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**TENDENCY AND PROSPECTS ASSESSMENT  
FOR THE DEVELOPMENT OF “GREEN ENERGY”  
IN THE CONDITIONS  
OF SUSTAINABLE DEVELOPMENT**

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**TENDENCJA I OCENA PROGNOZ ROZWOJU  
„ZIELONEJ ENERGII”  
W WARUNKACH ZRÓWNOWAŻONEGO ROZWOJU**

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**Summary:** The article formulates the scientific research: consideration of the prospects for development of the renewable energy in the world and in the European Union; the analysis and the condition of the energy strategy of Ukraine and the two projects of a new document – Energy Strategy of Ukraine till 2035; and the exploration of the strategy development prospects of “green energy” in Ukraine. The aim of the research is to evaluate the prospects of the development of “green energy” in Ukraine by means of analysis and synthesis of the power strategies of the countries of the world, Europe, as well as Ukraine. Ukraine has committed itself to reduce greenhouse gas emissions, having signed Paris agreement on climate change on April 22, 2016. It has a direct impact on the development of energy sector and affects the strategy to expand the use of renewable energy.

**Keywords:** renewable energy sources, energy strategy.

**Streszczenie:** Artykuł formułuje badania naukowe skupiające się wokół takich zagadnień, jak: uwzględnienie perspektyw rozwoju energii odnawialnej na świecie i w Unii Europejskiej; analiza i stan strategii energetycznej Ukrainy i dwóch projektów nowego dokumentu – Strategia energetyczna Ukrainy do 2035 r.; eksploracja perspektyw rozwoju strategii „zielonej energii” na Ukrainie. Celem badań jest ocena perspektyw rozwoju zielonej energii na Ukrainie poprzez analizę i syntezę strategii energetycznych krajów świata, Europy, a także Ukrainy. Ukraina zobowiązała się do ograniczenia emisji gazów cieplarnianych po podpisaniu paryskiego porozumienia w sprawie zmian klimatu 22 kwietnia 2016 r. Ma to bezpośredni wpływ na rozwój sektora energetycznego i oddziałuje na strategię zwiększania wykorzystania energii odnawialnej.

**Słowa kluczowe:** odnawialne źródła energii, strategia energetyczna.

## 1. Introduction

Nowadays an awareness of the necessity of energy efficient measures is spreading globally. The reduction of carbon emissions is the solution of the problem to improve energy security and the prevention of global climate change. The threat of global warming and exhaustion of fossil fuels and other factors force countries to change the structure of the energy sector significantly. They are developing and implementing the strategies to reduce total energy consumption by implementing energy efficient technologies and replacing traditional energy sources with renewable energy ones. Ukraine has also committed itself to reduce greenhouse gas emissions, having signed Paris agreement on climate change on April 22, 2016. It has a direct impact on the development of energy sector as the major source of greenhouse gases.

In general, solving this problem, European countries are involved in energy balance alternative and renewable energy sources (RES). This allows to improve the situation in several areas: economic – reducing energy dependence, environmental – reducing emissions in the atmosphere, social – creating new industries and new jobs.

According to the Paris Agreements, each country, depending on the circumstances and its national priorities, undertakes the most ambitious commitments to reduce emissions. In addition, it was decided that each of the signatory countries would provide low-carbon development strategy to 2020 that should explain how a country would reach this figure to reduce emissions and timing to the middle of this century. Another feature of the Paris Agreement is a number of provisions relating to strict requirements to provide assistance to the developing countries – which are particularly vulnerable or very poor in order to fulfill these obligations [Trofimova 2016].

Ukraine ratified the Paris Agreement in July 2016, having shown a high degree of responsibility for solving common environmental problems by switching to low-carbon development, reducing the risks associated with the adverse effects of climate change, coupled with the provision of sustainable development.

## 2. The conditions and prospects of the development of the renewable energy in the world and in the European Union

Therefore, we find it necessary to consider the energy strategy of different countries and the place of renewable energy in them.

