

LOCAL DEVELOPMENT OF ALTERNATIVE ENERGY IN THE CONDITIONS OF GLOBALIZATION AS A FACTOR OF REDUCING RISKS AND MODERNIZING THE ECONOMY OF THE COUNTRY

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Abstract. The main direction of modernization of the world energy is the development of the so-called alternative (unconventional) energy, which implies the use of sources, technologies and forms of organizing energy production other than those currently dominant in a given country (region). The diversification of the economy, achieved through the development of alternative energy and other components of "green" growth, makes it possible to mitigate the crisis situation, the problem of employment in particular, and at the same time enhances the competitiveness of energy producers by obtaining new promising niches in the world market. When assessing the significance and prospects of alternative energy, we should not talk about replacing conventional sources, but about supplementing, diversifying the existing base of energy production at the local (regional) level with less capital-intensive installations on local renewable energy sources.

Key words: Alternative energy, Globalisation, Local democracy, Strategic planning, Public administration.

1 Introduction

The engine of the globalisation process is the modernisation and transition of the world economy, primarily industrialised countries, to a new technological order, which, along with a qualitative update of the technological base, an increase in production efficiency and the competitiveness of the economy, is designed to improve the quality of life and living environment. The foreign economic policy of "green" growth, implementing this transition, was officially adopted by the OECD in 2009 as a strategic direction for the development of all member-countries of this organisation for the long-term period (until 2030) and more distant period (until 2050) [1].

The modernisation of the energy base of the economy is the foundation of "green" growth, which is conditioned by at least three reasons. The first reason is the enduring importance of the energy sector, which plays a strategic role in economic development and security at all levels (national, regional and international) throughout modern history. According to the forecasts of the International Energy Agency (IAE), global energy demand will grow by 1/3 by 2035 [32].

The second reason is the increasing depletion of the most accessible and profitable reserves of conventional energy resources and the rise in prices for them, as well as the shift of their production to areas with extreme natural conditions, with hard-to-recover reserves of hydrocarbons, etc., which significantly increases the cost of these resources. For importing countries, this means heightening energy security concerns [77].

The third reason is global climate changes caused by an increase in the concentration of greenhouse gases in the atmosphere, which are directly linked by the international climatological community to man-made emissions, primarily from energy facilities [33]. According to the IAE forecast, as a result, the average global temperature by 2100 may increase by 3.6°C. The economic policy of Ukraine is still weakly taking into account the climatic factor and the need to reduce greenhouse gas emissions, giving an unconditional priority to reducing the energy intensity of production and energy saving in order to increase the efficiency and competitiveness of the national economy.

In the foreseeable future, the potential of macro structural transformations for the growth of energy efficiency of the economy will be limited. Priority should definitely be given to technological modernisation, primarily in the real sector of the economy [43, 44].

In the near future, the center of gravity of the state innovation policy in Ukraine should be shifted to the real sector, primarily to industrial and energy enterprises, giving the excessive emphasis of the current policy on high technologies directly in the information and communication sector.

The factor of climate changes – as a real reason (if we take into account the mentioned IAE scenario) or, which is much more likely, as a convincing pretext and catalyst for qualitative changes in the economy, as well as a tool for limiting counterparties and an incentive for encouraging domestic producers in the competition for an accelerated transition to a new technological way of life – will play an increasingly prominent role.

2 Literature Review

Due to the limited resources, society always faces the problem: how to distribute them so that to achieve the best results. The issue of resource depletion also applies to energy [1]. Despite the fact that the lion's share in total energy production is occupied by traditional sources, the share of alternative energy is growing every year. In the second half of the XIX century Jevons noted that increasing energy efficiency leads to increased demand for energy sources [57]. Thus, today the question arises not only about improving the efficiency of traditional energy sources and their waste-free use, but also about finding new types of energy [78].

In the world market, the demand for alternative energy has a steady upward trend, it is connected with limited resources for energy from traditional sources, the ever-increasing cost of fuel and energy resources, the need to protect the environment, access to cheap energy sources.

