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## **PROBLEMS AND TRENDS OF UKRAINE'S TRANSITION TO THE EU ENVIRONMENTAL AND ENERGY SYSTEM**

The article is devoted to the problems and trends of the transition to the ecological and energy system of the EU countries and Ukraine. It examines the essence and necessity of such a transition, as well as the transition levels at which countries are located and the corresponding energy clusters. The purpose of the scientific research is to analyse the levels of the energy transition of the countries of the European Union, to identify the problems and trends of their development, as well as to propose possible ways to further improve the energy policy of Ukraine in order to achieve environmental sustainability and energy security. The study found that the transition to an ecological and energy system is necessary to ensure sustainable development and reduce the impact on the environment. It is indicated that the EU countries are already making the transition to a new energy system with low carbon emissions, and are also actively using renewable energy. At the same time, Ukraine is at the initial stage of transition and has significant potential for the development of renewable energy and energy efficiency. At the same time, the problem of such a transition was identified, namely, excessive overloading of electricity consumers with tax pressure, which leads to a low level of consumption per capita. In addition, clusters of countries that are at different levels of transition to an ecological and energy system were identified. These clusters take into account the level of development of renewable energy and energy efficiency. The definition of these clusters can help countries in the development and implementation of national energy policies.

**Keywords:** energy transition; environmental and energy system; renewable energy; renewable energy sources; electricity consumption; EU countries.



**Formulation of the problem.** In today's world, the energy transition is one of the most important topics for states and international organizations. The countries of the European Union occupy one of the leading places in the world in terms of the level of development of energy technologies and the use of renewable energy sources. Ukraine's strategic vision is to join the EU. The process of energy transition is complex and long-term, as it requires significant investments and coordination of various sectors of the economy. In this regard, the problems and trends of the energy transition in the EU countries are an actual scientific topic. Over the past decades, the global community has been steadily growing in its attitude to environmental issues and reducing dependence on fossil fuels. Accordingly, the countries of the European Union are actively working on the implementation of the energy transition to more sustainable and renewable energy sources. Energy transition is a topical issue not only for individual countries, but also for the whole world. Due to the development of technology and scientific achievements of today, many countries, in particular the countries of the European Union, pay more and more attention to the environmental aspect of energy production and consumption.

However, in order to ensure environmental sustainability and energy security, EU countries and Ukraine need to deepen the implemented energy transition policy, as well as solve numerous problems and challenges related to this process. Therefore, the reliability of the operation of the electric power industry is a basic condition for both individual European countries and between governmental formations. Therefore, the role of uniting the energy systems of different countries is increasing and reaching the level of transnational and transcontinental energy systems. For the formation of such future networks, the energy transition is taking place in line with the concept of sustainable development and greening.

**Analysis of recent research and publications.** Energy transition is a fairly urgent topic of modern scientific research. Dubnevich et. al. (2021) assesses the influence of environmental policy information tools in stimulating the energy transition through the development of renewable energy sources (RES) in Ukraine. A fairly powerful system of research on the role and influence of tools on the implementation of the energy transition has been conducted (Melović and Ćirović, 2020; Rogge & Reichardt, 2016; Rosenow et. al., 2017). The problems of implementing the green energy transition lie within the interests of civil Ukrainian society. A prominent representative is the «Energy Transition» Coalition,

which is actually an association of non-governmental organizations that promote the intensive use of renewable energy sources.

The electric power industry requires increased research from the standpoint of finding measures to implement the sustainable development of the world economy. And for this, there is a need to assess the achieved level of the energy green transition of European countries and Ukraine, in order to ensure the reliable functioning of the energy industry of the 21st century, and to guarantee a stable supply of the national economy and the population with electric energy. In general, with a fairly intensive study of the energy transition of the 21st century, a gap is observed, which comes down to a comprehensive assessment of the level of individual countries in such an energy transition.

**Formulating the article goals.** The purpose of the research is to analyze the levels of the energy transition of the countries of the European Union, to identify problems and trends in their development, as well as to propose possible ways to further improve Ukraine's energy policy in order to achieve environmental sustainability and energy security.

Objectives of the study are:

- carry out a quantitative assessment of the level of the energy transition of European countries;
- assess the prospects of Ukraine's development in the direction of energy transition and integration into the EU.

**Outline of the main research material.** Important components of the energy transition are the planning and coordination of the actions of the government, business and public organizations, the development of the right strategy and the implementation of certain policies, energy sources such as solar, wind, hydro, geothermal and biomass.

