UDC 620.9+620.92
DOI: 10.31339/2313-8114-2020-1(13)-55-60

The Current Situation and World Trends of Green Energy Development

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(Received: 28.12.2019, Revised: 25.01.2020, Accepted: 23.02.2020)

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Abstract. The relevance of the paper lies in the development of "green energy" as an increase in the energy efficiency of the global economy of the country. The main drivers of new capacities are the disposal of old, less efficient fossil fuel units. Low natural gas prices and favourable renewable energy costs make natural gas and renewable energy sources the main sources of new generation capacity by 2050. The main purpose of the paper is to highlight the main problems of the Ukrainian electricity market, analyse the process of popularising green energy, highlight cases when switching to alternative sources is a profitable process in conditions of uncertainty and rising prices for conventional energy carriers. The paper uses general scientific and specific research methods, in particular, methods of analysis and synthesis, scientific deduction and induction. The paper analysed in detail the current state of energy in Ukraine, developed proposals for improving the regulation of alternative energy at the state level and for popularising green energy in Ukraine. It has been established that alternative energy sources can also be more profitable than conventional energy sources. Alternative energy and conventional energy carriers were comprehensively studied. In addition, favourable economic conditions have been identified for the construction of alternative energy facilities and the development of a "green" economy, which in the future will ensure the sustainable development of Ukraine

Keywords: electricity market, energy intensity of the economy, renewable energy, green tariff, energy efficiency

The Problem Statement

The rapid growth of world production in the second half of the 20th century led to an increase in demand for resources, an important place among which is occupied by primary energy. Primary energy consumption in the world is constantly growing, so in 2018, this figure was equal to 13864.9 million tonnes of oil equivalent, which is 3.7 times more than in 1965, when it was 3701.5 million tonnes [1]. Against the background of increasing primary energy consumption in the world, the trend towards a decrease in global energy consumption, that is, total energy consumption per unit of GDP, has been a positive trend over the past decades, which is evidence of an increase in the energy efficiency of the global economy.

Analysis of Recent Research and Publications

The problem of alternative energy in Ukraine was covered by such scientists as I.P. Gaidutskiy [2], M.H. Slokva, O.V. Pyankova [3], A.O. Kasich, Ya.O. Litvinenko, P.S. Melnichuk [4], I.V. Kremenovska [5], I.S. Sagaidak, T.M. Chorna, N.L. Avramenko [6], S. Savchuk [7]. In their works, special attention is focused on studying the prospects for using renewable energy sources.

Purpose of the Study

The main purpose of the paper is to highlight the main problems of the Ukrainian electricity market, analyse the process of popularising green energy, highlight cases when switching to alternative sources is a profitable process in conditions of uncertainty and rising prices for conventional energy carriers.

Research Results

Over a period of all years, Ukraine has been characterised by the lowest values of the energy efficiency indicator in the world, in 2018, the energy intensity of its economy was 0.238 kJ/$ 2015 GDP at purchasing power parity (PPP),

Suggested Citation:
Redko, K.Yu., & Furs, O.S. (2020). The current situation and world trends of green energy development. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 7(1), 55-60.

which exceeds the global average by more than two times. China's energy intensity improved by almost 40% in the period from 2000 to 2018 and by 2.7% in 2019 due to the introduction of an energy efficiency policy focused on energy-intensive industries, which led to a high demand in the country for energy efficiency services [3].

Since July 1, 2019, a new liberal model of the electricity market has been launched, according to the Law of Ukraine "On the Electricity Market" adopted in 2017 [8]. The law deprives the state of the right to regulate the tariffs of electricity producers. However, it provides for self-regulation of the market through mechanisms of competition, supply, and demand. To benefit from the new rules of the game presented in the monopolistic market, Rinat Akhmetov's DTEK company was used, which abuses its monopoly representative, detects any prices in its electric power industry, using that there is no alternative for the buyer [9]. A. Gerus, in his work [9] investigated that DTEK in the only liquid and working market, the "day-ahead market", at certain hours created artificially electricity shortages, which is conditioned upon fact that everyone who could not buy electricity on the "day-ahead market" is given electricity at the price of the "balancing market", and this is another 15% more expensive.

