# FINANCIAL CONDITION OF THE DEVELOPMENT OF THE MARKET OF RENEWABLE ENERGY SOURCES

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**Abstract**. In the context of the current global economic crisis, the increasing attention of the world community is given to increased structural transformation of fuel and energy complexes of countries. The main content of these processes is to increase the economic efficiency of energy use and reduce the dependence on their imports, which is extremely relevant for Ukraine. Thus, it is evident that there is a need for in-depth scientific consideration of the above-mentioned processes in order to localize existing problems, as well as to develop recommendations for their solution. The article generalizes the tendencies of development of the field of alternative energy in Ukraine and the world, conducted an analysis of the financial state of renewable energy sources, developed recommendations for the improvement and development of this industry. In the course of the study, there were positive changes in the field of alternative energy were discovered, but to date there are still a range of problems that require a state settlement: regulating the alternative energy market needs to be revised by creating new incentive mechanisms for companies active in the alternative energy market and developing effective guidelines; elimination of bureaucratic procedures for obtaining state benefits; activation of bank

financing programs for investment in renewable energy projects. Large-scale development of energy from renewable sources will allow to create a new ecologically safe branch of energy, which will help to increase the level of diversification of energy resources and strengthen the energy and ecological safety of Ukraine.

**Keywords:** financial condition, alternative energy industry, financing, financial analysis, economic efficiency, renewable energy sources.

## 1 Introduction

In the context of the current global economic crisis, the increasing attention of the world community is given to increased structural transformation of fuel and energy complexes of countries. The main content of these processes is to increase the economic efficiency of energy use and reduce the dependence on their imports, which is extremely relevant for Ukraine. Thus, it is evident that there is a need for in-depth scientific consideration of the above-mentioned processes in order to localize existing problems, as well as to develop recommendations for their solution.

At the moment, Ukraine is trying to keep pace with developed European countries, maximizing its own natural potential, which by the way is favorable for the development of four main areas of alternative energy (wind power, solar energy, small hydropower plants, biofuel production from organic raw materials of their own production) [8, 22].

Ukraine's energy policy must ensure the security of supply, reduction or diversification of international dependence, increase the efficiency of production and use of electricity and heat, and take into account the possibilities of future commitments on climate protection [6].

Ukraine has considerable technical potential for the use of renewable energy sources. Thanks to its significant agricultural sector there are very good preconditions for using bioenergy. There is quite a good technical potential for solar and geothermal energy, but in the medium term, their use does not seem economically feasible. The development of this technical capacity will be determined by economic preconditions, as well as the framework conditions of the energy policy. Renewable energy sources play a secondary role only in the energy policy of Ukraine [6].

An important feature of Ukraine is the very close connection between the state and private capital. On the one hand, this connection facilitates the implementation of large-scale projects organized on the basis of the private economy, since they can be implemented on a "top-down" basis. This also applies to renewable energy sources. However, on the other hand, this approach reduces the trust of foreign investors in the structures of political subordination and inhibits the activity of medium-sized enterprises.

German experience shows that the renewable energy sector exist because of private companies - and above all of medium-sized enterprises. These firms in the framework of a social market economy have a specific profile of requirements for capital equipment, risk preparedness and ability to perform administrative tasks, which should be taken into account in determining the direction of the framework

conditions of regulation. Widely used financing projects of the development of RES. Project finance is of great importance especially for comparably small projects – ca. 83% of projects that are smaller than 50 MW use it, but only 36% of projects in the cluster 50–100 MW, and just 28% of even larger projects. Of course the typical project size differs by technology – correspondingly. Recalling that renewables in Germany qualify for a feed-in tariff that takes away all the merchant risk, it is the generally smaller, less risky projects that rely on project finance – putting the contamination risk reason into question, which will be further assessed by the regression analysis [16].

During the last years of the democratization process in Ukraine, certain forces of civil society have been formed, which, along with an active position on ecology and climate protection, also require wider use of renewable energy sources. Together with strict autocratic approaches to energy policy in Ukraine, this has caused the emergence of new instruments for promoting, in particular, for alternative energy sources, such as the Green Tariff Act. This law, like the German Law on Renewable Energy, will temporarily stimulate the production of energy from renewable sources. The development of the renewable energy sector in Ukraine will be driven by a number of general political and economic factors that affect the investment climate, favorable financial conditions and economic prosperity in general.

## 2 Methodology and aim of the study

The goal of the research is to study financial condition of the development of the market of renewable energy sources.

The study was based on the generally accepted methods for data quantification, presentation, observation, processing, grouping of observation materials and statistical summary.

