

ПРОБЛЕМИ І ПЕРСПЕКТИВИ ЕНЕРГЕТИЧНОГО СЕКТОРА

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POTENTIAL FOR THE DEVELOPMENT OF RENEWABLE ENERGY IN THE AGRICULTURAL SECTOR OF THE ECONOMY

The article identifies unresolved major problems in the energy sector of Ukraine. Certain changes in the direction of renewable energy have been identified that have actively influenced its development. The calculations of the potential domestic market for biogas plants for 2020 are outlined. The general goals that can be achieved through state support are outlined. The indicative forecast of the potential of electricity production by 2035 is characterized. The commitments within the framework of environmental safety of Ukraine to the European Union are generalized. Directions of improvement of dynamics of development of renewable energy are offered.

Keywords: *potential, development, renewable energy, agricultural sector, national economy, energy resources, renewable energy sources.*

Introduction. There are dramatic changes around the world in approaches to the formulation of states' energy policies. Developed economies prefer renewables. Countries such as the United Kingdom, Canada, Belgium, Italy, Sweden, Austria, France, Finland and others have announced the rejection of coal. Such a rejection of traditional energy sources and an active transition to the use of renewable energy has become an irreversible process and one of the major global trends called «energy of the future» or decarbonisation of energy systems.

Issues such as the desire to enhance the energy and economic security of countries, the reduction of planetary stocks of traditional energy resources, the negative impact of energy on the environment, the significant rise in energy prices and other factors have led to decisive action to seek opportunities to upgrade and reboot the energy sector.

Ukraine is strengthening its position by effectively utilizing its own potential in the renewable energy sector, in particular through the rational production of energy and its economical consumption. In general, renewable energy is a sub-sector of the country's energy engaged in the production, transformation and distribution of various types of energy resources.

Currently, major energy issues remain unresolved in Ukraine:

- constantly growing needs for energy resources;
- limited natural resources (oil and natural gas);
- rise in the price of energy resources;
- energy poverty;

- climate change (global warming (greenhouse effect) due to human activity);
- environmental pollution by technological emissions;
- insufficient funding for research, development, demonstration projects and the promotion of advanced technologies;
- low level of financing of research and design works of innovative direction;
- wasted as a languid power engineering as well, which is due to high capital costs, especially in the construction of new nuclear units (in connection with this share NPP Ukraine in the structure of power generation can be dramatically reduced from 45% in 2012 to 13% in 2050).

Therefore, the topic of scientific research is the potential development of renewable energy in the agrarian sector of the economy is relevant, has both practical and theoretical significance.

Literature review, indicating that the time perspectives related to issues of potential renewable energy development in the agricultural sector. The European Union and Ukraine directly covered in their publications, reports and statements of experts, scientists, practices and employees of agencies and organizations directly related to renewable energy in Ukraine such as: Ministry of Agrarian Policy of Ukraine, National Agency of Ukraine for Effective Provision use of energy resources, Scientific Engineering Center «Biomass», NGO «Renewable Energy Agency» Renewable Energy Institute of NAS of Ukraine.

The team of scientists consisting of O. Dyachuk, M. Chepelev, R. Podolets, G. Tripolska, V. Wenger, T. Saprykina and R. Yukhimets [1] in cooperation with civil society organizations, public authorities, profile associations and independent experts supported by the Foundation named after Heinrich Böll Foundation in Ukraine jointly completed report on the design baseline and alternative scenarios of the energy sector «Ukraine's transition to renewable energy by 2050» which placed: background of energy sector in the world and Ukraine in particular; general methodological approach; components of the potential of renewable energy sources in Ukraine, national technological perspectives (transport sector, building sector, industry and agriculture); development of the Ukrainian energy sector by 2050 under different scenarios and their economic impact.

Scientists and leading experts such as G. Geletukha, T. Zhelezna, G. Golubovska-Onisimova and A. Konechenkov [2; 10; 12] have published a large number of papers on prospects for agriculture and forestry in Ukraine in the field of renewable energy. In their publications, they have emphasized the possibility of expanding the range of available energy resources (biomass as fuel), creating new markets for agricultural producers, in particular the combination of food and energy markets.

We agree with the unconditional victory, approved by the Supreme Rada of Ukraine in bill 10357D (2019 year), which returns the right to build a solar power plant in the ground for households and energy cooperatives. It means recovery action «green rate» for private solar power capacity of 30 kW, which have been installed or will be installed on the site within their own yard.

Along with the fact there is a number of outstanding issues related to the potential of renewable energy in the agricultural sector and the economy of Ukraine.