Fuel and energy production in Ukraine is shown in Figure 1. It can be seen that since 2013, there has been a decrease in coal and peat production by almost 3 times, but wind and solar production has increased 2 times during this period (Fig. 1).

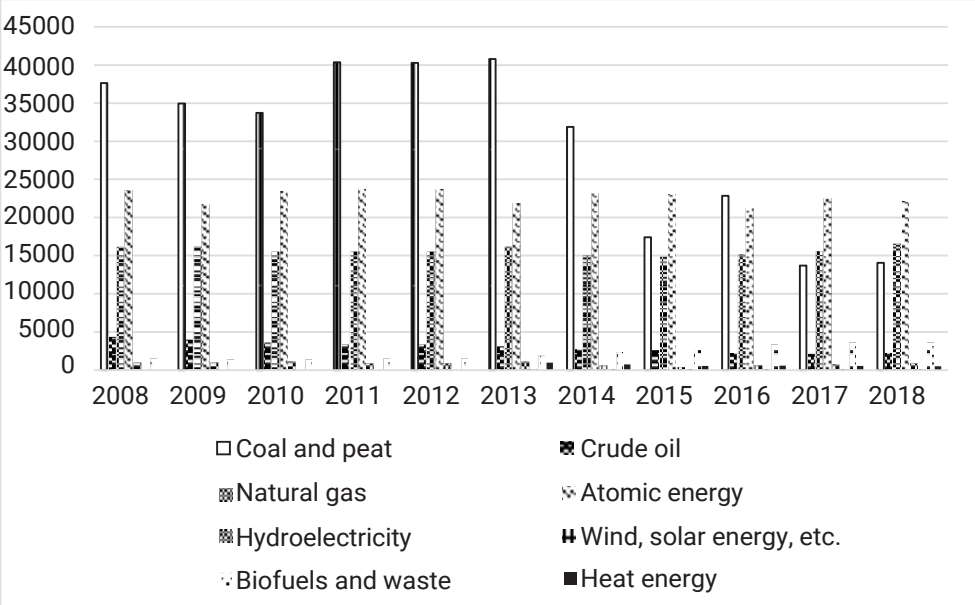

Figure 1. Graphical representation of fuel and energy production in Ukraine 2008-2018, thousand tonnes of oil equivalent
Source: developed based on [1]

According to the state agency for energy efficiency, in the first three months of 2018, it was established:

- almost 100 MW of solar power plants;
- 47 MW of wind farms;
- 6.2 MW of biogas power plants;
- 5.1 MW of biomass power plants;
- 1.5 MW of small hydroelectric power plants [10].

The cost of electric energy for domestic consumers in 2018 in Ukraine was 1.28 UAH kW, but now a considerable increase in price is planned to 2.88 UAH kW. For EU consumers, electricity prices, including taxes and fees, were the highest in the second quarter of 2018 in Denmark (0.31 euros per kW), Germany (0.30 euros per kW), and Belgium (0.29 euros per kW), while the lowest prices were recorded in Bulgaria (0.10 euros per kW), Lithuania and Hungary (0.11 euros per kW each). However, it is worth noting that more than half of the price of electricity in Denmark and Germany is made up of taxes and fees, and a third – in Belgium. In addition, in Bulgaria, taxes and fees account for 17%, in Lithuania – 30%, and in Hungary – 21% [10].

For non-domestic consumers, electricity prices (excluding WAT and other taxes and fees) in the second semester of 2018 ranged from 0.17 euros per kW in Cyprus and 0.13 euros in Malta to 0.06 euros per kW in the Netherlands, Poland, and Finland. In 2018, the share of energy from renewable sources in gross final energy consumption reached 18.0% in the European Union (EU), more than double the share of 2004 (8.5%). Increasing the share of renewable energy sources is essential for achieving the EU's climate and energy goals. The EU's goal is to reach 20% of its energy from renewable sources by 2020 and at least 32% by 2030 [10]. Among the 28 EU member states, 12 states have already achieved a share equal to or greater than their national mandatory goals for 2020, and non-European Union countries have nevertheless achieved the desired level of alternative energy production presented in Table 1.