Assessing the financial condition of the development of the market of renewable energy sources, we used the following statistical methods which relate to quantitative methods of economic analysis:

1) statistical observation - recording information on certain principles and for certain purposes;

2) series of dynamics: absolute growth, growth rates;

3) summary and grouping of economic indicators according to certain characteristics;

4) comparison of indicators: with competitors, standards, dynamics;

The method of comparison with the previous period was also used. It is the comparison of economic indicators of the current period with those of the previous period. Also, the comparison with the best indicators was made – the best practice gives an effect when the comparison is conducted with indicators of similar enterprises. The most used method was the method of horizontal analysis (temporary) - the comparison of each position of reporting with the corresponding position of the previous period, consisted in the construction of several analytical tables.

## 3 Renewable energy development in the world

Due to global mixing of greenhouse gases, an efficient climate policy must be done on a global scale. Renewable energy does not lead to greenhouse gas emissions and thus is a crucial part of a strategy to reduce emissions [7].

The development of the renewable energy industry is the important support for the sustainable development of social economy. It is of great significant for economic security and national security and its strategic significance is immeasurable. The process of cultivating, developing and upgrading the renewable energy industry is a comprehensive system project that includes finance, resources, technology and management. As the core of modern economic development, finance plays an important role in the cultivation, development and up gradation of renewable energy industries. The renewable energy industry needs long-term, huge and uninterrupted funding, especially in the early stages of development when it has significant characteristics of high input, high risk and high returns. The optimization and upgrade of the renewable energy industry cannot be separated from financial support, and the establishment of a modern electricity market to promote the large-scale application of renewable energy requires financial support [4, 5, 21].

The most dynamic in recent years are the production and implementation of photovoltaic solar power plants and stations. More than 60% of all facilities put into operation around the world by the end of 2015 have been added over the past three years. In the whole world, the total installed power of photovoltaic systems (stations) has reached 222.3 GW. At the end of 2015, the leaders with installed power of solar photovoltaic systems (stations) were countries such as China (40 GW), Germany (39.6 GW), Japan (33.3 GW), USA (25.5 GW) and Italy (18.9 GW). In 2015, China became the undisputed leader in renewable energy development - this year it installed 14.8 GW of photovoltaic systems (stations). The business value of PV (photovoltaic applications) should be compared to the GDP of each country. [19]. While the positive impacts stimulated by the development of renewable energy are apparent in terms of direct and indirect stimulation of RE-related sectors, other sectors, especially those related to the conventional energy supply chain, may suffer negative impacts. The development of renewable energy on such a large scale has wide-ranging implications. Investment toward the construction of fossil-fired power plants and other sectors which are stimulated by demand for products of the previously mentioned high-carbon sectors decreases. Meanwhile, benefits accrue in upstream sectors of RE investment, e.g., electronic machinery, and in the research and development sectors [2].

In 2016, global renewable electricity generation grew by an estimated 6% and represented around 24% of global power output. Hydropower remained the largest source of renewable power, accounting for around 70%, followed by wind (16%), bioenergy (9%) and solar PV (5%). In 2015, net additions to grid-connected renewable electricity capacity reached a record high at 153 GW, 15% higher than in 2014. For the first time, renewables accounted for more than half of new additions to power capacity and overtook coal in terms of world cumulative installed capacity [18]. The use of wind energy is expanding around the world, which results in lowering the cost of turbines, raising the level of state support and increasing investor recognition of the positive characteristics of wind power generation. In 2014, the total share of wind power generation accounted for more than 3% of world electricity supply [3, 20].

# 4 Renewable Energy Development Potential in Ukraine

## 4.1 Energy potential of RES

Energy efficiency and the use of renewable energy sources has become a pressing need of time, as it promotes solving energy supply problems, as well as many environmental, economic and social problems. Of the various types of RES, the most widespread and affordable for Ukraine are wind and solar energy, biomass and energy of small rivers, geothermal energy and the environment. According to the State Agency for Energy Efficiency and Energy Saving of Ukraine (State Energy Efficiency), the total annual technically achiveable energy potential of the RES of Ukraine in terms of conventional fuel is approximately 98 million tons of standard fuel. (Table 1), which is almost 50% of the total energy consumption in Ukraine at present and is forecast to reach 30% of energy consumption in 2030.

