

Abstract

The aim of the article is to study the implementation of innovative projects for the use of renewable energy sources in the “economy of the future”. According to the concept of “green” energy transition, the following areas of “economy of the future” are identified: energy efficient industry, buildings, heat energy; electric transport; circulating economy, waste reduction; support for research and innovation on electricity storage, production and storage of green hydrogen; digitalization and technological changes; renewable energy sources – wind, solar, bioenergy. It is proved that renewable energy sources can meet 80% growth in electricity demand over the next 10 years. By 2025, renewable energy sources will displace coal as the main means of electricity generation. If states adopt more aggressive policies, the role of renewable energy will be even more active in the next five years. It is proved that it is important to create an appropriate market environment to attract large-scale private investment in innovative renewable energy projects. After all, without sufficient investment, networks will be a weak link in the transformation of the electricity sector, which will affect the reliability and security of electricity supply. The transition to renewable energy sources in the general energy supply, including transport and heating, is most active in large cities. To transition the city to the “green” energy, the issues of attracting investment, changing consumer behavior, integration of electricity with heat supply and transport, the state of existing energy infrastructure (electricity, gas, heating networks), distribution of energy consumption between sectors (buildings, mobility) and players in supply (large energy companies, enterprises, cooperatives).

The research of the basic tendencies of realization of projects of use of renewable energy sources in Ukraine is carried out. To ensure competitive conditions for the production of electricity from alternative energy sources, the introduction of incentive mechanisms and the installation of capacities for the accumulation of electricity at power plants is envisaged. Financial support for renewable energy at the state level is provided in two areas: tax benefits and credit support. Among the tax benefits and mechanisms in world practice are the following: investment tax credit; production tax credit; mechanism of partial or full compensation of interest for the use of loans by industrial companies and individual farms for the installation of energy storage systems; mechanism for exemption from taxation of imported equipment for energy storage systems, etc. However, Ukraine has not yet taken sufficient legislative and diplomatic steps to do so. Important are the problems of balancing the network, defaults and debts to market participants, the restructuring of the “green” tariff.

Key words: renewable energy sources, innovative projects, green energy.

Introduction

The transition to renewable energy is a key element of the European energy strategy. The EU strategy declares the intention to reduce harmful emissions into the atmosphere by 40% from 1990

^A National Defence University of Ukraine, Professor of the Department, D.Sc., (Economics), e-mail: lana.bond@ukr.net, ORCID: 0000-0002-1687-1172

^B Ivano-Frankivsk National Technical University oil and gas, Head of the Department, Prof., D.Sc., (Economics), e-mail: perevozova@ukr.net, ORCID: 0000-0002-3878-802X

^C Ivano-Frankivsk National Technical University oil and gas, Postgraduate student, e-mail: mezhirich@gmail.com, ORCID: 0000-0001-5139-4562

levels and to produce almost a third of electricity from renewable sources by 2030 (Transforming our world). Increasing the share of renewable energy sources will reduce the consumption of fossil fuels, significant volumes of which (especially natural gas) are imported from Russia. Reducing energy dependence will increase systemic security and geopolitical risk resilience for both EU countries and Ukraine (Bondarenko & Makoveieva, 2020). To achieve these goals, countries are joining various agreements on the development of renewable energy, reducing carbon emissions and improving energy efficiency.

Support for renewable energy is a priority for energy development in the vast majority of European Union countries, especially given the program of action of the European Green Agreement to achieve a climate-neutral economy by 2050 (European Green Deal). The European Commission has adopted a package of the legislative initiatives “Clean Energy for All Europeans” to achieve 32% share of renewable energy sources in the EU energy balance by 2030 and an energy efficiency index of 32.5% (Clean Energy for All Europeans). It is planned to produce almost half of the world’s electricity by 2050 by technology renewable energy sources. This was made possible by a sharp drop in the cost of wind and solar technologies, as well as energy storage technology.

The transition to electricity from renewable sources is the main trend of state energy policy both in the world and in Ukraine. The world has already established state mechanisms to support large-scale reformatting of the energy sector through the global use of renewable energy sources. Analysis of the world experience shows that the fastest developing renewable energy

sources in the United States, EU countries (Denmark, Sweden, Austria, Finland, Germany, Portugal, Spain), Japan, China, Brazil and India.

The goals of greening, sustainable development of society stimulate business to revolutionary changes and the search for new business models to increase value for investors (Bondarenko et al, 2020). The latest models that expand the market opportunities of the economic entities are the presence in the segment of renewable energy.

Global investment costs in the renewable energy sector are growing steadily: growth of 9% (Compound Annual Growth Rate, CAGR) from 2010 to 2017 was mainly provided by an attractive range of the implemented tariffs and subsidies, as well as favorable legislation.

Despite the obvious benefits of renewable energy – reducing harmful emissions, overcoming the problem of the depletion of natural resources, development of innovative technologies, creating new jobs in the energy sector, etc. – the production of “green” electricity is currently less competitive than traditional generation.

Thus, the assumptions of the study are that the high level of innovation of the segment renewable energy sources is the basis for increasing the investment attractiveness of Ukraine’s economy, which requires effective tools and specific government incentives.

Research hypothesis: improvement of the mechanisms to stimulate innovation of the segment development renewable energy acquires practical significance for the growth of energy independence of the national economy, the creation of new jobs and the formation of a new competitive segment of the economy with high added value.

Material and methods

The vector of sustainable development of the high-tech countries is environmentally friendly energy. Energy transformation is associated with the development of alternative energy technologies, which combines technologies to improve energy efficiency and technologies for the use of renewable energy sources. The

synergistic effect of the combination of such technologies is the innovative development of both the economy and society as a whole. The transition to more advanced energy sources is an indicator of the transition to a new technological level of development. Moreover, the study showed that the stages of technological

improvement of renewable energy sources and the recognition of their economic significance have determined the independence of investment activity in renewable energy from fluctuations in energy prices (Buchnev, 2016).