### 2.1. Danish energy strategy features

The government of Denmark ratified the “Energy Strategy 2050” in 2011, which presented a proposal for achieving long-term goals – national independence from coal, oil and gas in 2050. This promising strategy based on the findings of the

Commission on Climate Change and the results of previous policies and energy deals, establishes the approaches necessary to achieve long-term energy goals of Denmark, and clearly defines the medium-term action for the government. Another aim of the strategy is to ensure the country's energy sector and Danish position as a world leader in energy, climate change prevention and environmental protection. The strategy of Denmark will also achieve other goals and commitments, such as climate and energy package objectives of the EU and the Energy Agreement 2008. The government also wants the country to be among the top three countries for the successful implementation of renewable energy by 2020 and to become one of the most energy efficient countries in the Organization on Economic Co-operation and Development in 2020 too [Danish Energy Strategy 2050 2011]. Thus, a significant expansion of renewable energy means that Denmark earlier than other countries will receive the largest share of renewable energy in its system. By 2020, the consumption of biomass, wind, biogas and bio-fuels will grow due to existing and new technologies. With a significant increase in the use of solid biomass, biogas and bio-fuels, bio-energy will continue to occupy a large part of the total consumption of renewable energy in 2020 [Danish Energy Strategy 2050 2011].

## **2.2. Austrian energy strategy features**

Today Austria energy strategy is based on renewable energy, implementation of energy efficiency in business sphere and the security of delivery. Renewable energy sources are currently in the second place in the structure of energy consumption in Austria (30%), after oil (36%); 58% of all renewable energy is the biomass and organic waste. Austrian Energy Strategy till 2020 is aiming at increasing the share of renewable energy sources in gross final energy consumption up to 34%. Additionally, the implementation of energy efficiency and energy saving is playing an important role and because of this it is being planned to keep renewable energy till 2020 at the level of 2005 (about 1150 units of measurement per year). Without any use of energy efficiency measures, gross final energy consumption in the country in 2020 would increase by 200 units of measurement per year. Nowadays in Austria there are debates at the community and government levels on the necessity of a new strategy with great timing and ambitious plans. Austrian Association of Renewable Energy proposes to adopt a new energy strategy at least until 2030 with the following key goals: reducing final energy consumption by 940 units of measurement per year compared with 1990 and increasing the share of renewable energy till 60% and reduce greenhouse gas emissions by 60% by 2030 [Geletuha, Zhelezna, Prahovnik 2015].

## **2.3. Swedish energy strategy features**

Energy policy in Sweden is guided by two Swedish government laws which were approved by the Parliament in Sweden in 2009. Switching to a policy of sustainable development and environmental protection, competitiveness and long-term stability

of the country brings a new level outside the trading market of the European Union. In this case, 2/3 of the emissions should be reduced directly in Sweden and 1/3 – due to investments in other EU countries or with the use of flexible economic mechanisms of trade; at least 50% – the share of renewable energy strategy in gross final energy consumption and 10% – the share of renewable energy in the transport sector.

Long-term priorities are the following: Sweden is aiming at the gradual substitution of fossil fuels in heating systems till 2020. In 2017 the government as a part of changes to its strategy to expand the use of renewable energy decided to reduce energy consumption in the whole country by 43% by 2035, compared with the levels in 2000 [Swedish Energy Strategy 2016].