**Table 1**. Technically achiveable renewable energy production potential for renewable energy sources and alternative fuels

| № | Areas of development of RES | Annual technically achievable energy potential, miln. tons of conventional fuel |
|---|---|---|
| 1. | Solar power engineering, including | 6,0 |
| electric | | 2,0 |
| thermal | | 4,0 |
| 2. | Small hydropower | 3,0 |
| 3. | The energy of the environment (heat pumps) | 18,0 |
| 4. | Geothermal heat energy | 12,0 |
| 5. | Bioenergy, including | 31,0 |
| electric | | 10,3 |
| thermal | | 20,7 |
| 6. | Wind power | 28,0 |
| Total amount of replacement of traditional fuel and energy resources | | 98,0 |

Sources: [17]

This potential is quite significant, technically and economically attractive in conditions of significant increase of prices for traditional energy resources in Ukraine. The project of the updated Energy Strategy for the period up to 2030, promulgated by the Cabinet of Ministers of Ukraine in June 2012, planned (in the baseline scenario of development) to riched the share of renewable energy up to 10% of the installed capacity - in 2030 and up to 5% in 2020 (at 20% of the consumption of renewable electricity planned by the EU) [17].

By joining the Treaty establishing the Energy Community, Ukraine has undertaken to implement certain elements of the acquis communautaire on energy, environment, competition and renewable energy in the legislative field of Ukraine. Accordingly, there is the need for a detailed analysis and refinement as target

indicators of RES in the documents of the strategic level, as well as the current legislation.

### 4.2 Energy potential of the Sun

Taking into account the climatic peculiarities of the territory of Ukraine and the presence of powerful enterprises (including producers of semiconductor materials, as well as microelectronic and electrical devices, which makes it possible to obtain additional profit for the production of electricity using photovoltaic technologies), the transformation of solar energy into electricity production using photovoltaic devices is one of the most promising directions of the development of renewable energy in Ukraine.

**Table 2**. Solar Energy potential in Ukrainian territory

| № | Regions | The potential of the solar energy | | |
|---|---|---|---|---|
| | | Theoretically - possible potential (x $10^9$) tons of o.e. / year | Technically achievable potential | |
| | | | billion kW * hour / year | (x $10^5$) tons of o.e. / year |
| 1 | Crimea | 3,95 | 2,2 | 1,89 |
| 2 | Odessa | 3,92 | 2,09 | 1,79 |
| 3 | Kherson | 3,29 | 1,84 | 1,69 |
| … | ... | ... | … | ... |
| 16 | Kirovograd | 2,38 | 1,26 | 1,08 |
| 17 | Sumy | 2,24 | 1,21 | 1,04 |
| 18 | Lviv | 2,17 | 1,12 | 1,1 |
| … | ... | ... | … | ... |
| 25 | Chernivtsi | 0,84 | 0,46 | 0,41 |
| Total | | 63,01 | 33,77 | 29,63 |

Sources: http://saee.gov.ua/uk/pressroom/1133

Photoelectric equipment can be effectively operated throughout the year, but most effectively - for seven months a year (from April to October) in the southern regions and five months a year - in the northern (from May to September). As of January 1, 2016, in Ukraine, under the "green" tariff for electricity production, there are 112 solar power plants with installed capacity of almost 838.83 MW. The above-mentioned objects in 2015 produced over 475.1 million kWh of electricity.

Depending on the size and complexity of the system, the prices for autonomous PV vary considerably. Due to technical developments and mass production, prices for small standard systems have declined in recent years [1].

As of January 1, 2016, the total capacity of solar installations of private households operating at a "green" tariff is 2.6 MW. The indicated plants produced 410 268 kWh of electricity in 2015, which is 11 times as much as in 2014, thanks in particular to the use of the green tariff for private households producing electricity from alternative sources of energy.

### 4.3 Wind energy potential

According to the International Agency for Renewable Energy (IRENA), the total wind potential, which is the second largest renewable energy resource in Ukraine, is 16-24 GW. Wind power industry of Ukraine can potentially provide annual energy equivalent of 10.5 million tons of oil equivalent, which will save about 13 billion cubic meters of natural gas annually.

**Table 3.** The highest potential of wind energy in the regions (at an altitude of 100 m)

| № | Regions | The specific potential of wind energy | |
|---|---|---|---|
| | | Natural, kW. hour / $m^2$ per year | technically achievable, kW. year / $m^2$ per year |
| 1 | Crimea | 6 781 | 1 061 |
| 2 | Kherson | 6 079 | 956 |
| 3 | Zaporozhye | 5 771 | 935 |
| 4 | Ivano-Frankivsk | 5 538 | 902 |
| 5 | Odessa | 5 481 | 915 |
| 6 | Donetsk | 5 300 | 903 |
| 7 | Lugansk | 5 137 | 891 |
| 8 | Nikolaev | 5 047 | 885 |
| 9 | Dnipropetrovsk | 4 540 | 850 |
| 10 | Chernivtsi | 4 222 | 708 |
| 11 | Zakarpattya | 4 175 | 702 |
| 12 | Lviv | 3 799 | 646 |

Sources: http://saee.gov.ua/uk/pressroom/1133

According European and domestic experts, the potential of wind power in Ukraine makes good use of wind power plants with total capacity of 16 GW, excluding offshore wind farm.