Renewable energy is a branch of energy that receives and uses energy from renewable sources (Syrotiuk, 2008). Renewable energy sources are able to renew themselves naturally. That is, renewable energy cannot be fully utilized in the long run (Mkhitarian, 1999). Natural energy sources include: solar energy, water, wind, organic biomass, etc. In scientific sources there are three types of such sources: solar energy; earth energy and energy that can be obtained through the motion of the planet (Mysak et al., 2014).

For practical use, there are two groups of renewable energy sources (Dudyuk et al., 2008):

- non-traditional renewable energy sources of the 1st group: energy of the sun, water, geothermal energy, wind, etc.;
- non-traditional renewable sources of the 2nd group: energy obtained from biomass, products of its processing, household waste, etc.

According to the World Renewable Energy Policy Network of the 21st Century (REN 21), the global trend is the rapid development of renewable energy markets, their investment attractiveness, and growing public support in the world. The use of green energy and the full transition to it is the main goal of the EU in

the framework of the Green Deal project (Green Deal). The document regulates state support for market development, expansion of this market for households. There are transformational requirements for the economies of EU member states in the field of transport, industry, agriculture, etc. Green Deal updates investment projects aimed at the development of green energy, partnership support in their implementation and dissemination of best practices (Renewable Energy Prospects for the European Union).

Since 2008, Ukraine has committed itself to developing renewable energy. In 2017, these commitments were enshrined in the Energy Strategy of Ukraine until 2035 “Security, energy efficiency and competitiveness”, according to which by 2025 in the energy balance of the country the share of the “green” energy should be 25% (Energy Strategy of Ukraine). Achieving these goals will require improved technological solutions, significant investment, updated legislation and structural changes in the economy.

In early 2020, the Ukraine presented the Concept of the “green” energy transition to 2050, the key goal of which is to bring the share of electricity produced from alternative sources to 70% over the next 30 years (The concept of “green” energy transition of Ukraine until 2050). The main directions of the “green” energy transition are presented in the Fig. 1.

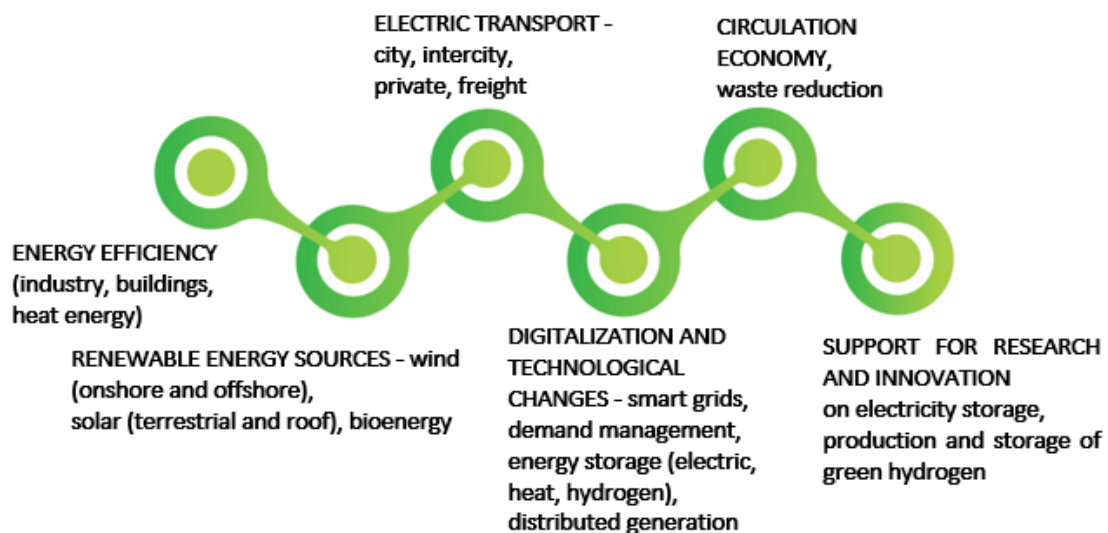


Figure 1. The main directions of the “green” energy transition
(The concept of “green” energy transition of Ukraine until 2050)

According to the Concept of the “green” energy transition, the following areas of the “economy of the future” are identified:

- energy efficient industry, buildings, heat energy;
- electric transport – city, intercity, private, freight;
- circulating economy, waste reduction;
- support for research and innovation on electricity storage, production and storage of green hydrogen;
- digitalization and technological changes – smart grids, demand management, energy storage (electricity, heat, hydrogen), distributed generation;
- renewable energy sources – wind (onshore and offshore), solar (ground and roof),

bioenergy.

According to experts, even without a “green” tariff, investing in renewable energy is more profitable than in traditional sources. However, today in Ukraine only 5% of energy is generated by “green” power plants, while the other 95% is produced by the traditional method.

Problem definition. The aim of the article is to study the implementation of innovative projects for the use of renewable energy sources in the “economy of the future”. In the framework of this study, the following problematic issues are identified: to determine the basics of segment innovation renewable energy sources; identify areas for improving the mechanisms to stimulate innovation in the development of the segment renewable energy sources of Ukraine.

Results and discussion

Transformation of demand for renewable energy sources under the influence of the crisis pandemic COVID-19

Global trends indicate the priority of

renewable energy sources in the energy balance. The dynamics of increasing the capacity of renewable energy sources by type, presented in Fig. 2.