The essence of the energy transition is that the change in technologies and sources of energy production should provide a more sustainable and ecologically clean path of development. This process includes a number of measures aimed at reducing emissions of carbon and other harmful substances into the atmosphere, reducing dependence on energy imports, improving energy efficiency, and increasing the use of RES.

One of the main aspects of the energy transition is ensuring the country's energy security and reducing dependence on external suppliers of oil and gas, which can pose a threat to the economy and national security. In addition, the energy transition helps to improve the state of the environment and the health of the population, reduce energy costs, stimulate innovation and new technologies, which in turn contributes to



the development of the economy and increasing the country's competitiveness.

legislative initiatives that contribute to the development of the energy transition. In addition, it is important to provide infrastructure for the production and supply of RES, develop technologies for energy storage and transportation, increase energy efficiency, and introduce new innovative solutions and practices in the energy industry.

The successful implementation of the energy transition also requires the involvement of various groups of society, including the population, the scientific community, and other interested parties. Communication and education about the importance of the energy transition and the possibility of using RES is also an important factor that will help increase awareness and support in this area.

In general, the energy transition is a complex process, but at the same time it opens up new opportunities for sustainable development of the country and reducing the impact on the environment. It is important to support and facilitate the development of this process by implementing policies and measures that stimulate the use of RES and reduce the use of traditional energy sources.

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The history of the energy transition begins at the beginning of the

20th century, when the first ideas about the use of renewable energy sources were born. In 1900, the American physicist Nikola Tesla proposed the idea of using solar energy to generate electricity. In the 1920s, windmills began to be used to mechanize agriculture in the United States and Europe.

During the 20th century, renewable energy technologies developed rather slowly, as cheap traditional energy sources such as oil, coal and gas came to the fore. However, in the second half of the 20th century, the growth of energy use and the growth of environmental pollution became problems that needed to be solved.

In the 1970s, debates began in the US and Europe about the energy transition, that is, about changing approaches to energy production and reducing dependence on traditional sources. In the 1980s, the first renewable energy support programs were established, such as the Feed-in Tariff program in Germany and the Renewable Portfolio Standard in the USA.

Since the beginning of the 21st century, major legislative acts have been passed aimed at reducing the use of coal and gas and increasing the use of renewable energy. Countries such as Germany, Denmark and Sweden have become leaders in renewable energy, introducing strong support programs to develop renewable energy and reduce the use of coal and gas. For example, Germany passed the Renewable Energy Act in 2000, which sets targets for increasing the share of renewable energy in the country's total production capacity.

The Paris Agreement, which was adopted in 2015, was also an important event in the history of the energy transition. The agreement stipulates that countries commit to reducing their emissions of greenhouse gases that lead to climate change and to promote the development of renewable energy.

Today, the energy transition is a global phenomenon, which is becoming more and more relevant in connection with the growth of global energy demand and the aggravation of environmental problems. Many countries are adopting energy transition strategies aimed at reducing the use of coal and gas and increasing the use of renewable energy, which will contribute to a greener world and reduce dependence on finite resources.

Regulation of the energy transition in the EU is carried out through special legislative and regulatory instruments. One of the most important documents is the European Energy Transition Strategy, adopted in 2015, which provides for the achievement of 3 main goals by 2030: reducing greenhouse gas emissions by 40%, increasing the share of renewable



energy in the total production capacity to 32%, and increasing energy efficiency by 32.5%.

Various tools were adopted to activate the energy transition, among which we can highlight:

1. The Renewable Energy Directive, which sets mandatory goals for the use of renewable energy sources in EU countries.

2. The Energy Efficiency Directive, which contains mandatory requirements for reducing energy use and increasing energy efficiency in EU countries.

3. The EU Emissions Trading System, which sets limits on carbon emissions and issues greenhouse gas emission allowances that can be bought and sold on the market.

4. Financial support of renewable energy and energy efficiency projects from the EU.

5. Measures regarding the development of renewable energy technologies and the reduction of the use of coal and gas.

Thus, the energy transition is an objective process of the further development of the energy industry and is implemented as a separate conditional stage of an ecological and energy nature. We emphasize that this is a conditional stage and refers to the era of energy development of humanity on the planet Earth. It takes place in the energy industry and is associated with the change of energy production sources and technologies to more sustainable and environmentally friendly ones. This process occurs both in connection with the need to reduce greenhouse gas emissions into the planet's atmosphere. The main goal of the energy transition is to reduce the use of traditional fuels such as coal, oil and natural gas, and move to the use of energy from the elements of the sun, wind and water.

