

## ECONOMIC OVERVIEW OF THE CONCEPTUAL INNOVATIVE RESEARCH OF ALTERNATIVE ENERGY GENERATION



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The role of the energy industry cannot be overestimated in the era of the global energy consumption. At present, no industry can do without the use of electric and thermal energy. Energy is the basic part of the engine of world progress. Recently, humanity began to think about the limited use of raw materials for the production of electric and thermal energy from traditional energy resources: coal, oil, gas. And this concern is not unfounded.

The renewable or regenerative energy (the "Green energy") is the energy from the sources that, on a human scale, are inexhaustible (which are replenished naturally).

"More for less money" – it so that is possible to characterize the dynamics of investments in the alternative energy. The global trends in the use of the renewable energy sources indicate that it is possible to successfully increase the use of the renewable energy sources, and the amount of the useful energy generated by this way to increase to 95% at final consumption. In the European Union, the state of the development of the renewable energy in general is close to the global indicators. Eleven of the 28 EU member states have already reached 20%: Bulgaria, Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden. In addition, Austria and Slovakia lack only 1 % to the target set for 2020.

Modern solar panels still have a rather low coefficient of efficiency. And therefore, to get from them high production figures one has to cover sufficiently large spaces with the panels. Wind power engineering is an industry specializing in the transformation of the kinetic energy of the air masses in the atmosphere into electric, thermal and any other form of energy to use it in the national economy. The conversion is carried out by way of using a wind turbine (for getting electricity), wind

turbines (for getting mechanical energy) and many other types of aggregates. The new environmentally safe energy source in the field of nanobiology is called osmotic energy. Energy is generated by contacting fresh and salt water through a membrane with a thickness of three atoms. The international cooperation in the field of energy allows to direct the investment resources to the global projects. The Netherlands, Denmark and Germany reached an agreement signed in Brussels on March 23, 2017, on investing in a joint construction of a large wind power hub in the North Sea.

Delivery, conversion and energy consumption implies unproductive losses.

Considering the advantages of investing into the alternative energy, it should be emphasized that the share of unproductive losses in the use of the RES is almost absent.

Thermal energy costs are determined by the results of energy audit using the thermal imager. One of the most promising incentives for the development of the alternative energy is the "green" tariff – a mechanism for encouraging energy production, which gives state guarantees to producers, that the energy produced by them will be purchased at higher prices than traditional energy producers' energy.

**Abstract.** In the article the world economic trends of the alternative energy are presented. The article reviews the conceptual proposals and innovative research in the field of alternative energy. The ways of formation of effective energy management and rational energy policy are offered. A comparative analysis of the targets for the share of renewable energy in gross final energy consumption in the European Union. The most successful programs in solar and wind energy generation are characterized.

**Keywords:** *energy generation, alternative energy, resources, renewable sources, innovations, investments, energy efficiency, energy policy, green tariff.*

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## Introduction.

More than one hundred countries of the world, including Ukraine, have proclaimed the alternative energy as a priority of their policy. Most of them provide benefits to the producers of the "green" energy, realizing that its development is in line with the country's strategic goals: energy independence, cheap energy, jobs, and environmental care.

The achievement of certain scientific results and scientific and practical achievements in this area are facilitated by quite a large number of scientific events of the international level in order to promote the establishment and development of high-quality scientific and technological cooperation between scientists of European countries. Among them: symposia in June 2016 and February 2017 on the basis of the University of Banking (Kyiv, Ukraine), the National Academy of Public Prosecutor of Ukraine, Slovyansk State Pedagogical University, Poltava University of Economics and Trade, and the conference in Poznan, Suwalki (Poland), Poltava, Lviv, Slavyansk (Ukraine) and others.

The role of the energy industry cannot be overestimated in the era of the global energy consumption. At present, no industry can do without the use of electric and thermal energy. Energy is the basic part of the engine of world progress. Recently, humanity began to think about the limited use of raw materials for the production of electric and thermal energy from traditional energy resources: coal, oil, gas. And this concern is not unfounded.

## Literature review and problem statement.

The scientific works of the Ukrainian and foreign scientists are devoted to the analysis of the energy potential of all types of non-traditional energy. Among them there are H. Pivnyak [18, p.55], O. Sokhatska [22, p.39], V. Lyashenko, O. Kvilinsky, A. Tolmacheva [14, pp.155-164], K. Pająk, S. Zwierzchlewski, [17, pp. 27-30] and others.