The most promising regions - the south and southeast, where the average annual wind speed at 80 meters height exceeds 7.5 m / sec.

The Wind Power Potential map shows the presence in Ukraine of significant areas with high wind power potential. For the construction of wind farms of such capacity, over 200 billion hryvnias of investments are needed. According to the results of the conducted studies, the presence in each region of Ukraine of localizations, which ensure the implementation of effective investment projects of wind power.

From the zoning of the territory, it follows that realization of the implementation projects:

- solar power plants are most effective in the Autonomous Republic of Crimea, Odessa, Dnipropetrovsk, Kherson, Kharkiv, Zaporozhye, Chernihiv, Donetsk, Luhansk, Zhytomyr, Kyiv, Mykolayiv and Poltava regions;
- ground wind power plants are most effective in the Autonomous Republic of Crimea, Kherson, Zaporozhye, Ivano-Frankivsk, Odessa, Donetsk, Luhansk, Dnipropetrovsk, Chernivtsi, Transcarpathian and Lviv regions.

In Ukraine, the support of renewable energy, in particular wind power, is enshrined at the legislative level. The wholesale electricity market is obliged to buy from entities that have a "green" tariff and to pay the full cost of electricity, regardless of the size of installed capacity or volumes of its release.

## 5 Economic indicators. Sources of financing.

The main factor affecting the economic performance of the production of thermal and electric energy using solar and wind energy is the cost of the main equipment of power systems.

Renewable energy is, in fact, a multi-billion dollar industry and the most dynamic sector of the global energy market. Globally installed renewable energy capacity is expected to more than double over the next ten years from approx. 130 GW in 2003 to 300 GW in 2013 [15].

In determining the projected specific investment, the cost of the main equipment as domestic producers of products for solar energy, such as “Kvazar” OJSC in Kyiv (photovoltaic), “SINTEK” in Zaporozhye (producer of thermal collectors) and European associations: European PV Platform (photovoltaic), European Solar Thermal Technology and the leading countries in the world (USA, Japan, China, etc.). The average investment cost of the abovementioned producers corresponds to the data from the International Renewable Energy Agency (REN 21) report.

In the field of photovoltaic power, the specific values of photovoltaic systems in the world and in Ukraine (depending on the selected basic equipment) make an average of 1.2 - 1.5 thousand USA dollars / kW of installed capacity. The level of specific investments and the total investment need for photovoltaic systems construction are presented in the following tables.

### 5.1 Solar power

The following table presents the initial parameters for calculating the technical and economic indicators of solar electricity in Ukraine, and in the table 5 - the need of investments until 2020

**Table 4.** Indicators of technical and economic calculations of solar power industry in Ukraine

| Indicator | Value, $ / kW | Share, % |
|---|---|---|
| Specific cost of equipment | 1125 | 75 |
| Additional expenses (foundations, installation, other) | 300 | 20 |
| Expenses for the development of electric networks and connection of PV stations (photovoltaic station) to the network | 75 | from 5** |
| Total specific investments in PV stations | 1500* | 100 |

Sources: own resources

Note: * - the specific cost of investments is taken from the report of the International Renewable Energy Agency; ** - the indicator is determined after the feasibility study of the PV stations power scheme has been developed.

**Table 5.** Total demand for investments in the construction of PV stations

| Indicators | 2016 | 2017 | 2018 | 2019 | 2020 | Deviation (+/-) |
|---|---|---|---|---|---|---|

| | | | | | | 2020/2016 |
|---|---|---|---|---|---|---|
| Additional power of PV station, MW / year | 250 | 200 | 250 | 300 | 300 | 50 |
| Construction cost, mln. $ / year | 375 | 300 | 375 | 450 | 450 | 75 |
| Total cost, $ million | 375 | 675 | 1050 | 1500 | 1950 | 1575 |

Sources: own resources

Should be note, that at the beginning of 2015, 819 MW of PV power stations were constructed. According to the research, it can be said that the additional power of the photoelectric power plant by 2020 should increase by 50 MV / year The cost of building up to 2020 also has to increase by 75 million dollars a year, which is estimated at 450 million dollars by 2020.