#### **2.4. German energy strategy features**

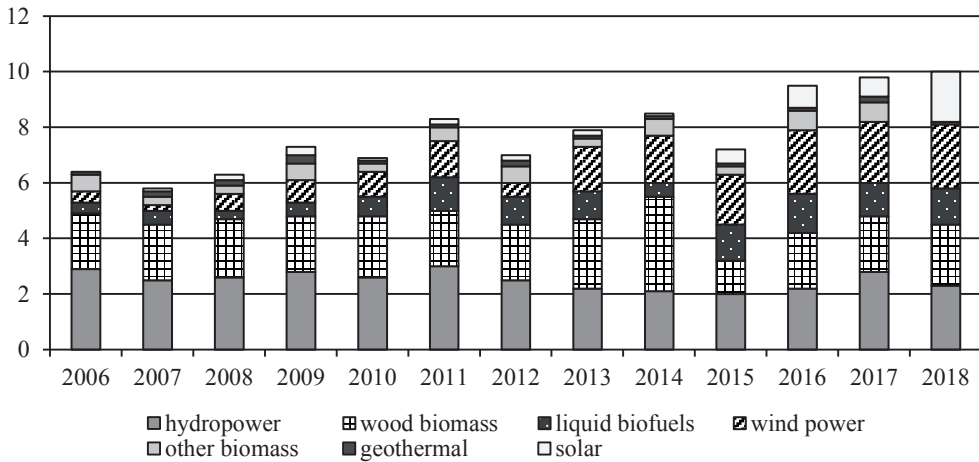
German energy strategy till 2050 (adopted in 2010) provides a complete rejection of the use of nuclear energy by 2027. The implementation of the plan began with the suspension of eight oldest nuclear power plants. Renewable energy strategy was identified as the main component of the power structure of the country in the coming future. Also, legal mechanisms were developed to stimulate the development of renewable energy and energy efficiency. In 2050, the contribution of renewable energy to the total final energy consumption should be 60% and power consumption 80%. This primary energy consumption will be reduced by 20% in 2020 and 50% in 2050 from the level in 2008. The housing stock in Germany was identified as the major sector for implementing energy efficiency measures. The concept of energy efficient buildings, as outlined in the energy strategy till 2050 includes three main points: the reduction of heat consumption by 20% by 2020, reduction in demand for primary energy in the residential sector by about 80% by 2050 (it will require a doubling of current renovation rates – from 1% of the housing per year to 2%), and making all new buildings “energy efficient” from 2020 according to specific indicators of energy consumption [Geletuha, Zhelezna, Prahovnik 2015].

#### **2.5. American energy strategy features**

In 2014 President Obama proposed the so-called “Comprehensive Energy Strategy”, which key element is the development of renewable energy, primarily electricity generation. In particular, it is planned almost to triple the amount of electricity from renewable energy sources – up to 20% in 2030 (excluding hydropower). Greenhouse gas emissions at the US power plants have to be decreased by 32% till 2030 [EIA 2017]. According to the organization – U.S Energy Information Administration which was published in March 2017 the wind energy capacity at the end of 2016 was 81 gig watts (GW) (Figure 1).

EIA expects that the increase in production capacity will bring total capacity to 95 GW of wind by the end of 2018. Solar energy is expected to be the fastest growing

quadrillion Btu



**Fig. 1.** US renewable energy supply (2017-2018 – projections)

Source: adapted by the authors from [EIA 2017].

source of renewable energy in the forecast period, with a total capacity of utility-scale increasing by 44% from the end of 2016 to 31 GW in 2018. With this level of growth, solar energy is expected to be 1.4% of the total utility-scale electricity production in 2018. After a decline of 1.9% in 2016, energy-related emissions of carbon dioxide (CO<sub>2</sub>) are projected to decrease by 0.2% in 2017 and then grow by 1.6% in 2018. The energy emissions of CO<sub>2</sub> are sensitive to weather changes, economic growth and energy prices.

## 2.6. Indian energy strategy features

India presented its targets under the climate agreement in Paris. India seeks to reduce emissions intensity by 33 to 35% compared with 2005 till 2030 the long-term commitments to curb greenhouse gas emissions. India plans to launch new initiatives that prioritize policies for solar, wind and energy efficiency, green infrastructure, and cleaner fuels while attracting climate financing. As a major emerging economy with a growing population, India's strong emissions intensity reduction and clean energy goals are significant gains in the global fight against climate change. Key features of India's INDC include: target 40% of electricity from non-fossilized fuel based energy sources by 2030, with the support of technology transfer and financing climate change adaptation strategy for increasing investment in development programs in sectors vulnerable to climate change, including agriculture, water resources, Himalayan region, coastal areas, health and disaster management; create an additional

flow of carbon from 2.5 to 3 billion of tones equivalent to CO<sub>2</sub> by increasing forest areas by 2030 [Jaiswal 2015]. As expected, India and other developing countries did not indicate absolute reduction of the light and energy problems, but rather focused on the development of a low carbon economy. Objectives are a central focus on the development of clean energy. Earlier this year the Modi government announced for 2022 clean energy targets of 175 giga-watts (GW), with 100 GW of solar, 60 GW of wind and 5 GW for hydropower. Energy efficiency is another important application of significant impact, given that most of the infrastructure of India which will exist by 2030 has not been built yet.