International experience with key program elements of industrial energy efficiency of greenhouse gas and emissions reduction target-setting programs studied L. Price [19, pp.56-57], C. Forbes [7, p.12], N. Stern [23, p.662].

As a result of the conducting research, the work of the leading Ukrainian scientists dealing with problems of the alternative energy use have been analyzed, namely,

S. Kudra, I. Bondarenko, H. Varlamov, I. Volchin, A. Shindlovskyy, V. Shynkarenko and others. Also there have been used the articles in the periodicals and electronic publications devoted to the issues of the renewable energy in Europe.

The aim of the article is to highlight the world innovations and international cooperation in the field of the alternative energy, as well as to outline possible prospects for its development and means for increasing the efficient use of the alternative energy.

**Research results.** The renewable or regenerative energy (the "Green energy") is the energy from the sources that, on a human scale, are inexhaustible (which are replenished naturally).

The basic principles of the use of the renewable energy appear out of its nature and are as follows: firstly, in its infinite presence in the environment, secondly, in the possibility of maximum approximation of the sources to the objects of consumption, and thirdly, in the reduced level of unproductive losses at transmission and consumption [11, pp.269-272].

All of the above mentioned is an economic advantage that persuades investors towards the alternative energy.

The renewable energy is generated from the natural resources, such as:

- sunlight,
- water streams,
- air streams (wind),
- geothermal heat,
- biological assets (products of vital activity).

The world practice of the XXI century shows the rapid growth of investment in innovative energy.

The positive dynamics of the development of alternative energy is confirmed by the forecast of the International Energy Agency, which predicts in 2030 the growth of world demand for the use of alternative sources of energy for heating by 7%. Investments in renewable energy sources by 2030 will amount to \$ 5.5 trillion, which will amount to almost 50% of all investments in the energy industry [20].

"More for less money" – it so that is possible to characterize the dynamics of investments in the alternative energy. The volume of the investments in the RES has

decreased in comparison with 2015 and 2014, but the objects of the RES have been built more. \$ 241.6 billion it is so much was invested in the new renewable energy (excluding large hydroelectric power plants), 23% less than in the record-breaking 2015 [24]. However, there were built more – 138.5 HW against 127.5 HW a year earlier.

We emphasize that investments into the RES have been about twice the rate for generating fossil raw materials for five consecutive years. That is, it can be assumed that this is no longer an alternative, but the most common type of the energy sources.

The forecast of the potential financial and capital investments has made it possible to make a perspective analysis of the absolute indicators (HW) of the energy generation using the renewable sources in Europe.

The global trends in the use of the renewable energy sources indicate that it is possible to successfully increase the use of the renewable energy sources, and the amount of the useful energy generated by this way to increase to 95% at final consumption. But, if it is initially to create a favorable energy efficiency policy and a system of rational energy management.

In Ukraine, there has been an increase in the installed capacities of the alternative energy for the last 4 years. By the end of 2016, 1117 MW of the renewable energy was installed, which produced about 1% of electricity in Ukraine.

The largest share is occupied by the wind and solar power plants (925 HW and 492 HW of electricity produced, respectively).

According to the experts' estimates, the economically feasible potential of introducing the alternative energy sources in Ukraine by 2030 is estimated at 16 – 22 HW, compared to 1.1 HW, which were practically set at the end of 2016. In comparison with Europe, according to the Economic Discussion Club, the share of the renewable sources in the gross final consumption of energy was 16.7%, or over the past decade, has been increased by 2 times).

In the European Union, the state of the development of the renewable energy in general is close to the global indicators. The RES's contribution to the final energy consumption is 15% (Table 1), including biomasses – about 9%. The share of the RES in electricity production is 25.4%, with biomasses being about 5%.

Table 1.