Table 1. Total share of energy from renewable sources, 2008-2018 (%) – 2009/28/EU directive

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bulgaria	10.3	12	13.9	14.2	15.8	18.9	18	18.3	18.8	18.7	20.5
Denmark	18.5	20	21.9	23.4	25.5	27.2	29.3	30.8	31.8	34.7	35.7
Estonia	18.6	22.9	24.6	25.3	25.5	25.3	26.1	28.2	28.7	29.1	30
Croatia	22	23.6	25.1	25.4	26.8	28	27.8	29	28.3	27.3	28
Latvia	29.8	34.3	30.4	33.5	35.7	37	38.6	37.5	37.1	39	40.3
Lithuania	17.8	19.8	19.6	19.9	21.4	22.7	23.6	25.8	25.6	26	24.4
Austria	28.9	31	31.2	31.6	32.7	32.8	33.7	33.5	33.4	33.1	33.4
Portugal	22.9	24.4	24.2	24.6	24.6	25.7	29.5	30.5	30.9	30.6	30.3
Romania	20.2	22.2	22.8	21.2	22.8	23.9	24.8	24.8	25	24.5	23.9
Slovenia	15	20.1	20.4	20.3	20.8	22.4	21.5	21.9	21.3	21.1	21.1
Finland	31.4	31.3	32.4	32.8	34.4	36.7	38.8	39.3	39	40.9	41.2
Sweden	44.7	47.9	47	48.2	50.2	50.8	51.9	53	53.4	54.2	54.6
Iceland	67.3	69.6	70.3	71.5	72.4	71.7	70.5	70.3	70.2	70.7	72.2
Norway	62.1	65.1	61.5	64.7	65.5	66.7	69.2	69.2	70.2	71.6	72.8
Montenegro	32.5	39.5	40.7	40.7	41.5	43.7	44.1	43.1	41.6	39.7	38.8
Albania	32.4	31.4	31.9	31.2	35.2	33.2	31.5	34.4	35.5	34.5	34.9
Serbia	15.9	21	19.8	19.1	20.8	21.1	22.9	22	21.1	20.3	20.3

Source: developed based on [11]

As demand for electricity increases markedly, the main drivers of new capacity are the disposal of older, less efficient fossil fuel units; the immediate prospect of renewable energy tax breaks; and the continued decline in capital spending on renewable energy sources, especially solar photovoltaic ones. Low natural gas prices and favourable renewable energy costs make natural gas and renewable energy sources the main sources of new generation capacity by 2050. In the United States, as of February 2020, solar energy accounts for 15%, 46% is planned by 2050, wind energy – 15%, but 33% is planned [11].

Renewable energy sources (including hydropower) will be the fastest-growing source of electricity generation for the period of 2018-2050, growing at an average rate of 3.6% per year. By 2050, China, India, Europe, the OECD, and the United States will have almost 75% of the world's renewable energy sources. It is predicted that by 2025, renewable energy sources will exceed coal as the main source of electricity generation, and by 2050, renewable energy sources will account for half of the world's total electricity production [11].

The growth rate of the share of energy in Ukraine from renewable sources is not very satisfactory – only 4.6% as of 2018. After all, according to the sustainable development strategy of 2030, the forecast of the appropriate total renewable energy capacity of Ukraine in 2030 will be 12.6% of the total installed capacity or 8 GW (14 GW including large hydroelectric power plants), and the output volume will be 14 TW (28 TW including large hydroelectric power plants) [1].