Issues that have not been resolved before include the need to clarify the development of renewable energy in Ukraine in the agricultural sector, as well as to formulate proposals on existing potential.

The purpose of the article. The goal of the article is to identify, substantiate and further develop practical recommendations on the potential of renewable energy development in the agricultural sector of the Ukrainian economy.

Results and discussion. An important benchmark for achieving Ukraine's Sustainable Development Goals, as set out in the National Sustainable Development Goals: Ukraine [3] report, is the provision of affordable and clean energy. At the same time, providing access to inexpensive, reliable, sustainable modern energy sources involves diversifying the supply of primary energy resources, increasing the share of energy from renewable sources [4, p. 98].

On a global scale, the need for renewable energy is increasing, and there is a growing need for the development of this sector in Ukraine. According to the National Renewable Energy Action Plan by 2020, the state's energy needs from renewable energy sources should reach 11% and 25% by 2035 [1]. The priority in the context of European integration and global development trends is the transition from fossil (hydrocarbon) fuel to renewable energy. Therefore, Ukraine needed directions accelerate the energy transition on the principles of sustainable development from fossil to renewable energy.

In the last 3 years in Ukraine there have been some changes in this direction:

- the amount of production of electric vehicles has increased and the range of their models is expanding; increased capacity to accumulate electricity;
- technologies are being actively used to significantly improve the energy efficiency of buildings;
- progress has been made in the digitization of all energy sectors (IT technologies, networks, etc.);
- investments in research and development of «clean» technologies and construction of new facilities in the field of renewable energy have increased.

Legislation has been duly improved, a number of programs, strategies and plans developed by the Government, Parliament, the State Agency for Energy Efficiency and Energy Saving of Ukraine, and proposals and wishes of all market participants have been made public [5-9]. Thus, thanks to the consistent actions of the Government to improve the regulatory framework in the field of renewable energy, in particular, millions of dollars have been invested in: Ukrainian «green» projects; the introduction of 1670 MW of new thermal capacity using renewable energy sources; to install 278 MW of renewable energy facilities [1, p. 3].

The potential market for biogas plants for 2020 is given in Table.1 [2, p. 15; 10, p. 90]. According to scientists, in the near future will be intensively developing technologies for the use of biogas from landfills and treatment plants. The total use of biogas in 2030 could reach 10,2 TWh/year, and in 2050 – increased to 17,4 TWh/year (technical potential) [10, p.90]. Unfortunately, Ukraine is lagging behind in terms of the use of renewable energy sources not only from economically developed countries of the world (including the countries of the Visegrad Group), but also from the global index.

Table 1

Potential market for biogas plants for 2020 [1]

Type of equipment	Capacity of the domestic market, pcs.	Power		CO ₂ reductions million tonnes/year	Operating time, h/year	Natural gas replacement billion m ³ /year	Total investments million, UAH
		MW _t	MW _{is}				
Large biogas installations	2900	711	325	22,36	8360	1,15	1465
Landfill gas mini-power plants	90	20	80	3.26	8360	0.21	404
Total	2990	731	405	25,62	8360	1,36	1869

According to statistics, the share of renewable resources in total final energy consumption in the world was 20% in 2017, therefore in Ukraine this figure was only 6%.

Significant problems arise when providing agricultural producers with fuel. There is a situational dependence of the state on energy imports and the level of prices on the world oil market, as well as a decrease in agricultural production. As a result, there is a significant decrease in state budget revenues.

In a view of the foregoing, the settlement of problems is possible due to the development of biofuel production, which will allow to provide the agrarian sector (in the future and other branches of economy) with fuel and at the same time to ensure compliance with the relevant requirements of the European Union.

These goals can be achieved through the Government support in the following areas:

- to set for fuel producers separate indicative plans for increasing the volume of production of biological fuel;
- introduce a mechanism for monitoring compliance by such manufacturers with specific indicative plans, including the introduction of a system of sanctions for their breach;
- oblige fuel sales points to maintain biofuels or conventional fuels with biofuels for consumers;
- introduce a system to encourage the use of biofuels by agricultural machinery and transport.

It is necessary to point out separately the need to develop and adopt standards in this field at the level of the Cabinet of Ministers of Ukraine and to create an effective mechanism for achieving the goals set in the Decree of the President of Ukraine «On measures for the development of biological raw material production» and the Law of Ukraine «On alternative types of liquid and gas fuel».