Various scientists have studied the problems of renewable energy development, but today there are many unresolved issues regarding the introduction of energy-saving technologies in Ukraine [6], namely: ways of financing, uncertainty about the alternative energy to be developed, failure to implement governmental programs to increase the share of renewable energy, energy complex, lack of specific levers of state influence on producers and consumers of unconventional energy.

3 Materials and Methods

The main direction of modernisation of the world energy sector is the development of the so-called alternative (unconventional) energy. Its broad interpretation, which we also adhere to, implies the use of sources, technologies and forms of organising energy production other than those currently dominant in this country (region) – energy efficient technologies (including cogeneration), as well as environmentally friendly, low-carbon, energy sources, including renewable sources (RES) and nuclear power plants, which are gradually replacing hydrocarbon fuels.

According to IEA and USEIA forecasts, the share of alternative energy sources will grow. As noted by the IAE, the continued growth of hydropower and the rapid development of wind and solar energy have strengthened the position of renewable energy as an integral part of the global energy mix [8, 9, 11, 12]. According to the optimistic forecasts of this report, by 2035, renewable energy sources alone (excluding nuclear power plants) will provide almost one third of the total electricity generation [62].

Thousands of companies around the world have set carbon-neutral goals: implementing energy efficiency measures, purchasing or producing electricity from renewable sources, abandoning fossil fuels, electrifying production processes and transport.

Energy efficiency and electrification measures are extremely important to reduce the harmful effects on the environment [17-19, 21]. However, the question arises: *what resources will electricity be generated from?*

It is assumed that in Ukraine by 2050 the share of electricity in the structure of energy consumption by industry will be 50% compared to almost 25% in 2019.

New technologies will not only reduce the use of carbon-intensive energy, but also help optimise their use in production processes [25-27, 30, 31]. The introduction of new technologies will play an important role, especially in the two most energy- and carbon-intensive industries: metallurgy and cement.

Today in Ukraine, as well as in the world, there is an exacerbation of the problem of shortage of fuel and energy resources, which affects not only the conditions of the national economy, but also the general vector of development of the country [2-5]. Such conditions worsen the level of energy supply and the predictability of the economic situation in Ukraine. Today, Ukraine can meet its own fuel needs with less than half of its total energy consumption. There are two ways to solve this problem:

1) Find new energy importers who will supply at lower prices than they are today [7];

2) To develop unconventional types of energy for which there are favorable conditions. In the context of limited resources for traditional energy production, in our opinion, the development of alternative energy is more promising and reliable, which will ensure energy, economic, and for Ukraine in certain issues political independence from external factors.

4 Results and Discussion

Alternative energy is an energetic industry that specialises in obtaining and using energy from renewable sources. Renewable energy sources include energy from solar radiation, wind, seas, rivers, biomass, heat of the Earth, secondary energy resources that exist constantly or occur periodically in the environment [37-39, 41]. The world practice of energy development shows that the developed countries of the world are not only actively looking for alternatives to fossil fuels, but also increasing the consumption of alternative energy sources. Renewable energy sources already play an important role in energy supply. When renewable sources are used, the demand for traditional ones' decreases [64]. This addresses the issue of environmental conservation, as well as the limitations of traditional energy resources.

In world practice, there is a change in the structure of energy consumption and production with a tendency to increase the share of renewable energy resources, which has a long-term nature and is designed for relatively stable and predictable economic conditions. In addition, the amount of investments in alternative energy is growing every year, which indicates the prospects of this type of energy and the trend of growth in the near future.

To further increase the production and consumption of alternative energy many countries around the world are developing programs for the development of alternative energy, aimed at providing this type of energy not only to industrial enterprises but also to households [45-51]. Thus, the use of renewable energy sources is a powerful market with a powerful multiplying effect in education, science and industry, which requires and absorbs significant amounts of investment. It is noteworthy that one of the leading countries investing in RES is China, not just developed countries [13].

Ukraine has prepared a draft of the "Second National Defined Contribution of Ukraine to the Paris Agreement" (NVB2). The document, in particular, states that renewable energy can replace the old coal generation.