Achieved and planned targets for the share of the RES in the gross final consumption of energy in the European Union (%)

Countries of the EU	2013	2020	Countries of the EU	2013	2020
the EU	15,0	20			
Belgium	7,9	13	Luxemburg	3,6	11
Bulgaria	19,0	16	Hungary	9,8	13
Czech Republic	12,4	13	Malta	3,8	10
Denmark	27,2	30	Netherlands	4,5	14
Germany	12,4	18	Austria	32,6	34
Estonia	25,6	25	Poland	11,3	15
Ireland	7,8	16	Portugal	25,7	31
Greece	15,0	18	Rumania	23,9	24
Spain	15,4	20	Slovenia	21,5	25
France	14,2	23	Slovakia	9,8	14
Croatia	18,0	20	Finland	36,8	38
Italy	16,7	17	Sweden	52,1	49
Cyprus	8,1	13	Great Britain	5,1	15
Latvia	37,1	40	Lithuania	23,0	23

Source: <http://energefficiency.in.ua/stati/vozobnovlyamaya-energiya>

In order to comply with the 2DS climate change scenario, in 2011, the European Union reaffirmed its official goal of reducing greenhouse gas emissions (decarbonisation) by 2050 to 80-95% compared to the levels of 1990. Since the energy sector is one of the main sources of human greenhouse gas emissions, so the main reserves for reducing these emissions should be found and implemented in it.

The share of the renewable energy from the renewable sources in the European Union in 2015 is 16.7% of the total volume, and is closer to the EU's target which will have been 20% by 2020 [5].

Sweden is the leader according to this indicator – more than half (53.9%) of its energy comes from the renewable sources. Next are Finland (39.3%), Latvia (37.6%), Austria (33.0%) and Denmark (30.8%).

Eleven of the 28 EU member states have already reached 20%: Bulgaria, Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden. In addition, Austria and Slovakia lack only 1 % to the target set for 2020.

In 2014, the share of the energy from the renewable sources made up 16.1%, and in 2004, when Eurostat first published such statistics, this figure was only 8.5%.

Solar power plants use solar energy directly (photovoltaic SES operate on the principle of the internal photoelectric effect),

and indirectly – using the kinetic energy of steam.

In 2016, 75 HW of photovoltaic solar power plants were invested and built in the world, 50% more than a year earlier. Due to this, the total installed power of photovoltaic solar power exceeded 300 HW. In the countries consequently: China – 34 HW, the USA – 13 HW, Japan – 8.6 HW, Europe – 6.5 HW.

The worlds largest photovoltaic solar power plant, Topaz Solar Farm, with the capacity of 550 MW, is located in California, the USA. There have already been installed 9 million solar panels.

The solar power plant in Mohawk has become the largest in the world, its area is 14.24 square kilometers, and it is called Ivanpah Solar Electric Generating System and is related to the type of thermal solar power plants. Its power reaches 392 MW. The station has 3 towers of 140 meters high (which are essentially plants that generate energy), surrounded by 300 thousand mirrors.

The mirrors focus sunlight on the collector located at the top of the tower, there is also a water reservoir, where the heat energy is directed, collected by the mirrors. After the mirrors direct the sunrays to the collectors, there it is created the steam at high pressure and a temperature of about 500 degrees Celsius, which is transmitted to the turbine and generator. In addition, the technology of dry cooling, which reduces water consumption

to 90%, is used. As a result, the water circulates through the system several times, and then it is used to clear the station's mirrors.

Modern solar panels still have a rather low coefficient of efficiency. And therefore, to get from them high production figures one has to cover sufficiently large spaces with the panels. A conceptual technology called Betaray allows to increase the coefficient of efficiency at about three times. Betaray is a small sized installation that can be located in the courtyard of a private house or on the roof of a multistory building. Its construction is based on a transparent glass sphere with a diameter of just under one meter. It accumulates the sunlight and focuses it on a fairly small photovoltaic panel. The installation itself is dynamic. It automatically adjusts itself to the sun's position in the sky, so that at any moment it works at the maximum possible [3].

Wind power engineering is an industry specializing in the transformation of the kinetic energy of the air masses in the atmosphere into electric, thermal and any other form of energy to use it in the national economy. The conversion is carried out by way of using a wind turbine (for getting electricity), wind turbines (for getting mechanical energy) and many other types of aggregates. By the beginning of 2016, the total installed capacity of all wind turbines was 432 HW.

The Enercon E-126 is a model of the wind turbine produced by the German company Enercon. With a mast height of 135 meters, a rotor diameter of 126 meters and a total height of 198 meters, this large model can generate up to 7.58 megawatts of power per turbine. The basement mass of the turbine tower is about 2500 tons, the tower itself is 2,800 tons, the car body is 128 tons, the generator 220 tons, the rotor (including shovels) 364 tons. The total weight is about 6000 tons [4].