In order to develop renewable energy in the agricultural sector in Ukraine, it is necessary to change the mechanism of its stimulation. Thus, the introduction of a new system of support for renewable energy in the agricultural sector. Through the implementation of auctions must be ensured at the legislative level and at the same time guarantee the auction winners unimpeded connection of new capacities to the national grid. The volume of new renewable energy capacity should be in line with the Energy Strategy of Ukraine until 2035 and be determined by the corresponding annual quotas at the national level.

It should be noted that in Ukraine the share of fossil fuels in the energy balance of the country is decreasing, and the share of renewable energy sources in consumption is gradually increasing accordingly. This positive fact is due to changes in the price environment, technologies and world trends.

An indicative forecast of electricity production potential by 2035 is given in Table 2.

Table 2

An indicative forecast potential electricity production by 2035, billion kilowatt hours

Name of constituents of electricity generation structure (basic)	Years				
	2015	2020	2025	2030	2035
NPP	87,6	85	91	93	94
TPP / TPP	67,4	60	64	63	63
Hydro	7	10	12	13	13
RES (sunandwind)	1,6	9	12	18	25
Total (electricityproduction)	163,7	164	178	185	195

Source: [7].

Although substantial renewable energy development is planned in Ukraine from the current 5 % to 25% by 2035, but it is too early to compete with world leaders. However, Ukraine must make a quantum leap in the field of renewable energy. The main tool for stimulating the development of renewable energy in Ukraine remains the «green» tariff, which is installed on electricity produced from renewable energy sources by 2030 and pegged to the euro.

Following the entry into force of the Paris Agreement (December 12, 2015), it requires the international community to take decisive consolidated action to counteract global warming on Earth. With regard to environmental commitments and environmental safety of generation in Ukraine, the current level of pollutant emissions exceeds EU standards by an average of 7-80 times depending on their type. It is planned to fulfill them by SO₂ and dust by 2028, by NO_x – by 2033, providing an individual approach for each unit to fulfill its obligations [7].

The problem of decarbonisation and reduction of pollutant emissions to the renewed level of commitment by 2020 can generally be solved in Ukraine by reducing the energy intensity of the country's GDP, the overall reduction in total primary energy supply calculated as the amount of

production, imports, export, international bunkering of ships and changes in energy resources in the country, as well as subject to partial decommissioning of TPPs.

In 2016, the Government approved the Concept of Implementing Public Policy in the Field of Climate Change for the Period up to 2030 [8], which aims to improve public policy in the field of climate change in order to achieve the sustainable development of the state creating legal and institutional preconditions for ensuring a gradual transition to low-carbon development in the face of economic, energy and environmental security and increased public well-being.

Thus, the transition to low-carbon development of Ukraine is envisaged by:

- expanding the energy efficiency improvement plan in accordance with the «National Energy Efficiency Action Plan for 2020»;

- reduction of energy intensity of gross domestic product in accordance with the Sustainable Development Strategy «Ukraine 2020»;

- increasing the amount of absorption of greenhouse gases by exercise event in the in the field of forest management and land use;

- increasing the share of energy produced from renewable energy sources in the general structure of energy consumption of the state in accordance with the «National Renewable Energy Action Plan for the Period to 2020» [8; 11].

In turn, Ukraine has every real chance to increase its share of renewable energy. To this end, it is necessary to improve national programs that are purposefully aimed at stimulating accelerated use of RES.

According to the scenario of development of Ukraine's transition to 100% renewable energy, the main role is played by biomass and biofuels – 41%, wind energy – 20%, solar energy – 16% [12, p. 461; 13]. According to the forecasts of the Association of Alternative Fuels and Energy Market Participants of Ukraine, in 2016-2018 the intensive development of renewable energy has allowed to create about 15 thousand new jobs. According to the data of the Association in the next two years to further the development of renewable sources of energy will ensure work is 60-70 thousand people [14].

The necessary measures to stimulate the domestic market and increase the share of renewable energy by 2020 were discussed in the framework of the EU-Ukraine Renewable Energy Investment Forum [9]. As a result, appropriate reforms in Ukraine's own energy policy according to the legislation of one of EU (Ukraine-EU Association Agreement; Treaty establishing the Energy Community).

Important are the efforts of the European side and international organizations to implement best practices in Ukraine and to take into account existing experience in the transition to clean energy [9; 15]. Renewable energy sources are the most important energy resources and are competitive in such energy fields as electricity generation, heat and power supply.

RES have unstable energy potential, including variability of wind speed, intensity of solar radiation, drying of rivers and etc. Therefore, they should be used in combined power systems in combination with each other. In addition, renewable energy systems in local heat and electricity used in conjunction with different types of battery of heat and electricity, as well as storage systems based on hydrogen, which increases efficiency and renewable energy provides uninterrupted power supply to consumers. With this in future first term, renewable can be one of the major sources of production of hydrogen from water [15].