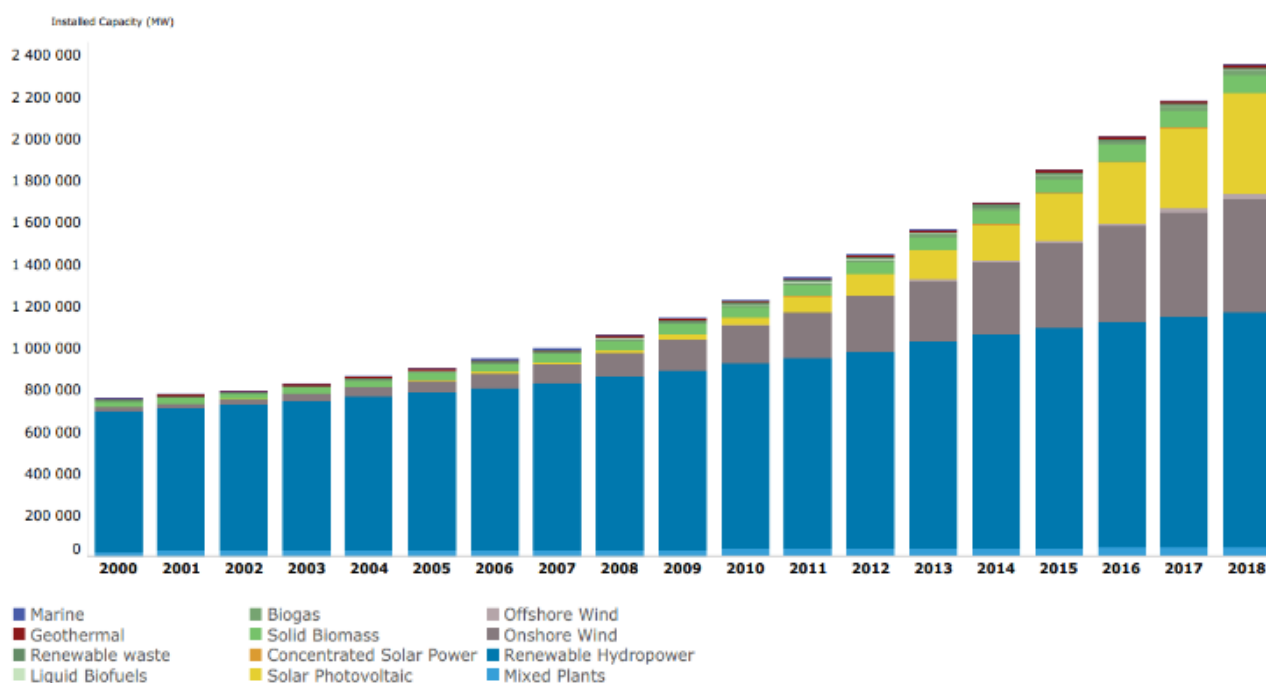


Figure 2. Global trend of increasing the capacity of renewable energy sources by type (IRENA))

According to Bloomberg, according to research by the American think tank Ember, in the first half of 2020, renewable energy accounted for almost 10% of total energy

produced (Bloomberg). At the same time, there is an increase in demand for green energy (Fig. 3).

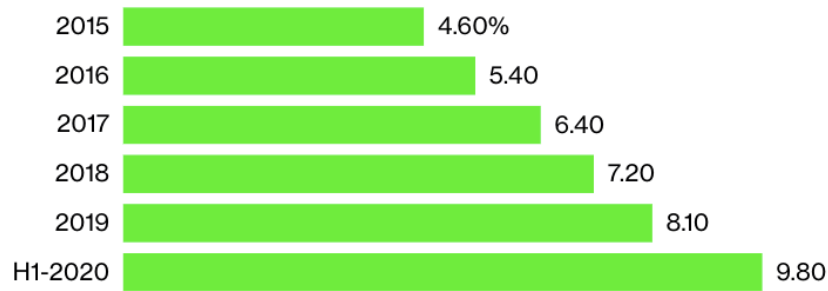


Figure 3. Global trends of increasing demand for renewable energy (Bloomberg)

According to Ember Group's analytical study, which was conducted on the basis of 48 countries, which produce about 83% of the world's electricity, in the first half of 2020, the amount of renewable energy increased by 14% compared to last year. Against the background of quarantine due to a pandemic COVID-19, due

to global self-isolation and reduced plant production, there has been a reduction in electricity consumption. The overall demand for electricity in the EU in 2020 decreased by 7%. Fossil fuel energy production in the first half of 2020 decreased by 18%, "green" energy production increased by 11% (Fig. 4).

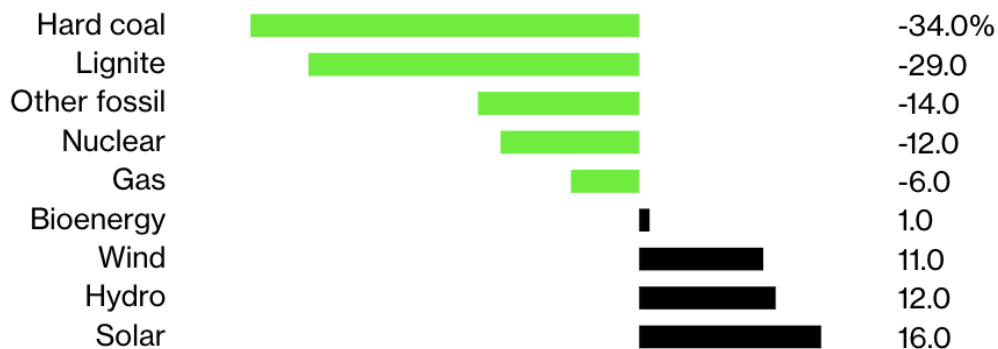


Figure 4. Trends in demand for energy sources in the EU in 2020 (Bloomberg)

The analysis showed an increase in the number of wind turbines and solar panels and a sharp decrease in demand for coal and fossil fuels (Fig. 5).