In April 2019, the Verkhovna Rada adopted the Law of Ukraine "On Amendments to Certain Laws of Ukraine Concerning Ensuring Competitive Conditions for the Production of Electric Energy from Alternative Energy Sources" [12], according to which, starting from 2020, "Green" auctions are introduced and mandatory participation of investors in solar power plants with a capacity of more than 1 MW and wind farms with a capacity of more than 5 MW (or one turbine) is fixed. The law replaces the system of state support for alternative energy facilities in the form of a "green" tariff with a system of "green" auctions, in which state support will be received by the investor who offered the lowest tariff for energy produced by the facility at the auction [12].

The minimum tariffs for "green" electricity produced from wind energy by electric power facilities, the capacity of which does not exceed 30 kW from 2020 to 2024 at the level of 113.41 kopiykas/kW (excluding WAT), and from solar energy – 176.55, have been approved by law. There is also a fixed tariff for wind power in the period from 2025 to 2029 – 101.14 kopiykas/kW, and for solar power – 157.26 [13]. It is not surprising that some businesses have rushed to install solar panels and sell excess electricity to generate additional income. The company Solar-Tech, which specialises in the installation of solar power plants, estimated that for an enterprise that consumes 149000 kW of electricity per year, the payback period is 5.7 years, and for the sale of excess energy in the amount of 17120 kWh – 4.8 years [14] (Table 2).

Table 2. Energy from renewable sources 2009-2018

	Units of measurement	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total energy supply from renewable sources	thousand toe	2463	2611	2514	2476	3166	2797	2700	3616	3907	4289
Share of energy supply from renewable sources	%	2.2	2	2	2	2.7	2.6	3	3.8	4.4	4.6

Source: developed based on [1]

To resolve the situation on the renewable energy market, it is necessary to take the following steps:

1. Create conditions for investment in the green sector. Every year, capital investment in the carbon mining sector decreases, but investment in the foreign economic activity sector increases [1]. This is explained by, firstly, the sustainable development programmes of European countries, and, secondly, to the exhaustion of usual energy sources: oil, gas, coal, and peat.

2. Provide financing for the "Guaranteed buyer" programme [15]. It was with this state-owned enterprise that all producers of "green" energy were obliged to conclude contracts, which was aimed at ensuring payments but created only a deficit in Ukrenergo, which is explained by the high price of "green" energy. However, wind and solar tariffs are expected to decrease by an average of 25% by 2029. In the meantime, it is planned to bring the tariff to the market level not by reducing it but by increasing the cost of electricity produced by conventional sources [15].

3. State control and levelling of manipulations in the existing energy market. Due to the monopoly position in the electricity market and the artificial creation of a deficit, the price of electricity increases by 30-40% at certain hours, which in turn encourages some consumers to import from abroad.

Conclusions

In times of acute environmental pollution, producers face the task of greening production. And this is not just a selective decision but the strategy of each far-sighted country. In Ukraine, the alternative energy sector is developing slowly but certain structural changes are noticeable, although they are far from planned. Many small and medium-sized enterprises have already installed solar panels to reduce the cost of production and generate additional profits.

Now, the most promising reform of the state is the system of "green" auctions, which can easily fail without the introduction of additional measures of "freedom" of the auction. In addition, it is worth remembering that despite all the anti-monopoly reforms, the electricity market actually remains under the control of one company. Further research will require the search for tools and mechanisms in the renewable energy incentive system with an assessment of the economic consequences of their application using methods and models of modelling and forecasting.

References

[1] Official website of the State Statistics Service of Ukraine. (n.d.). Retrieved from http://www.ukrstat.gov.ua.

[2] Haidutskyi, I.P. (2016). Priorities for sustainable low-carbon development in Ukraine. *Ekonomika ta Derzhava*, 9, 23-28.

[3] Slokva, M.H., & Piankova, O.V. (2019). Environmental management in the context of contemporary global energy and environmental trend. *Economics and Organization of Management*, 4(36), 154-167.

[4] Kasych, A.O., Lytvynenko, Ya.O., & Melnychuk, P.S. (2013) Alternative energy: World and domestic experience. *Scientific Notes of Ostroh Academy National University, "Economics" Series*, 23, 43-47.