It is expected that in 2030 the share of electricity production from renewable sources will be about 30% (including large hydropower plants).

According to the results of the first quarter of 2021, the share of electricity production from renewable sources was 5.5%, and together with large hydropower plants - 11.4%. That is, the share of "green" electricity in consumption is 11.4%.

With the current political trends in the country, achieving the goals of NVB2 in 2030 seems illusory.

What should a responsible business do that has set goals to consume 30%, 50% or 100% of "green" energy now or in the coming years? Let us consider the options.

4.1 Installation of RES for Own Consumption

According to IFC experts, by 2030 the potential of Ukrainian enterprises to install SES for their own consumption will be 2-3 GW, and the amount of investment for the implementation of these projects – 1.5-2 billion dollars.

Investing in the installation of RES, businesses of all sizes – from small to large industrial – get only benefits. Against the background of constantly rising energy prices, using, for example, the roof of your company to install solar panels is a very smart decision. This allows to replace partially the consumption of "dirty" electricity with "green" and save on energy costs.

The fact is that the cost of RES technologies is declining every year. Capital investments per 1 kW of solar power plant in Ukraine in 2021 are in the range of 550-750 dollars.

At the same time, the average cost of 1 kW of electricity, taking into account the cost of transmission, distribution and delivery, costs the industrial consumer UAH 2.4-3.4 including VAT. Therefore, the establishment of RES for own consumption will reduce the enterprise's electricity costs in the long run.

Another advantage of projects for own consumption is the lack of costs for connection to the network and obtaining permits [10]. Solar panels can be installed on the roofs or walls of commercial premises, warehouses, factories, schools, hospitals. Solar panels can be used to cover car parks. Regional enterprises with a high level of consumption should consider the installation of wind turbines and bio power plants [52-56]. Businesses can also install energy storage systems. They allow to accumulate it when it is generated in excess, and use it later. In this way, it is possible to form a more stable schedule for providing enterprises with "green" energy during the day.

You can use solar energy not only to produce electricity, but also to heat water. This is another measure to improve the energy efficiency of the enterprise [58-61]. Although the installation of solar panels in Ukraine is less popular than the installation of local SES.

An interesting area is agro-photovoltaics - a symbiosis of solar energy and agriculture. Solar panels are installed not only on the roofs of greenhouses, but also over fields of berries, potatoes and grain crops.

SolarPower Europe sees a threefold benefit in this technology: increased crop yields, reduced water consumption and renewable energy production [63, 67-71]. Agro-photovoltaics is seen in the EU as an important tool on the path to carbon neutrality.

Agriculture is the sector that has the most negative impact on the environment and climate change, through methane emissions from livestock in particular. The greenhouse effect of methane is 25 times higher than that of carbon dioxide [65].

Enterprises reduce the negative impact of livestock waste by producing biogas or electricity from it. In addition to livestock waste, crop waste is also used to produce "green" heat and electricity.

Ukraine as an agrarian country has significant potential for the construction of such projects, but their cost is much higher compared to solar and wind energy technologies.

4.2 Purchase of "Green" Electricity under Direct Contracts from the Producer

The amount of electricity that an enterprise can obtain from RES facilities installed to meet its own needs is usually insignificant.

The most effective and widespread way in the world to achieve a greater share of consumption of "green" electricity by the company is entering into long-term corporate contracts for the sale of electricity (PPA – power purchase agreement).

The buyer and the producer of RES record the cost of electricity produced for the period of the contract (usually 10-15 years) [14]. The owner of the power plant produces and supplies energy to the buyer's place of consumption through its own networks. For example, railways are big consumers of electricity.

In 2017, the Dutch railway company NS became the first company in the world whose trains run on energy from wind farms, giving its passengers the opportunity to make CO₂-neutral trips.

NS consumes about 1.2 TW of electricity per year. NS has entered into a direct electricity supply contract with Eneco for the amount of consumption.

French railway SNCF Voyageurs plans to consume 40-50% of electricity from renewable sources by 2025. They have recently signed a 20-year contract to supply electricity from a solar power plant under construction.