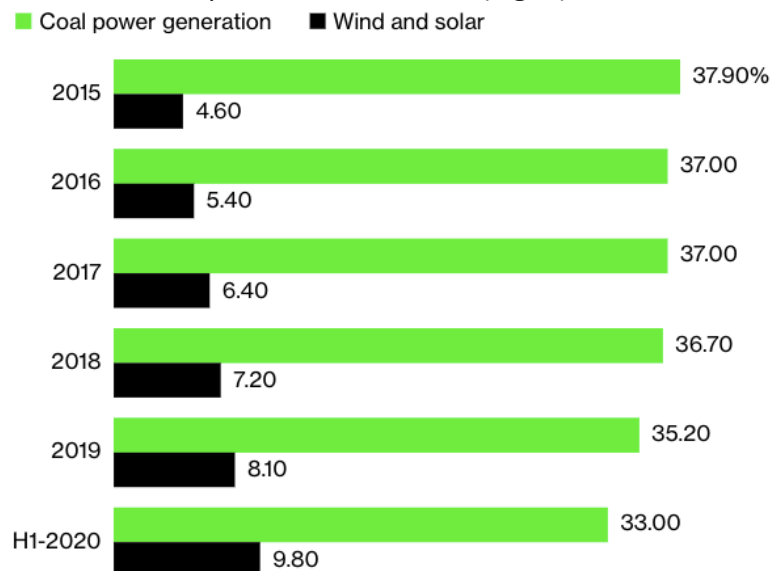


Figure 5. Reduction of coal production in the world from 2015 to 2020 (Bloomberg)

The largest reduction occurred in the Western Europe. In China (68% of the country's total energy was based on coal), production has decreased to 62% over the last 5 years, and 10% of total production belongs to renewable energy. According to forecasts, total coal consumption will decrease by approximately

79% by 2030 (by 13% annually).

In 2018, the share of energy from renewable sources in the gross final energy consumption in the EU reached 18%, which is more than twice as high as in 2004, which was then at 8.5% (Fig. 6).

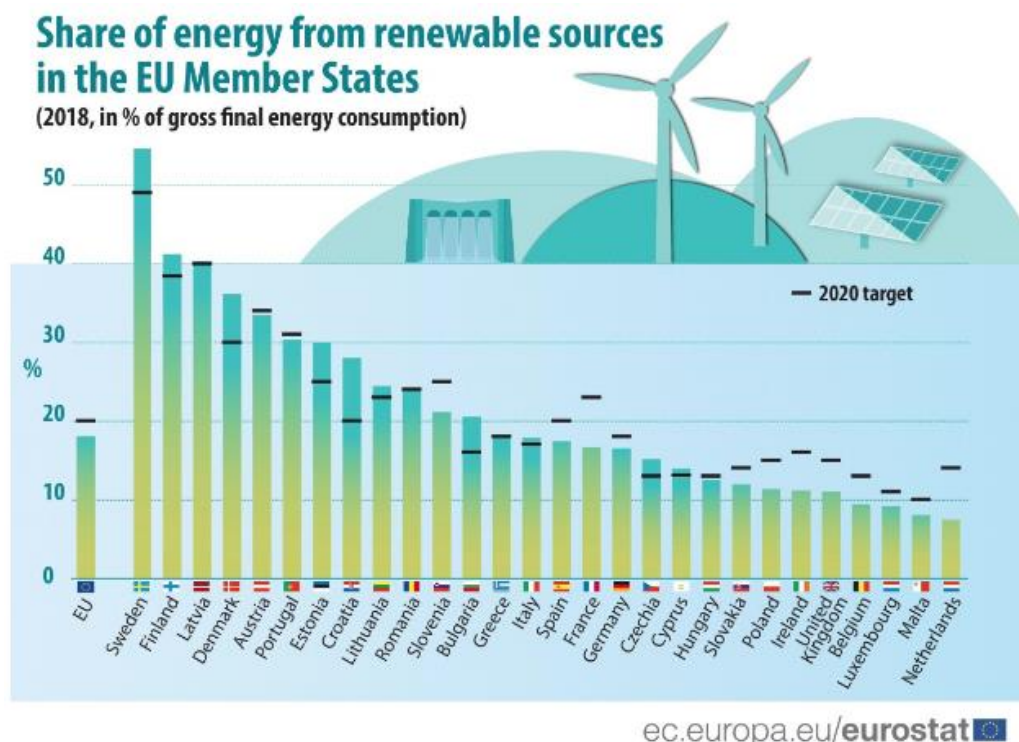


Figure 6. Renewable sources in gross final energy consumption in EU countries (Eurostat)

Among EU member states, 12 countries have already achieved the EU target (20% by 2020) at the national level. Sweden has the highest share – 54.6%, and the Netherlands – the lowest – 7.4%.

According to the report World Energy Outlook (WEO, 2020), the only source of energy that is expected to grow in the near future is renewable energy. The largest share of growth is generated by solar energy, which contributes to lower prices, cheaper solar energy, especially compared to coal and gas power plants.

The pandemic hit the oil industry hard, and declining demand led to falling oil prices. It is expected that in 2020 demand as a whole will be 8 million barrels per day less than in 2019. Recovery of oil demand is difficult to predict. Under such conditions, a lack of investment in the industry could lead to future price fluctuations. The economic consequences for oil-dependent countries will be particularly severe.

According to forecasts (WEO, 2020), renewable energy sources can meet 80% growth in electricity demand over the next 10 years. By 2025, renewable energy sources will displace coal as the main means of electricity generation. If states adopt more aggressive policies, the role of renewable energy will be even more active in the next five years. However, without sufficient investment, networks will be a weak link in the transformation of the electricity sector, which will affect the reliability and security of electricity supply (WEO, 2020).

Global investment in renewable energy sources

An important factor in the development of the renewable energy technologies is a significant and rapid reduction in their cost. That is, the implementation of the “green” energy projects is economically justified. Invest in the new renewable energy sources three times the inflow

of foreign investment in fossil fuel production capacity and twice as much in fossil fuel and nuclear capacity. According to REN21 estimates, the leaders in the global investment in the development of renewable energy sources (74%) by 2018 were China, Europe and the United States. In particular, China accounted for 45% of

the world investment, European countries – 15%, the United States and Asia-Oceania – 14%. In 2018, the global investment in clean energy amounted to 332.1 billion US dollars. The leaders for investors were solar photovoltaic and wind power plants (Fig.7).