[5] Kremenovska, I.V., & Sviatohor, O.A. (2015). An alternative view of "alternative" energy and "green" tariffs. *Comparative and Analytical Law*, 3, 114-118.

[6] Sahaidak, I.S., Chorna, T.M., & Avramenko, N.L. (2018). "Green tariff" as a mechanism of renewable energy in Ukraine. *Efficient Economy*, 10. doi: 10.32702/2307-2105-2018.10.64.

[7] Savchuk, S. (2020). Where are the guarantees for green energy? Retrieved from http://reform.energy/analitics/sergey-savchuk-gde-garantii-dlya-zelenoy-energetiki-mnenie-13783.

[8] Law of Ukraine No. 2019-VIII "On the Electricity Market". (2017, April). Retrieved from https://zakon.rada.gov.ua/laws/show/2019-19#Text.

[9] Herus, A. (2019). DTEK destabilization: Why electricity prices rise through Akhmetov's monopoly. Retrieved from https://www.epravda.com.ua/columns/2019/10/7/652338/.

[10] Official website of the State Energy Efficiency of Ukraine. (n.d.). Retrieved from https://saee.gov.ua/.

[11] Supply, transformation and consumption of electricity. (n.d.). Retrieved from https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_cb_e&lang=en.

[12] Law of Ukraine No. 2712-VIII "On Amendments to Some Laws of Ukraine to Ensure Competitive Conditions for the Production of Electricity from Alternative Energy Sources". (2019, April). Retrieved from https://zakon.rada.gov.ua/laws/show/2712-19.

[13] Resolution of the National Commission for State Regulation of Energy and Utilities No. 1817 "On Approval of the Procedure for Establishing, Eevising and Terminating the "Green" Tariff for Electricity for Economic Entities, Electricity Consumers, Including Energy Cooperatives, and Private Households Whose Generating Plants Produce Electricity from Alternative Energy Sources". (2019, August). Retrieved from https://zakon.rada.gov.ua/laws/show/v1817874-19.
[14] Network solar power plants for businesses for their own consumption. (2019). Retrieved from https://solar-tech.com.ua/ua/povyschaem-rentabelnost-biznesa-s-pomotschyu-solnechnoi-elektrostancii-2019-09-18.html.
[15] Resolution of the Cabinet of Ministers of Ukraine No. 994-p "On Approval of the Investment Plan of the State Enterprise "Guaranteed Buyer" for 2020-2022". (2020, August). Retrieved from https://www.kmu.gov.ua/npas/pro-zatverdzhennya-investicijnogo-a994r.