4.3 Do Corporate PPAs Work in Ukraine?

Over the last ten years, the development of solar energy has been gained due to the "green" tariff. However, the situation is changing. In 2020-2021, the state complicated significantly the development of large-scale commercial projects.

Reducing the level of the "green" tariff, the introduction of strict rules of liability for imbalances and violations of payment guarantees for purchased electricity have made solar energy unattractive to investors [34].

Nevertheless, solar energy technologies are becoming more attractive to consumers amid rising electricity costs and declining equipment costs. In particular, so-called corporate PPAs or direct electricity supply contracts are becoming increasingly popular.

Under the terms of such a supply, the producer of "green" electricity can sell it directly to the consumer under a bilateral contract of sale [66].

For such a supply electrical networks of transmission system operators or the so-called direct line from the power plant to the consumer's facility can be used. However, such activities have a number of shortcomings and obstacles for consumers and producers of electricity.

First, in order to conclude a bilateral contract for the sale of electricity, the consumer must obtain the status of a participant in the electricity market, take responsibility for imbalances and other related responsibilities [16]. Violation of these rules can lead to significant penalties and disruptions to electricity supply. This significantly increases the administrative burden and may only be relevant for large organisations.

Secondly, the cost of electricity will take into account the tariffs of electricity transmission organisations (NEC "Ukrenergo" and oblenergo) for distribution and transmission services.

Third, the implementation of such projects will require the connection of the station to the grid, which involves additional financial (payment for connection services) and organisational (approval of the feasibility study, technical conditions, project) costs.

Nevertheless, investments in generating capacity at consumer facilities can be realised.

To do this, partners can use the energy service agreement. Under this mechanism, the investor can install generating equipment and connect it directly to the consumer's facility.

The consumer will pay for the amount of savings, i.e. for the amount of reduction in electricity consumption under the main contract concluded with the electricity supplier.

The cost of such "negligence", i.e. energy savings, can be set by agreement of the parties at a discount from the market value of electricity.

What will the parties gain from the implementation of this mechanism?

Consumer:

- Receives cheaper electricity;
- Retains the ability to purchase electricity from its own electricity supplier;
- is not responsible for imbalances.

Investor:

- Receives stable terms and a fixed value of the contract for the long term;
- Reduces the cost of connecting the power plant to the grid.

In view of this, in the coming years we expect an increase in the number of such agreements in Ukraine for commercial real estate, shopping centres and industrial facilities that have significant electricity consumption and an area sufficient to accommodate generating equipment [15].

To achieve the goals of decarbonisation of the corporate PPA model will not be enough. The main part of the energy transition should be based on the development of industrial RES facilities. However, the unification of the mechanism of corporate [74-76] contracts for the purchase and sale of electricity will provide a significant contribution to the decarbonisation of Ukraine's economy.

4.4 For the "Green" Energy Transition, over 2 Billion Tons of Steel will be Required and the Interaction of Business with the State

The "green" energy transition is a global trend in climate and economic policy, which entails the need for a radical restructuring of entire industries. The role of metallurgy in this process is very important, since key decisions for achieving carbon neutrality in energy, construction, transport and mechanical engineering are based on the use of steel. According to the GMK Center, the implementation of plans for a global "green" energy transition in various industries by 2050 will require at least 2 billion tons of steel. Experts spoke about this at the round table "Features of the" green "energy transition and the role of metallurgy", organised by the GMK Center.

Due to the green energy transition, existing sectors of the economy will change their appearance. The construction, transport, energy and industrial sectors must be completely rebuilt, which will change the structure of the economy. This is impossible without metallurgy as a steel producer. The green transition requires green steel. In other words, metallurgy needs decarbonisation, but the decarbonisation of other industries depends on metallurgy. For a "green" energy transition, the consistency of state policy is very important, since the implementation of environmental goals is always the result of interaction between the state and business.

At the Ministry of Energy level, there are at least three "green" transition projects [35]. First, the KPMG consulting company is developing a National Energy Strategy. It is assumed that by the end of the year decisions on market models, incentives, balances will be known, and a forecast for the production and consumption of electricity will be formed. Second, consultancy Roland Berger is developing a draft National Hydrogen Strategy. The third project is related to updating the plan for the development of renewable energy, which is being written by one of the industry associations [36].