### 2.7. Saudi Arabian energy strategy features

“The Kingdom of Saudi Arabia took a decision in 2040 to completely eliminate the use of fossil fuels. Conventional oil and coal will be replaced by renewable sources – solar and wind energy. To achieve this goal, the government is planning to invest 109 billion \$ US in infrastructure development of solar power plants for the next 20 years. The installed capacity of these plants is expected to reach 41 GW in 2040” [Geletuha, Zhelezna, Prahovnik 2015, p. 26].

## 3. Analysis and conditions of energy strategy of Ukraine

At present, the Energy Strategy of Ukraine which was approved by the Cabinet of Ministers of Ukraine in summer of 2013 is valid till 2030. Regarding the tasks and areas of the Energy Strategy of Ukraine the necessity is stated to create preconditions for a substantial reduction in energy intensity of the economy by introducing new technologies, advanced standards, modern systems of control, management and accounting, transportation and consumption of energy products and the development of market mechanisms to encourage energy conservation.

The organization of major events of energy strategy will achieve the following results:

- full support of the growing demand for electricity due to urgent modernization of hydroelectric power station, the extension of the lifetime of nuclear power plants, significant investments in modernization and expansion of the electric grid economy,
- increase of gas production to 40-45 bln cubic meters per year and access to 90% of domestic consumption of gas,
- full support of the demand for coal by increasing the cost-effective coal production up to 75 mln. tons per year (and coke up to 40 mln. tons per year).

Thus, the strategy based on the principle of maximum to supersede the existing old facilities, ignored the issue of environmental safety and bet on the most “dirty”

and outdated energy sources. Energy strategy based actually on the continued operation of nuclear power plants increases the risk of accidents. Strategy (baseline) involves the growth of energy consumption by 25% in 2030 (238,1 million of tons of conventional fuel) compared with baseline in 2010 including the planned substantial increase in electricity consumption – by 55% in 2030 compared with 2010.

The strategy of Ukraine concerning renewable energy sources is controversial. Under the strategy, the government should encourage the development of renewable energy to reduce fossil fuel resources and the negative impact on the environment.

However, the development of renewable energy is based on economic competition with conventional energy sources without government's subsidy as for renewable sector or related industries.

Also note that, in the current energy strategy there are hardly specific targets for the development of renewable energy – it is just renewable energy in gross final energy consumption which is to be achieved in 2020.

Thus, on July 1, 2016 the total capacity of Ukrainian facilities “green” generation facilities including solar and wind energy, small hydro and biomass power plants (bio-gas-stations) exceeded 1028 MVt. If we talk about specific share of renewable energy in the total energy of the country, this figure was just over 2% [Berezovs'ka 2016].

Therefore, following steps have to be taken by the state: increasing the attractiveness of exploration and development of renewable energy sources that have a high probability of economic payback in the future, the most promising in terms of production in Ukraine, supporting the development and implementation of competitive technologies, encouraging localization of necessary equipment.

Therefore, the current energy strategy of Ukraine requires periodic adjustments. Taking into consideration the drawbacks of the current energy strategy and commitments undertaken by Ukraine on its accession to the Energy Community Renewable Energy, the National Action Plan for Renewable Energy until 2020 was adopted by government on 1 October 2014 [Resolution of Ministry...2017]. The State Agency of Ukraine for Energy Efficiency and Energy Saving is responsible for the development of the National Action Plan for Renewable Energy in the period of 2020. In the Energy Strategy of Ukraine the state energy efficiency was also developing the part of the electricity and renewable capacity in the period to 2030 and the development of heating and transport sectors in the technology allocation. According to the National Action Plan for Renewable Energy the share of energy from renewable sources in gross final energy consumption will reach 11% in 2020, which means the combined use of energy from renewable sources at 8,53 million of tons of conventional fuel per year (357 units of measurement per year). In 2030 the estimated use of energy from renewable sources will be 15,5 millions of tons of conventional fuel per year (649 units of measurement per year) “without any



changes” scenario. That share will reach 17,7% of the estimated gross final energy consumption in the amount of 87,636 million of tons of conventional fuel per year. Taking into account the anticipated growth in gross final energy consumption by 32% over the period of 2009-2030, the overall share of energy from renewable sources will be 6 times higher.

Thus, favorable conditions should be provided for the development of renewable energy, which is required by the legislation. The state should also support the development and implementation of competitive technologies and the localization of the necessary equipment. Such measures will create a basis for further reduction of building stations costs and the expansion of renewable energy.