Список використаних джерел

[1] Офіційний сайт Державної служби статистики України. URL: http://www.ukrstat.gov.ua. (дата звернення: 05.03.2020).
[2] Гайдуцький І.П. Пріоритети сталого низьковуглецевого розвитку України. *Економіка та держава*. 2016. Вип. 9. С. 23–28.
[3] Слоква М.Г., П'янкова О.В. Екологізація управління у контексті сучасних глобальних енергетичних та екологічних трендів. *Економіка і організація управління*. 2019. № 4(36). С. 154–167.
[4] Касич А.О., Литвиненко Я.О., Мельничук П.С. Альтернативна енергетика: світовий та вітчизняний досвід. *Наукові записки Національного університету «Острозька академія», серія «Економіка»*. 2013. Вип. 23. С. 43–47.
[5] Кременовська І.В., Святогор О.А. Альтернативний погляд на «альтернативну» енергетику та «зелені» тарифи. *Порівняльно-аналітичне право*. 2015. Вип. 3. С.114–118.
[6] Сагайдак І.С., Чорна Т.М., Авраменко Н.Л. «Зелений тариф» як механізм відновлюваної енергетики України. *Ефективна економіка*. 2018. Вип. 10. doi: 10.32702/2307-2105-2018.10.64.
[7] Савчук С. Где гарантии для «зеленой» энергетики? URL: http://reform.energy/analitics/sergey-savchuk-gde-garantii-dlya-zelenoy-energetiki-mnenie-13783 (дата доступа: 10.03.2020).
[8] Про ринок електричної енергії: Закон України від 13.04.2017 р. № 2019-VIII. URL: https://zakon.rada.gov.ua/laws/show/2019-19#Text (дата звернення: 05.01.2020).
[9] Герус А. Дестабілізація по-ДТЕКівськи: чому ростуть ціни на електроенергію через монополію Ахметова. URL: https://www.epravda.com.ua/columns/2019/10/7/652338/ (дата звернення: 11.01.2020).
[10] Офіційний сайт Держенергоефективності України. URL: https://saee.gov.ua/ (дата звернення: 10.01.2020).
[11] Supply, transformation and consumption of electricity. URL: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_cb_e&lang=en (accessed date: 12.01.2020).
[12] Про внесення змін до деяких законів України щодо забезпечення конкурентних умов виробництва електричної енергії з альтернативних джерел енергії: Закон України від 25.04.2019 р. № 2712-VIII. URL: https://zakon.rada.gov.ua/laws/show/2712-19 (дата звернення: 10.01.2020).
[13] Про затвердження Порядку встановлення, перегляду та припинення дії «зеленого» тарифу на електричну енергію для суб'єктів господарської діяльності, споживачів електричної енергії, у тому числі енергетичних кооперативів, та приватних домогосподарств, генеруючі установки яких виробляють електричну енергію з альтернативних джерел енергії: Постанова Національної комісії, що здійснює державне регулювання у сферах енергетики та комунальних послуг від 30.08.2019 р. № 1817. URL: https://zakon.rada.gov.ua/laws/show/v1817874-19 (дата звернення:12.01.2020).
[14] Мережеві сонячні електростанції для бізнесу під власне споживання. URL: https://solar-tech.com.ua/ua/povyschaem-rentabelnost-biznesa-s-pomotschyu-solnechnoi-elektrostancii-2019-09-18.html (дата звернення: 11.01.2020).
[15] Про затвердження інвестиційного плану державного підприємства «Гарантований покупець» на 2020–2022 роки: Постанова Кабінету Міністрів України від 12.08.2020 р. № 994-р. URL: https://www.kmu.gov.ua/npas/pro-zatverdzhennya-investicijnogo-a994r (дата звернення: 11.01.2020).

Сучасний стан та світові тенденції розвитку «зеленої енергетики»

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Анотація. Актуальність статті полягає в розвитку «зеленої енергетики», як підвищенні енергоефективності глобальної економіки країни. Основними чинниками нових потужностей є вибуття старих, менш ефективних енергоблоків викопного палива. Низькі ціни на природний газ та сприятливі витрати на поновлювані джерела енергії призводять до того, що природний газ та відновлювані джерела енергії будуть основними джерелами нової генераційної потужності до 2050 року. Основною метою наукової статті є висвітлення головних проблем ринку електроенергії України, аналіз процесу популяризації зеленої енергетики, висвітлення випадків, коли перехід на альтернативні джерела є вигідним процесом, в умовах невизначеності та росту цін на традиційні енергоносії. У статті використано загальнонаукові та специфічні методи дослідження, зокрема методи аналізу та синтезу, наукову дедукцію та індукцію. У статті було детально проаналізовано нинішній стан енергетики України, розроблено пропозиції для вдосконалення урегулювання альтернативної енергетики на державному рівні, і для популяризації зеленої енергетики в Україні. Було встановлено, що альтернативні джерела енергії також можуть бути вигідними, ніж традиційні енергоносії. Було комплексно вивчено альтернативну енергетику, і традиційні енергоносії. До того ж визначено сприятливі економічні умови для спорудження об'єктів альтернативної енергетики, розвитку «зеленої» економіки, що у майбутньому дозволить забезпечити сталий розвиток України

Ключові слова: ринок електроенергії, енергоємність економіки, відновлювальна енергетика, зелений тариф, енергоефективність