The energy potential of renewable sources, including in the agrarian sector of the Ukrainian economy is given in Table 3. The data of the analytical table. 3 indicate that Ukraine has significant technical and achievable energy production potential from renewable energy sources, estimated at 87,0 million tonnes. Pp/year. The cost-effective energy potential is much lower [16]. The realities require the government of Ukraine to fully intensify its research work in the field of renewable energy, create a legislative and regulatory framework and a system of state economic incentives. All of these decisive steps will make it possible to use renewable energy sources efficiently and widely. Statistics show that in Ukraine the share of RES in the total energy supply is 3%, and in the electricity supply 7%, in particular at the expense of hydropower.

The potential energy of renewable sources in Ukraine

Areas of RES development	Annual technical energy potential		Annual volumes of natural gas replacement
	billion kW/h	mln. Tons of conventional fuel	billion m ³
Wind power	41,7	21	18,26
Solar energy	28,8	6	5,22
Geothermal energy	105,1	12	10,43
Hydropower	27,7	10	8,70
Bioenergy	162,8	20	17,40
The energy of the environment	154,7	18	15,65
Total RES	520,8	87	75,66

Source: [16].

The fourth power pack (Winter energy package) allowed to continue decentralizing electricity market and ensured the functioning of the flexible pricing. As a result, the pricing system for consumers has become more flexible, including an increase during peak times and a decrease in the period of reduced demand [17].

Energy consumption in Ukraine based on renewable energy sources for 2013-2017 years is given in Table. 4.

Table 4

Energy consumption in Ukraine based on renewable energy sources for 2013-2017 years *

Energy consumption indicators	Years					Decline (+, -) 2017 to:	
	2013	2014	2015	2016	2017	2013	2016
Total primary energy supply, thousand toe	115940	105683	90090	94383	89625	-26315	-4758
including:							
Hydropower, thousand toe	1187	729	464	660	769	-418	109
as a%	1,0	0,7	0,5	0,7	0,9	-0,1	0,2
Biofuels and waste, thousand toe	1875	1934	2102	2832	3046	1171	214
as a%	1,6	1,8	2,3	3,0	3,4	1,8	0,4
Wind and solar power, thousand toe	104	134	134	124	149	45	25
as a%	0,1	0,1	0,1	0,1	0,2	0,1	0,1
Total energy supply from renewable sources, thousand toe	3166	2797	2700	3616	3964	798	348
Share of energy supply from renewable sources, %	2,7	2,6	3,0	3,8	4,4	1,7	0,6

* 2014-2017 years without taking into account the temporarily occupied territories of the Autonomous Republic of Crimea and Sevastopol and parts of the temporarily occupied territories in Donetsk and Luhansk regions.

The analysis of the table. 4 indicates that total primary energy supply in 2017 was 89,625 thousand tons, which is 23% less than in 2013 and 5% less than in 2016; including volumes: hydropower in 2017 amounted to 769 thousand tons, which is 35% less than in 2013 and 17% more than in the previous 2016; biofuels and waste in 2017 were equal to 3046 thousand tons, which is 63% more than in 2013 and 8% more than in the previous 2016; wind and solar energy in 2017 amounted to 149 thousand tons, which is 43% more than in 2013 and 20% more than in the previous 2016. Therefore, the share of energy supply from renewable sources in 2017 was 4,4%, which is still higher by 1,7 p.p. than in 2013 and 0,6 p.p. than in 2016.

A positive fact for the Ukrainian energy market is the elimination of customs duties, quantitative restrictions on the import / export of energy products. In order to integrate the energy markets of Ukraine and the EU, strategic networks (demand, supply), energy policy formulation must take into account the energy networks and capabilities of the other party.

Conclusions. Thus, the dynamics of development of domestic renewable energy will depend mainly on:

- implementing economic reforms, in particular on transparency and non-discrimination in the energy market;
- implementation of European legislation in the field of energy;
- terms of integration with the European energy market;
- implementation of electricity production by all RES technologies available in Ukraine today, as they are rapidly becoming cheaper and improving. The most promising among them are wind and solar technologies, and bioenergy technologies can become leaders in heat generation;
- creation of conditions for procurement by public authorities of goods and services with high level of energy efficiency, taking into account requirements for economic efficiency, economic feasibility, technical suitability and competition;
- increasing funding for research and development work aimed at developing next-generation technologies and supporting green energy companies;
- introduction of the procedure of auctions by the Cabinet of Ministers of Ukraine and use as a platform of the electronic trading system Prozorro (setting the auction price (the price of 1 kW/h, offered by the auction winner, should not exceed the size of the green tariff at the date of the auction);
- a decrease in the level of greentarriff since 2020.