Several projects are moving towards converging on one point, in fact, laying the foundation for a nationwide strategy for a "green" energy transition. The approach to energy strategy in Ukraine is strongly biased towards energy independence.

4.5 "Green" Energy

All industries need green electricity to reduce CO₂ emissions. The IEA predicts a 2.7-fold increase in electricity production by 2050. By this time, almost 90% of electricity will be produced on the basis of renewable resources, which will create additional demand for steel for the construction of renewable energy facilities [20].

According to the GMK Center, the global energy sector will need 1.7 billion tons of steel for the "green" transition. This compares to current annual global steel production. The development of almost all areas of renewable energy and distribution networks is based on the use of steel.

Steel is used for the production of photovoltaic panels, pumps, tanks, heat exchangers in solar power plants, for the manufacture of power transmission towers in distribution and supply systems. Steel is also a basic material in renewable energy, where it is used, for example, for the manufacture of wind turbine masts. According to GMK Center's estimation, in 2021-2050 solar energy will need 566 million tons of steel, and wind energy – 1,129 million tons.

Now the share of "green" generation in the total energy mix reaches 8%, if we talk exclusively about the sun and wind. If we also add a hydropower component, then the share of renewable energy sources will be 12%. The energy strategy of Ukraine has a more ambitious long-term goal: by 2035, "green" energy should account for 25% of primary energy consumption.

The construction of new renewable energy facilities is impossible without investment in this industry. Attraction of investments, in turn, depends on the creation of transparent regulatory conditions, clear and equal rules of the game for all, and the fulfilment of government obligations to investors [72].

The government's position, recorded in the second nationally determined contribution to the Paris Climate Agreement, is that CO₂ emissions are supposed to be reduced only by reducing the use of coal. The development of alternative, "green" energy is considered to be quite a complex topic. When we have a dialogue between market players and the government, "green" energy will develop much faster.

4.6 "Green" Hydrogen

Although Ukraine has declared its desire to occupy the niche of a producer of "green" hydrogen for the European market, the implementation of these plans is still a question. To produce "green" hydrogen, "green" electricity is needed, however so far too little of it is being produced [24].

Hydrogen produced with the use of atomic energy, which could be produced by Ukraine – conditionally "yellow" – is not required by Europe. France, which also has a lot of nuclear power, is quite capable of producing it there. Therefore, they are ready to receive from us only "green" hydrogen, which will be produced using renewable energy sources.

The second problem that can impede the implementation of plans for the supply of new fuel to Europe is the lack of suitable

distribution channels [42]. The transportation of gas-hydrogen mixtures and hydrogen through the Ukrainian gas transmission system is practically impossible from the point of view of hydraulics. There will be a loss of resource on the way of pumping and other phenomena associated, for example, with gas withdrawal. The mode of movement of the gas-hydrogen mixture will be influenced by the groups of gas distribution networks and gas outlets connected to the main gas pipeline system. Then we will have to compensate for the pressure loss in the gas pipeline branch by the corresponding injection pressure of the hydrogen itself. These are very complex calculations that need to be constantly optimized.

According to Naftogaz's calculations, the use of pipelines for transporting gas-hydrogen mixtures and hydrogen is possible only if consumers' access to the gas transmission system is limited, and the length of the pipeline itself does not exceed 50-70 km.

But, probably, in the near future, hydrogen as a fuel may not be needed. Hydrogen technologies and carbon dioxide capture, which are now being actively discussed in our space and with which energy transformation is mostly associated with us, are just components of the strategy of global corporations, along with other measures. According to our observations, hydrogen is considered when electrification is impossible. Or when it is not possible to reduce emissions in other ways. That is, when other measures have not worked.