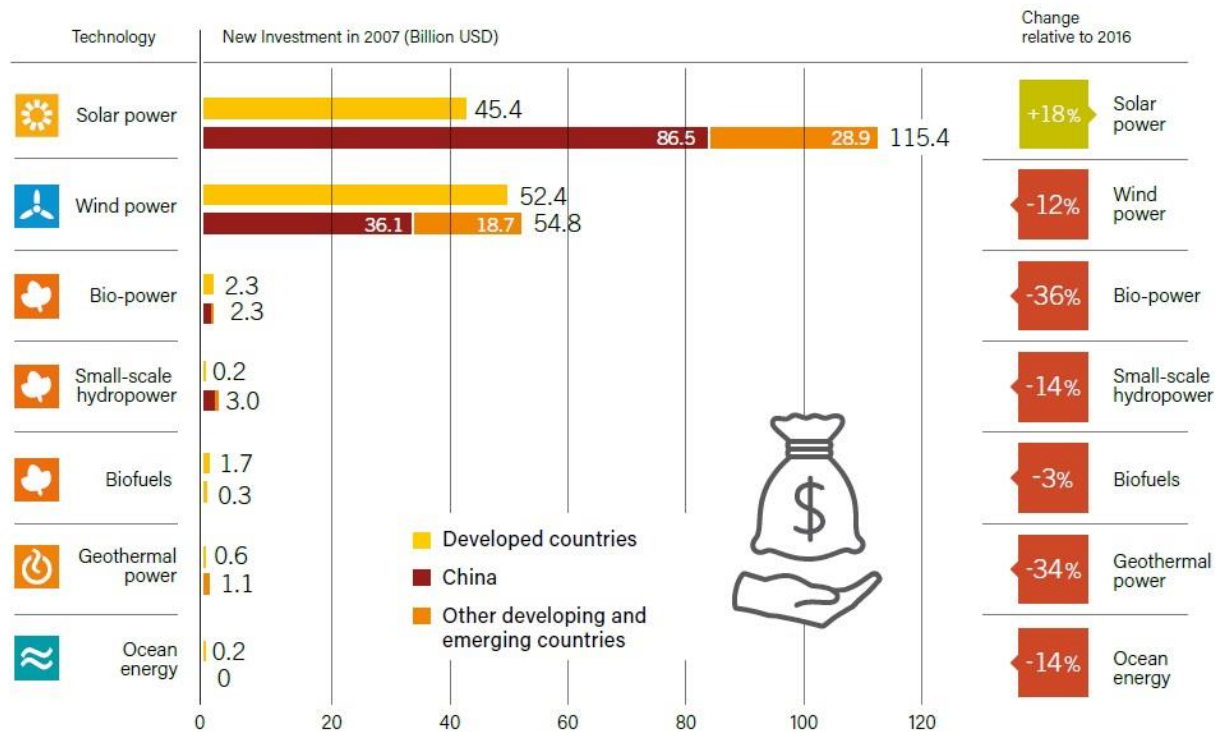


Figure 7. Global new investments in renewable energy by technology, 2007-2017 (REN21, Renewables 2018, Global Status Report, 2018)

According to experts, due to the COVID-19 pandemic, in 2020 investment in energy decreased by 18%.

Scenarios for the global energy sector to emerge from the crisis

The International Energy Agency published The World Energy Outlook 2020, in which experts focused on analyzing the development of the global energy system over the next 10 years, taking into account the effects of the COVID-19 pandemic, and provided recommendations for accelerating the global energy transition to renewable energy.

Experts analyzed ways out of the global energy sector out of the crisis using 4 potential scenarios:

1. The Declared Public Policy Scenario (STEPS), in which the COVID-19 pandemic will gradually come under the government control in 2021 and the world economy will return to the pre-crisis

levels. Under this scenario, global energy demand will fully recover in early 2023, renewable energy sources will meet 90% of global electricity demand over the next two decades, with solar energy dominating, and coal use will continue to fall (by 2040, the share of coal in global energy demand will fall below 20%).

Renewable electricity generation will increase by 75% by 2030 compared to 2020: hydropower, wind energy, solar energy, bioenergy and geothermal energy will provide almost 40% of global electricity supply. The development of renewable energy sources must be accompanied by significant investments in the modernization of power grids.

2. The Delayed Recovery Scenario (DRS), which states the same policy objectives as the STEPS scenario, but with a view to delaying recovery from the COVID-19 pandemic, which is causing

increasing long-term damage to the global economic system. Under this scenario, global energy demand will not fully recover until 2025. Demand for oil will fall below the level predicted by the STEPS scenario.

3. Sustainable Development Scenario (SDS), which envisages a sharp increase in the ambition of national policies and investments in clean energy in the next 10 years, which fully achieves the goals of sustainable development, including the terms of the Paris Agreement, ensuring full access to energy and improving air quality. Assumptions about the development of health care and the economy correspond to similar assumptions in the STEPS scenario. According to the SDS scenario, 2019 was the last year when CO₂ emissions reached their peak level and in the next 10 years will be 10 Gigatons lower than in the STEPS scenario.

4. The new zero-emission scenario until 2050 (NZE2050) is an improved version of the sustainable development scenario, based on a complete reorientation towards carbon neutrality policy. Concrete steps to achieve the new goals, for example, to reduce CO₂ emissions by 40% by 2030 – it is necessary to ensure 75% of electricity production from renewable energy sources and 50% of electric vehicle sales in 2030, compared to 2.5% in 2019.