From a theoretical perspective, the energy transition is explained philosophically. In a practical approach, it manifests itself in the assessment of indicators of the implementation of the relevant stations and volumes of electric current generation. This approach is scientifically narrow and superficial. Implementation of green technologies requires significant material and financial resources. In addition, it is necessary to take into account the level of scientific and technical potential of the country and especially its economic development. And this is generally a large number of macro indicators. Therefore, it is advisable to assess the level of the energy transition with a limited number of indicators.

Such indicators should be those that determine the essence of the process and from an economic approach. Namely, the main indicator should reflect the amount of electricity consumption. Other indicators

should take into account the costs of electricity production. In addition, it is necessary to take into account the contribution of renewable energy. From this approach, a set of indicators is formed: the price of household and industrial consumption without taxes and with electricity taxes; share of renewable energy and gross electricity consumption per capita.

Table 1  
Data for assessing the level of transition to the ecological and energy system of EU countries

EU countries	Household consumers without taxes, USD	Industrial customers without taxes, USD	Household consumers including taxes, USD	Industrial consumers including taxes, USD	Share of renewable energy sources in electricity production, %	Per capita (gross) electricity consumption, kWh
Austria	11,76	7,84	18,57	10,24	76,19	4979
Belgium	16,34	8,64	24,59	11,59	23,8	4880
Denmark	11,85	8,94	24,74	9,32	62,65	6339
England	19,3	13,05	20,28	13,66	40,7	4125
Finland	11,31	6,02	16,42	6,08	39,53	7169
France	11,05	8,03	16,62	9,89	25,02	3698
Germany	13,58	7,01	27,63	13,51	41,5	5487
Greece	12,63	10,14	16,49	11,74	35,93	7155
Hungary	6,76	6,54	8,58	6,83	13,66	12060
Ireland	18,99	12,61	21,55	12,61	36,4	5372
Italy	14,57	8,99	22,67	14,5	36	5742
Luxembourg	11,92	7,29	16,34	8,1	14,22	21584
Netherlands	13,4	6,87	19,58	9,02	30,39	6635
Norway	9,11	5,69	13,15	7,11	99	10418
Poland	11,09	8,62	18,31	8,71	17,17	6694
Portugal	9,87	7,08	18,31	9,68	58,43	4680
Slovakia	12,03	11,41	14,43	11,52	22,37	6012
Spain	18,51	10,24	22,68	10,6	47,1	4622
Sweden	6,89	4,87	13,57	4,91	75,7	3045
Switzerland	14	8,21	17,05	10,04	22,8	14797
the Czech Republic	12,69	8,82	15,01	8,91	14,54	4655
Turkey	5,67	5,86	7,02	7,02	35,2	4422
Ukraine	0,038	0,0041	0,046	0,037	8,1	2796

Source: calculated by the authors based on [6–8]

The calculation system itself is simple. First, we calculate the share of the tax burden on electricity consumption and derive its average value. Then the amount of electricity consumption per capita for renewable energy sources is calculated and we calculate the electricity consumption per capita due to renewable energy sources for the tax burden in EU countries and Ukraine. Based on this indicator, we determine the rank of the energy transition level.

**Table 2**  
 The level of evaluation of the ecological and energy transition of the EU countries and Ukraine

Energy clusters	Country ranks	EU countries	Share of taxes in household electricity consumption, %	Share of taxes in industrial electricity consumption, %	The average share of taxes on electricity consumption, %	Electricity consumption per capita due to renewable energy sources	Consumption of electricity per capita due to renewable sources of energy on tax burden
The transition has already been made	Base	Norway	44,35	24,96	34,65	10313,82	3573,89
		Denmark	108,78	4,25	56,51	3971,38	2244,37
	Ecological	Germany	103,46	92,72	98,09	2277,11	2233,68
		Austria	57,91	30,61	44,26	3793,50	1679,01
	Leader	Portugal	85,51	36,72	61,12	2734,52	1671,27
		Italy	55,59	61,29	58,44	2067,12	1208,07
Potential	Sweden	96,95	0,82	48,89	2305,07	1126,87	
	Ukraine	21,05	802,44	411,75	226,48	932,51	
	Netherlands	46,12	31,30	38,71	2016,38	780,49	
In the transition stage	Perspective	Switzerland	21,79	22,29	22,04	3373,72	743,49
		Luxembourg	37,08	11,11	24,10	3069,24	739,56
		Finland	45,18	1,00	23,09	2833,91	654,32
	Developing	Greece	30,56	15,78	23,17	2570,79	595,67
		Belgium	50,49	34,14	42,32	1161,44	491,48
	Mediated	Poland	65,10	1,04	33,07	1149,36	380,14
		France	50,41	23,16	36,79	925,24	340,35
		Turkey	23,81	19,80	21,80	1556,54	339,36
	Static	Spain	22,53	3,52	13,02	2176,96	283,48
		Hungary	26,92	4,43	15,68	1647,40	258,29
Slovakia		19,95	0,96	10,46	1344,88	140,64	
In the stage of preparation for transition	Static	Ireland	13,48	0,00	6,74	1955,41	131,80
		England	5,08	4,67	4,88	1678,88	81,86
	Investment	the Czech Republic	18,28	1,02	9,65	676,84	65,32