The new environmentally safe energy source in the field of nanobiology is called osmotic energy. Energy is generated by contacting fresh and salt water through a membrane with a thickness of three atoms. The potential of such a system is enormous. According to the calculations, a membrane with an area of 1 m<sup>2</sup>, 30% of which is covered by nanopores, is able to produce 1 MW of electricity. Investing in the development of this technology of energy generation is highly profitable, because all the materials are often

found in nature, and the whole model is easily increased to the industrial scale.

Investing in conceptual innovations for electricity production has become an incentive for the introduction of interesting projects and the development of a number of concepts for generating energy. Among such technologies there is air generation with the help of wind turbines Power Tree. The municipalities of some French cities are already investing in this technology.

The international cooperation in the field of energy allows to direct the investment resources to the global projects. The Netherlands, Denmark and Germany reached an agreement signed in Brussels on March 23, 2017, on investing in a joint construction of a large wind power hub in the North Sea.

The new artificial island with an area of 6 square kilometers will create on the largest sandy shrimp in the North Sea, which is called Dogger Bank.

This powerful hub will be the base for transmitting wind energy to the Netherlands, Denmark, Germany, the UK, Norway and Belgium. It is planned that more than 10,000 wind turbines will produce this type of energy.

The location of a power hub (island) must meet a number of requirements: optimal wind conditions, central location and relatively small depth.

Delivery, conversion and energy consumption implies unproductive losses.

According to the expediency (productivity) the final energy consumption is logically divided into two parts:

- 1) useful energy (energy consumption), which directly performs work;
- 2) unproductive energy (energy losses), lost in the conversion of heat generators, motors, and others.

In Europe, the problem of non-productive energy losses exists at all the stages of the transformation of energy and reaches an extraordinary size. Specific proportion of unproductive losses exceeds 62%. This is according to the International Energy Agency.

Considering the advantages of investing into the alternative energy, it should be emphasized that the share of unproductive losses in the use of the RES is almost absent.

Thermal energy costs are determined by the results of energy audit using the thermal imager. On the display of the thermal imager you can observe the temperature distribution of the object studied. In building structures

and elements of the engineering infrastructure of the building the warmer the color of the site, the higher the temperature on the real object. This allows at first sight to determine the zones of the energy costs.

An example of reducing energy consumption in transport is the use of electric motors. If a standard car engine spends only 15% of its energy from fuel combustion that merges into a fuel tank and the rest is lost in the form of heat, then the electric vehicle uses a target of 80% of the resource.

The model of the world energy system, which operates on the basis of 100% of the RES, has already been developed. This new and unique development demonstrates how a power system, in which the main energy sources are renewable energy sources, can work [9].

The model shows how electricity production can be organized to cover the demand every

hour of the calendar year. This development involves finding the most economical solution for the RES-electric power system. The optimal combination of generation, storage and logistics network economy provides electricity costs in the area of approximately 55 – 70 euros per megawatt-hour in all the major regions of the world.

The European Union under the program “Energy Europe” has supported another Repowermap conceptual project since 2012. Until nowadays, more than 55000 objects of the RES have been mapped available in 10 languages.

Similar information on the location of renewable energy systems stimulates investments. The support and development of such projects contributes to the creation of a positive investment climate in the regions, and investors, in their turn, have additional motivation.

## Conclusions.

The energy crisis once again proves the dependence of Ukraine on imported gas, nuclear fuel, and now coal, which has to be bought. The difficult situation requires new approaches to the industry reform, the search for the most energy-efficient ways. Aspiring to Europe, it is worth paying attention to the experience of the developed countries that reorient their energy to the alternative energy sources that are not dependent on the exhaustive resources.

The European integration processes should bring the national system of energy generation and energy consumption to the European standards. The construction of efficient energy management and rational energy policy requires a systematic approach, both at the microeconomic level and in the public sector.

One of the most promising incentives for the development of the alternative energy is the “green” tariff – a mechanism for encouraging energy production, which gives state guarantees to producers, that the energy produced by them will be purchased at higher prices than traditional energy producers’ energy.

And the most important fact is that the introduction of energy saving technologies can reduce the import of energy resources and reduce the political pressure on our country from the exporters of oil and gas. In addition, reducing the energy component of the cost of production allows Ukraine to become competitive on the foreign markets.

Further research should be aimed at implementing modern control and accounting methods for the efficient use of resources and energy. Also these methods should prevent unproductive losses in energy consumption.

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