The German think tank Energy Watch Group (EWG), which brings together German experts and parliamentarians, presented the Law on Stimulating the System Integration of Renewable Energy Sources into the country's energy system (Sector Coupling and Innovation Act for Renewable Energy). The use of renewable energy sources becomes part of the responsibility for the security of the energy supply system. It is planned to implement a tariff for so-called combined power plants – a tool to stimulate investment to fully cover the demand for 100% renewable energy sources. EWG has developed a fixed-feed-in-tariff (8 eurocents per kWh), which is supported by flexible market margins.

At present, the share of renewable energy sources in national electricity production in Germany has reached 50% of the country's total energy balance. However, the complete transition of the German energy system to 100% renewable

energy is still seen as a contradictory reality. One of the reasons for this is the distrust of the vast majority of Germans in the possibility of covering all the demand for electricity only from renewable energy sources. In addition, the German national legal system still lacks a regulatory framework that would allow reliable and adequate energy systems with 100% renewable energy sources to enter the market.

To ensure the optimal integration of all renewable energy sources into the country's energy system, it is necessary to significantly increase investment in this sector. According to EWG experts, such initiatives will help create a market that is attractive to a large number of new and existing companies that are in the starting position with their innovative system developments in energy storage, digital control and grid management, clean energy production and sectoral communications. languages. That is, it is important to create an appropriate market environment to attract large-scale private investment in innovative projects in renewable energy sources.

Investments in innovative projects using renewable energy sources

The transition to renewable energy sources in the general energy supply, including transport and heating, is most active in large cities. According to data published by the international organization Carbon Disclosure Project (CDP), more than 40 cities already receive 100% of electricity from the sun, wind, hydropower and biomass. Among them – Burlington (USA), Basel (Switzerland), Reykjavik (Iceland). Another 100 cities around the world are actively using "green" electricity, providing their electricity needs for more than 75% of renewable energy sources.

In total, more than 7,000 cities have joined the Covenant of Mayors (since 2008), a global climate and energy package whose main idea is to improve energy efficiency and move to renewable energy sources.

For the city's transition to "green" energy, the issues of attracting investment, changing consumer behavior, integration of electricity with heat supply and transport, the state of existing energy infrastructure (electricity, gas, heating networks), distribution of energy consumption

between sectors (buildings, mobility) and players are addressed, supply (large energy companies, enterprises, cooperatives).

Depending on its own resources, priorities and motivation, each city must develop a unique strategy for the transition to renewable energy sources.

For example, Frankfurt is one of the first cities in Germany to take a course to fully meet the energy needs of renewable energy sources in all sectors by 2050. A Master Plan, an energy office in the Department of Municipal Construction, was established in the city. Since 2008, 50 measures have been developed to combat climate change and reduce energy consumption, energy scenarios have been developed until 2050, taking into account current and future energy consumption in all sectors, population growth, and projected changes in energy prices.

The reduction of total energy consumption by 50% is planned due to increased energy efficiency, energy saving and infrastructural changes. Demand for energy is fully met by renewable sources. A set of measures for the modernization of electricity, heating, cooling and transport has been developed. This project is implemented with broad public support, public involvement in decision-making and informing them about the results and consequences of energy and climate policy.

Another example is the Swedish city of Malmö, where a policy of sustainable development and green energy solutions has been implemented since 1998. Currently, two districts of the city (Augustenborg and Västra Hamnen) fully meet their electricity needs from renewable energy sources (biogas, solar, wind and hydro). The city has implemented a climate change adaptation program (a rainwater harvesting system that flooded the Augustenborg area), 9,000 green roofs and a food waste system to produce biogas used as fuel for public transport. In 2001, the Västra Hamnen industrial area (western port) was rebuilt. The municipality has built and connected to the innovative system of district heating and cooling 350 residential buildings made of ecological materials.

In 2009, the strategic plan “Energistrategi för Malmö” was adopted, according to which the city

will provide all its energy needs from renewable energy sources by 2030. To achieve the goal, the strategy plans to halve overall energy consumption through energy saving, efficient waste management and the development of public transport and cycling infrastructure.

Cities use renewable energy sources: solar, wind, biopower, which significantly increases the level of the local economy, which has a positive impact on the development of the region as a whole. At the same time, the city pays special attention to the transport strategy – the replacement of the city fleet with electric cars and hybrid vehicles, the development of public transport, as well as the creation of infrastructure for cyclists. As a rule, in such cities energy management programs are created and active work on increase of energy efficiency is conducted.

Thus, according to the law passed at the state level, by 2045 California will completely switch to electricity from renewable sources. In the city, all new buildings must consume a minimum of energy and be built using renewable energy technologies for self-sufficiency. Building codes also guarantee the development of infrastructure near new buildings (in particular, charging stations for electric vehicles, etc.).

Examples of implementation of renewable energy projects in Ukraine

In Ukraine, in 2018, active work began on the development of a long-term strategy for the transition of the city of Zhytomyr until 2050 to a full energy supply of renewable energy sources. In three years, Zhytomyr has reduced heat consumption by a third. City lighting is completely replaced by LED, the construction of the first municipal solar power plant and the construction of the first municipal building in Ukraine with zero emissions, which will house a new center for administrative services. In general, the mayors of 181 cities in Ukraine have signed the International Covenant of Mayors for Climate and Energy. The authorities of these cities have declared voluntary commitments to increase energy efficiency and increase the use of renewable energy sources.

Innovative projects of warming of houses and laying of bicycle paths are being implemented in cities, new standards in construction are being

introduced, energy cooperatives are being created, and electric transport is being developed. The main idea of the development of the modern city is to reduce the consumption of fossil fuels, create more comfortable living conditions, opportunities to breathe clean air and bring the country's energy independence closer.

In Ukraine, there are already organizations that take care of the implementation of "green" innovative projects, including renewable energy sources. For example, for 10 years in a row he has been developing the ecosystem of sustainable entrepreneurship, climate innovation and the "green" economy in Ukraine and Eastern Europe of the public organization Greencubator.