Prospects for further exploration in this direction will relate directly to the diagnosis of state support for the agrarian sector of the Ukrainian economy as a factor in the development of renewable energy.

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ПОТЕНЦІАЛ ДЛЯ РОЗВИТКУ ВІДНОВЛЮВАНОЇ ЕНЕРГЕТИКИ В АГРАРНОМУ СЕКТОРІ ЕКОНОМІКИ

Анотація

Постановка проблеми. У світі відбуваються кардинальні зміни щодо підходів у формуванні енергетичної політики держав. Країни із розвинутою економікою активно переходять на використання відновлюваних джерел енергії. Такі проблеми як прагнення до посилення енергетичної та економічної безпеки країн, зменшення запасів традиційних видів енергоресурсів у планетарному масштабі, негативний вплив енергетики на навколишнє середовище, значне подорожчання енергоресурсів та інші фактори призвели до декарбонізації енергетичних систем. Україна зміцнює свої позиції у цьому напрямку і ефективно використовує власний потенціал в галузі відновлюваної енергетики.

Метою є визначення, обґрунтування і подальша розробка практичних рекомендацій щодо потенціалу розвитку відновлюваної енергетики в аграрному секторі економіки України.

Методи дослідження. Теоретико-методологічною основою наукового дослідження є діалектичний метод наукового пізнання, системний підхід до вивчення економічних явищ, положення сучасної економічної теорії, наукові праці вітчизняних вчених, що займалися і займаються питаннями, пов'язаними з відновлюваною енергетикою в аграрному секторі, рекомендації науково-дослідних установ з досліджуваної проблеми.

Наукове дослідження базується на використанні загальнонаукових методів досліджень: теоретичного узагальнення, системного аналізу і синтезу; логіко-історичного методу; системного підходу; термінологічного аналізу; інституціонального підходу; статистичного і фінансового аналізів; абстрагування та формалізації.

Результати. Виявлено невирішені головні проблеми в сфері енергетики України. Визначено певні зміни у напрямку відновлюваної енергетики, які активно вплинули на її розвиток. Наведено розрахунки потенційного вітчизняного ринку для біогазових установок на 2020 р. Окреслено загальні цілі, які можна досягти за рахунок державної підтримки. Охарактеризовано орієнтовний прогноз потенціалу виробництва електроенергії до 2035 р. Узагальнено зобов'язання в рамках екологічної безпеки України перед Європейським Союзом. Запропоновано напрями вдосконалення динаміки розвитку відновлюваної енергетики.

Наукова новизна. Набуло подальшого розвитку дослідження відновлюваної енергетики в Україні, що на відміну від існуючих підходів визначають концептуальне значення виключних можливостей природно-ресурсного потенціалу аграрного сектора економіки для енергетичної безпеки країни.

Висновки. Таким чином, динаміка розвитку вітчизняної відновлюваної енергетики залежатиме переважно від: впровадження економічних реформ, зокрема щодо прозорості й недискримінаційності на енергетичному ринку; імплементації європейського законодавства в енергетичній сфері; термінів інтеграції з енергетичним ринком Європи; здійснення виробництва електроенергії усіма наявними на сьогодні в Україні ВДЕ-технологіями, оскільки вони стрімко здешевлюються і вдосконалюються. Найбільш перспективним серед них є технології вітрової та сонячної енергетики, а біоенергетичні технології можуть стати лідерами в теплогенерації; створення умов для закупівель органами державної влади товарів і послуг з високим рівнем енергоефективності з урахуванням вимог щодо економічної ефективності, економічної здійсненості, технічної придатності та дотримання конкуренції; збільшення фінансування науково-дослідних і проектно-конструкторських робіт, спрямованих на розробку технологій наступного покоління і підтримку компаній, що займаються «зеленою» енергетикою; запровадження порядку проведення аукціонів Кабінетом Міністрів України і використання у ролі майданчика електронної торгової системи ProZorro (встановлення аукціонної ціни (ціна 1 кВт/год., запропонована переможцем аукціону, не повинна перевищувати розмір зеленого тарифу на дату проведення аукціону); зниження рівня «зеленого» тарифу з 2020 року.

Ключові слова: потенціал, розвиток, відновлювана енергетика, аграрний сектор, національна економіка, енергоресурси, відновлювані джерела енергії.

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