**5.2 Wind power**

In 2016, onshore wind energy continued to be heavily expanded, with some 4,443 megawatts newly installed, marking an increase over the previous year. After the dismantling of old installations (277 megawatts), net expansion in 2016 amounted to 4,166 megawatts. This is the second highest expansion figure since 2014 (4,651 megawatts). At the end of the year, a total of 45,412 megawatts of installed onshore wind capacity was linked up to the grid. However, the high level of expansion did not have a direct effect on the amount of electricity generated from wind turbines as there was comparatively little wind in 2016. This meant that the amount of electricity produced by onshore wind installations declined by nearly 7% over the previous year, falling to 66,3 billion kilowatt hours (2015: 70.9 billion kilowatt hours) [9].

The following table presents the initial parameters for calculating the technical and economic indicators of wind energy in Ukraine, and in the table 7 - the need of investments until 2020

**Table 6.** Indicators of technical and economic calculations (€ / kW)

| Indicators | Value, € | Share, % |
|---|---|---|
| Specific cost of wind turbines | 1000 | 65-70 |
| Additional expenses (foundations, installation) | 250 | 16-20 |
| Expenditures on the development of power grids and connection of wind turbines to the grid | 150 | 7-11 |
| Other expenses | 100 | 5-9 |
| Total specific investments in wind energy station (WES) | 1500 | 100 |

Sources: own resources

From this table we can say that the specific cost of a wind turbine is 1000 euros, additional costs are 250 euros, costs for the development of electricity networks and the connection of wind power to the network is 150 euros. In total, the installation of a wind turbine will be 1500 euros. The most capital-intensive is the purchase of wind turbines.

**Table 7.** Total demand of investments in the construction of wind energy station

| Indicators | 2018 | 2019 | 2020 | 2021 | 2022 | Deviation (+/-) 2022/2018 |
|---|---|---|---|---|---|---|
| Additional power of wind turbines, MW / year | 350 | 300 | 250 | 200 | 180 | -170 |
| Construction cost, million euro / year | 525 | 450 | 375 | 300 | 270 | -255 |
| Total cost, million euro | 1275 | 1725 | 2100 | 2400 | 2670 | 1395 |

Sources: own resorces

The additional capacity of the wind turbines of the planned period 2018-2022 will be reduced by 170 MW / year. In connection with the expansion of production and demand of wind turbines, the cost of construction in the coming years will decrease by 255 million euro. The total cost of the purchase and installation of a wind turbine will increase by 1395 million euro.

## 6 Priority measures to ensure the effectiveness of RES

The commitment by 195 countries to limit global warming to well below 2 degrees Celsius sent a clear signal: we have to radically rethink how we produce and consume energy if we are to meet this target. The pledge of 48 climate vulnerable countries at COP22 to use only renewable energy by 2050 further strengthens this resolve [10-14].

Ensuring implementation of the plan for the development of RES in terms of the development of solar generation

- development of power generating capacities. Construction of photovoltaic stations (FES);
- development of regulatory and legal support for the development of solar energy;
- scientific and technical support for the development of solar energy.

Ensuring the implementation of the plan for the development of WPP in terms of the development of wind power

- development of power generating facilities - construction / reconstruction of wind power plants in the regions of Ukraine;
- scientific and technical support for the development of wind energy;

## Conclusion

The study found that Ukraine has favorable financial and economic conditions for the development of renewable energy sources. Under the influence of the current world trends in the energy sector and in order to reduce energy dependence on expensive organic sources and increase the share of alternative energy in the energy balance of the country, the Ukrainian authorities in recent years have undertaken a number of measures to stimulate the alternative energy sector: the creation of a number of scientific institutions engaged in research in renewable energy sources; the

presence of a "green tariff", according to which the wholesale electricity market of Ukraine is obliged to buy electricity from alternative energy sources". But despite some positive developments in the field of alternative energy, there are still a range of problems that require a state settlement: the regulatory framework for regulation of the alternative energy market needs to be revised by creating new incentive mechanisms for companies active in the alternative energy market and developing effective guidelines; elimination of bureaucratic procedures for obtaining state benefits, which is possible provided that the existing system for providing them is simplified; activating banking programs to finance investment in renewable energy projects. Large-scale development of energy from renewable sources will enable the creation of a new environmentally friendly energy sector that will increase the level of diversification of energy resources and strengthen the energy and ecological safety of Ukraine.

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