In 2017, Ukraine received 1 million euros from the European Bank for Reconstruction and Development for the implementation of the program "Climate Innovation Vouchers" in the field of climate innovation. The Greencubator team implements the program: finds interesting projects, evaluates and decides which project will receive a grant, as well as monitors the further development of innovative projects.

Today the program supports 5 companies in the segment of sustainable mobility and sustainable transport, 3 companies in the renewable energy sector, 3 – in ventilation and air conditioning, 3 companies in the sector of smart-home and agribusiness.

The first municipal solar cooperative was established in Ukraine – Slavutych, in which there are both large and small producers of electricity. Such cooperatives already exist in Europe, in Germany there are more than a thousand of them. In the United States, such cooperatives own entire local networks. The creation of a cooperative is an effective mechanism for attracting investment in renewable energy sources.

Ensuring competitive conditions for the production of electricity from alternative energy sources in Ukraine

According to the Law of Ukraine "On the Electricity Market", the state policy in the electricity sector is aimed at promoting the production of electricity from alternative (renewable) energy sources and the development of distributed generation and equipment for energy storage.

The Law of Ukraine "On Alternative Energy Sources" provides for surcharges to the "green" tariff, the auction price for use at power facilities, including power plants (start-up complexes) that produce electricity from solar radiation, energy storage systems of Ukrainian production.

As a result of the Memorandum of Understanding concluded between investors in renewable energy sources and the Government of Ukraine, in 2020 it was decided to reduce the "green" tariff, strengthen the conditions for debt restructuring of SE "Guaranteed Buyer" to electricity producers, establish producer responsibility for imbalances, and implement "Green" auctions.

The share of renewable energy sources in the structure of Ukraine's energy resources was 3-4%. At the same time, biofuels, wind and solar energy are becoming increasingly popular.

One of the main players in the Ukrainian wind energy segment is DTEK VDE, an operating company that manages the DTEK Group's assets in the renewable energy sector (Botiev, Primorsk and Orel wind farms, with an installed capacity of 200 MW each, and the latter with a capacity of 100 MW each). (DTEK, 2018) The wind energy segment is quite attractive for foreign companies: Ukraine Power Resources LLC, First Summit Energy (Netherlands), Sivashenergoprom LLC, the current project of the Norwegian NBT AS and the French Total Eren (Ukraine Power Resources, 2018; FMO).

As in the wind energy segment, DTEK VDE is a key producer of solar electricity. The company currently operates the Trifanivka Solar Power Plant, a pilot project in the solar energy sector equipped with 37,000 solar panels (DTEK, 2018). In 2019, DTEK VDE launched the Nikopol Solar Power Plant. It has 750,000 solar panels with a total installed capacity of 200 MW and is the largest solar power plant in Ukraine (DTEK, 2019). Focusing on the "green" tariff, the Ukrainian solar energy market also includes such foreign companies as "China National Building Material Company" (CNBM), "TIU Canada Ltd.", "Recom LLC" and "Scatec Solar" (CNBM; TIU Canada, 2019; RECOM, 2019; Scatec Solar)

Biofuels and wastes were used primarily for heat production. At the same time, more than

80% of consumption was accounted for by household consumers (IEA, 2019). The key domestic producers of biomass energy in Ukraine are private STC Biomass and Salix Energy LLC. At the same time, Siemens Ukraine, a subsidiary of Siemens AG, is an important foreign player in this energy segment (Siemens Ukraine). After production, biomass materials are processed into solid, liquid and gaseous biofuels. This process is carried out by numerous Ukrainian companies. After that, the fuel is converted into thermal energy in more than 30,000 boiler houses in Ukraine (USAID / DiXi Group).

The global crisis has accelerated and deepened the energy crisis in the Ukrainian energy system, which was not ready for the rapid growth of “green” energy.

According to the regulator (National Commission for State Regulation of Energy and Utilities), the share of “green” power plants in electricity production in Ukraine is currently 8%, and 26% of all funds are spent on settlements with these power plants.

According to the State Agency for Energy Efficiency, there are currently 24,000 domestic solar power plants with a capacity of up to 30 kW in Ukraine. Their total capacity is 618 megawatts. People have invested about half a billion dollars in them, and they expect to get their investment back. In the first quarter of 2020, households installed more than 2,100 solar power plants with a total capacity of 65 megawatts. This is 1.5 times more than in the same period of 2019. The largest number of solar power plants was installed in Dnipropetrovsk (3200), Ternopil (over 2200), Kyiv (almost 2000), Ivano-Frankivsk (over 1800) and Zakarpattia (over 1400) oblasts.

To ensure competitive conditions for the production of electricity from alternative energy sources, the introduction of incentive mechanisms and the installation of capacities for the accumulation of electricity at power plants is envisaged. In general, financial support for renewable energy at the state level is provided in two areas: tax benefits and credit support. Among the tax benefits and mechanisms in world practice are the following:

- investment tax credit (ITS) for a certain

percentage of capital expenditures on relevant energy projects. It is an investment grant that provides financial support for a project that is expected to start producing a particular good or service in the future (in this case, renewable energy). The investment project is qualified to receive ITS in the year of construction, and receive it after the commissioning of the facility. Projects can distribute the received ITS for several years, transferring the unused amount to future periods. Usually used for the construction of solar power plants;

- production tax credit (PTC), which provides a taxpayer with a tax credit for electricity produced in the amount of a fixed amount per unit of output. PTC is paid only when the target product is delivered (in this case renewable energy). This type of subsidy is offered for a certain number of years of production, usually less than the full life of energy projects;

- mechanism of partial or full compensation of interest for the use of loans by industrial companies and individual farms for the installation of energy storage systems;

- mechanism of exemption from taxation of imported equipment for energy storage systems, etc.