4.7 "Green" Building

A study by the GMK Center says construction and real estate are the world's top sources of greenhouse gas emissions. They account for 38% of global emissions, with construction and production of building materials accounting for 10% (3.5 billion tons of CO₂). Another 28% of emissions (10 billion tons of CO₂) are generated during the operation of buildings (operating emissions) as a result of energy consumption for heating, air conditioning, lighting, etc. [22]. In the coming years, significant efforts and investments will be directed to reduce emissions in this direction. The IEA expects construction sector emissions to fall by 50% by 2030 to meet its carbon neutrality targets. And by 2050, operating emissions should be reduced to zero.

It is possible to reduce emissions in construction and real estate by renovating and extending the use of existing buildings, using materials produced with lower emissions, using materials that can be recycled, and increasing the energy efficiency of buildings [40].

Recently, the concept of ZEB (zero energy building) is gaining popularity. These are buildings that generate as much energy as they consume, or even more. The concept envisages the application of a number of energy efficiency solutions together with renewable energy facilities. Moreover, these solutions are based on the use of steel for fastening solar panels, steel window systems, energy piles, sandwich panels, and so on.

The main part of operating emissions from buildings is indirect emissions [73]. Therefore, there is an alternative in the development of energy efficiency in buildings – the development of renewable energy. In other words, if the energy used by buildings during operation is "green", then the indirect emissions of buildings will be zero.

Investments in energy efficiency in buildings and the construction of "carbon neutral buildings" provide high returns at the macro level, much higher than the return on renewable energy: \$ 1 million investments in energy efficient buildings creates 15 workplaces, and \$ 1 million invested in renewable energy – only 2-3 workplaces.

4.8 "Green" Projects

In the post-Soviet space, the main problem of environmental projects is the insufficient level of their elaboration. According

to experts, this is why it is difficult to find funding for such projects.

In Ukraine and in the post-Soviet space, there are much fewer opportunities than, for example, in North-Western Europe [28]. But here, too, there is a number of organisations that are already confirming their interest in financing these projects. At the same time, they emphasise that the issue of financing is not a matter of finance. It is a matter of maturity and project readiness. Unfortunately, the projects that we see in the post-Soviet space look just like presentations on paper without relevant data, without models.

The topic of financing is considered at the highest level. We recently had a focused dialogue with the EU, and the key issue was the formation of a platform for financial instruments [77]. It was decided how Ukraine and the EU could participate in projects to decarbonise the economy. Unfortunately, this mechanism will not work without quality projects. The design and development of projects is the only way to get funding.

There are other difficulties in obtaining financing for energy transformation projects [78]. Among them: technological and economic uncertainty associated with innovative technologies, a long planning horizon, the need to involve various partners and a whole pool of funding parties in the project, which creates difficulties in coordination between them. Equipment delivery times are also of great importance – they can reach 18 months.

A powerful inflow of investments and the rapid pace of development of alternative energy have given rise to serious expectations among some analysts and politicians in a confident victory step for it and the "green" economy as a whole in the coming decades [29]. This is evidenced by numerous reports and forecasts, including specialised UN organisations, prepared with the participation of international experts, governing bodies and scientific structures of both developed and developing countries.

5 Conclusion

The development of alternative energy is gaining momentum in the world. Scientists are developing new technologies to help improve the efficiency of renewable energy, and the industry has a long-term perspective. An important argument in favor of the development of alternative energy is that it is actively developing in many countries of the world, including developed and developing countries. The dynamics of the development of alternative energy is predetermined by a number of factors, first of all, the preservation of the priority of ensuring the energy security of the countries-importers of fossil fuels, which are the leaders of the world economy.

An important role is played by the powerful multiplicative and anti-crisis effect of alternative energy. With regard to the multiplying effect, it is necessary to highlight the connecting and stimulating role of innovative environmentally friendly technologies that make up the production and technological basis of this energy sector.

Ukraine needs a transition to alternative energy. The main forms of renewable energy development are projects implemented by public and private enterprises, or in the form of public-private partnerships. This will make it possible to implement the following conceptual principles: solving the problem of energy, economic, social and political tension in the state; balancing the country's fuel and energy balance; ensuring environmental protection; reducing the likelihood of environmental disasters; creation of new workplaces; stimulation of secondary effective funds through the development of other industries, the creation of intellectual property.

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