#### 4. Conclusions

Based on the research performed, the following conclusions may be made. The conducted analysis showed that contemporary Ukrainian power stations consuming Russian nuclear fuel, Russian natural gas and Donetsk coal from the zone of antiterrorist operation remain non-alternative power suppliers in Ukraine. Independence from traditional fuels can be achieved through the introduction of renewable energy sources and a long-term prospect (up to 2050) should follow the example of countries, which aim at switching to 50% or more “green energy” and reducing greenhouse emissions. Second, it is important to finalize and adopt the Energy Strategy of Ukraine until at least 2035 with ambitious goals concerning renewable energy and energy efficiency. In Ukraine, almost 80% of total final capacity of renewable energy is biomass technology

The synthesis of energy strategies of European countries has been determined: the introduction of energy strategy of Austria for the major renewable energy sources in this country is biomass and organic waste; the energy saving of the housing stock in Ukraine (a topical issue) including heating and (that is why) the introduction of elements of the concept of energy-efficient houses in Germany in this area and adding the main provisions to the Energy Strategy of Ukraine.

The intensification of energy saving at industrial enterprises of Ukraine is impossible without the replacement of traditional sources of energy with the alternative once. That is why the experience of European countries in using the potential of heat emissions, flue gases, waste water, solid household waste, generation of energy through heat pumps, solar collectors and biogas plants is important. In this case, the Swedish energy efficiency program in the energy-intensive industry is useful for the strategy of Ukraine.

Therefore, in order to fulfill the commitments undertaken by Ukraine towards the European Community in relation to the transition to alternative energy sources, it is necessary to improve the Energy Strategy of Ukraine with more ambitious targets for renewable energy and energy efficiency.



## References

- Berezovs'ka, Y., 2016, *Відновлювана енергетика. Точки зростання*, <http://tyzhden.ua/Society/175474> (access 1 March 2017).
- Danish Energy Strategy 2050, 2011, *From coal, oil and gas to green energy*, <http://old.efkm.dk/sites/kebmin.dk/files/news/from-coal-oil-and-gas-to-green-energy/Energy%20Strategy%202050%20web.pdf> (access 12 April 2017).
- EIA, Short-term energy outlook 2017, [https://www.eia.gov/outlooks/steo/report/renew\\_co2.cfm](https://www.eia.gov/outlooks/steo/report/renew_co2.cfm) (access 19 April 2017).
- Energy Strategy of Ukraine till 2030, 2013, *Розпорядження Кабінету Міністрів України №1071 від 24.07.2013 року*, <http://zakon5.rada.gov.ua/laws/show/n0002120-13/paran3#n3> (access 13 April 2017).
- Geletuha G., Zhelezna T., Prahovnik A., 2015, *Аналіз енергетичних стратегій країн ЄС та роль відновлювальних джерел енергії в них*, Біоенергетична Асоціація України, <http://uabio.org/activity/uabio-analytics> (access 13 April 2017).
- International Energy Outlook, 2017, [https://www.eia.gov/outlooks/ieo/pdf/0484\(2017\).pdf](https://www.eia.gov/outlooks/ieo/pdf/0484(2017).pdf), (accessed 24 April, 2017).
- Jaiswal A., 2015, *India commits to accelerate clean energy and climate action, clearing path to Paris climate talks*, [http://switchboard.nrdc.org/blogs/ajaiswal/india\\_commits\\_to\\_accelerate\\_cl.html](http://switchboard.nrdc.org/blogs/ajaiswal/india_commits_to_accelerate_cl.html) (accessed 1 March, 2017).
- Resolution of Ministry Cabinet of Ukraine #902-p of 01.10.2104, *Національний план дій щодо відновлювальної енергетики на період до 2020 року*, <http://zakon4.rada.gov.ua/laws/show/902-2014-%D1%80> (access 18 April 2017).
- Swedish Energy Strategy, 2015, <http://www.bfe.admin.ch/energiestrategie2050/index.html?lang=en> (access 22 April 2017).
- Trofimova I., 2016, *Паризька угода дасть поштовх до модернізації української економіки*, <https://www.oporaua.org/zhytlo/43407-iryna-trofimova-paryzka-uhoda-dast-poshtovkh-do-modernizat-sii-ukrainskoi-ekonomiky> (access 23 April 2017).