In Ukraine, the Energy Transition Coalition has been formed, which has united the stakeholders of the small-generation renewable energy market and the eco-community, which sees the solution to the problem in the comprehensive implementation of energy reforms. They should include upgrading energy infrastructure, reducing the use of “dirty” energy, developing distributed generation and citizens’ energy projects (prosumers, energy cooperatives). By the way, joining the European energy network will help solve the issue of network balancing. However, Ukraine has not yet taken sufficient legislative and diplomatic steps to do so.

Important are the problems of balancing the network, defaults and debts to market participants, the restructuring of the “green” tariff. The long-term policy of “green” energy transition should form the basis of the vector of state development and become the foundation for overcoming the current economic crisis.

Conclusions

Renewal of electricity from renewable sources is the main trend of state energy policy both in the world and in Ukraine. The world has already established state mechanisms to support large-scale reformatting of the energy sector through the global use of renewable energy sources. The latest models that expand the market opportunities of economic entities are the presence in the segment of renewable energy. Global investment spending in the renewable energy sector is growing steadily. It is proved that Renewable energy sources can meet 80% growth in electricity demand over the next 10 years. By 2025, renewable energy sources will displace coal as the main means of electricity generation.

The research of the basic tendencies of

realization of projects of use of renewable energy sources in Ukraine is carried out. The transition to renewable energy sources in the general energy supply, including transport and heating, is most active in large cities. It is established that in the world practice financial support of renewable energy at the state level is provided in two directions: tax benefits and credit support. However, Ukraine has not yet taken sufficient legislative and diplomatic steps to do so. Important are the problems of balancing the network, defaults and debts to market participants, the restructuring of the "green" tariff.

Mechanisms of institutional support of energy transformation – the direction of further research.

References

- Bloomberg: Renewable energy production in the world has doubled in the last 5 years, <https://nachasi.com/2020/08/20/renewable-energy-doubled/>
- Bondarenko S., Makoveieva O. (2020) Project approach in an anti-crisis management system of financial sustainability of industrial enterprise. *Journal of Scientific Papers "Social development and Security"*, Vol. 10, No. 2, P. 90-104. URL: <https://paperssds.eu/index.php/JSPSDS/article/view/203/209>
- Bondarenko S., Makoveieva O., Niziaieva V., Vorona A. (2020) High-tech manufacturing as a determinant of the economic development. *Journal of Scientific Papers "Social development and Security"*, Vol. 10, No. 1, – P.101–112. URL: <https://paperssds.eu/index.php/JSPSDS/article/view/181/184>
- Buchnev A.O. (2016). Innovative development of renewable energy as the main component of the economy of the future. 192 p.
- Carbon Disclosure Project (CDP), URL: <https://www.cdp.net/en>
- CNBM (n.d.), About, URL: <http://cnbm.com.ua/>.
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. Clear Energy for All Europeans COM/2016/0860 final, URL: <https://eurlex.europa.eu/legalcontent/EN/XT/?qid=1481278671064&uri=CELEX:52016DC0860#footnote21>.
- DTEK (2018), DTEK Renewables: Our Business, URL: <https://renewables.dtek.com/en/business/#botievckaya>
- DTEK (2019), Nikopol SPP starts green electricity generation, URL: <https://dtek.com/en/mediacenter/press/nikopol-spp-starts-green-electricity-generation/>
- Dudyuk D.L., Mazepa S.S., Hnatyshyn Y.M. (2008). Unconventional energy: basics of theory and problems. 188 p.
- Energy Watch Group (EWG), URL: <https://energywatchgroup.org/>
- European Green Deal, URL: <https://www.woodmac.com/nslp/european-green-deal/>
- Eurostat, URL: <https://ec.europa.eu/eurostat/web/main/home>
- FMO, About SyvashEnergProm LLC, URL: <https://www.fmo.nl/project-detail/54812>.
- Green Deal: The Innovation Council of Europe has allocated € 307 million to environmental startups, URL: <https://nachasi.com/2020/08/17/green-deal-startup/>

- IEA (2019), IEA Statistics, URL: <https://www.iea.org/statistics/>.
- International Renewable Energy Agency. REmap 2030: Renewable Energy Prospects for Ukraine. URL: <https://www.irena.org/publications/%202015/Apr/Renewable-Energy-Prospects-for-Ukraine>
- Mkhitaryan N.M. (1999). Energy of non-traditional and renewable sources. *Experience and prospects*. 320 p.
- Mysak J.S., Wozniak O.T., Datsko O.S., Shapoval S.P. (2014). Sunny energy: theory and practice. 340 p.
- On approval of the Energy Strategy of Ukraine for the period up to 2035 "Security, energy efficiency, competitiveness", URL: https://zakononline.com.ua/documents/show/377771__377836
- RECOM (2019), RECOM – Ukraine's green energy venture partner, URL: <https://recomsolar.com/recom-ukraines-green-energy-venture-partner/>.
- Renewable Energy Prospects for the European Union, URL: https://www.irena.org//media/Files/IRENA/Agency/Publication/2018/Feb/IRENA_REmap_EU_2018.pdf
- Scatec Solar (n.d.), Ukraine, URL: <https://scatecsolar.com/locations/ukraine/#ukraine>.
- Siemens Ukraine (n.d.), About, URL: <https://new.siemens.com/ua/en.html>.
- Syrotiuk M.I. (2008). Renewable energy sources. 248 p.
- The concept of "green" energy transition of Ukraine until 2050, URL: <https://mepr.gov.ua/news/34424.html>
- TIU Canada (2019), About, URL: <https://tiucanada.com/about/>.
- Transforming our world: the 2030 Agenda for Sustainable Development – United Nations, URL: <https://sustainabledevelopment.un.org/post2015/transformingourworld>
- Ukraine Power Resources (2018), Building a Portfolio of Wind Power Projects in Ukraine, URL: <https://ukrainepowerresources.com/>.
- USAID/DiXi Group (n.d.), Map: Energy Sector Transparency, URL: <http://map.ua-energy.org/en>.
- World Energy Outlook 2020, URL: <https://www.iea.org/reports/world-energy-outlook-2020>