Source: calculated by the authors based on [6–8]

The calculation made it possible to identify the relevant countries that have more or less common signs of the energy transition and thereby mark the sequence of the energy transition. These are the so-called energy transition clusters. Based on the selected clusters, countries were ranked by the level of energy transition. In total, eleven levels of energy transition are highlighted.

As for Ukraine, the energy transition took place quite dynamically until the existence of a single integrated domestic energy system, as indicated by its status in the ranking. And the country was practically on the border between the cluster in the stage of transition and the cluster



of the completed transition. Such a high position is explained by the high energy potential of Ukraine.

**Conclusion.** Therefore, the main priorities of the global concept of sustainable development and greening are quite successfully implemented in the EU countries. This process takes place quite unevenly and ambiguously, which indicates a rather broad proposed indicator of the energy transition level. Its range is tens of orders of magnitude. It is also clear that the countries in which the governments are actively implementing green energy are at the highest level of the energy transition (Germany, Sweden, and Italy). Therefore, Norway, which has almost completely switched to green energy, took the first place in the corresponding energy cluster of such ecological and energy transition.

Ukraine's energy potential and the corresponding stimulation of the introduction of green technologies by the government policy enshrined in the relevant legislation allowed Ukraine to occupy a high position in the ranking of the level of energy transition. Further such high development in the energy transition will be inhibited. This is not only due to the war on the territory of Ukraine, but primarily due to excessively high taxation of production, domestic sale and consumption of electricity. The gap in taxation between Ukraine and the EU countries is an order of magnitude (a dozen times). Such excessive taxation provokes a low level of electricity consumption. And from the point of view of state regulation, this situation indicates that the domestic energy industry is becoming a potential source of filling the Ukrainian budget and at the same time is losing the state of the basic foundation of domestic production not only on the world market, but also on the domestic market. If we do not intervene in such a situation, further development will lead to an increase in non-payments and the spread of paralysis of Ukrainian production. It is precisely from this position that the government's attempt to enter the economic space of the EU becomes clear. However, joining the EU will not automatically provide a solution to the primary growing energy problems of the Ukrainian economy, and may lead to the loss of the residual potential of the Soviet Ukrainian energy system. Green energy is not a panacea for solving such national economic problems. It is only an indicator of the effectiveness of state regulation of the national economy through the energy sector. And the energy transition itself should be considered only as one of the stages of the evolutionary development of society, and at the same time not the last.

In general, the success of the energy transition depends on making the necessary changes and stimulating the development of green technologies. Countries that successfully implement the energy



transition have a developed green energy infrastructure, which ensures an increase in the production and consumption of green energy. Therefore, the successful implementation of the global concept of sustainable development and greening depends on the successful transition of countries to a new ecological and energy system, which in turn is determined by a comprehensive approach and cooperation of all social forces of the country, including governments, the population and business structures.

Considering the above, in our opinion, in order to optimize the process of implementing the energy transition, it is necessary to more deeply investigate the factors influencing the energy transition:

1) perfectly identify the effect of the mechanism of the tax burden on the energy industry;

2) provide a thorough analysis of the energy pricing system and form a simple and logical approach with the selection of all active abuses, which leads to a decrease in the level of final consumption of electricity.

3) to analyze the remaining potential opportunities of the Ukrainian energy industry in accordance with the urgent economic and social needs of the domestic economy and not blindly following imposed trends or priorities.

4) to conduct fundamental philosophical and economic studies of the analysis of energy development in general and national economies in particular and to identify the trigger points of its development and the mechanism of their activation.

5) assessment of the balance between traditional and alternative energy, taking into account climate risks.

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## ПРОБЛЕМИ ТА ТЕНДЕНЦІЇ ПЕРЕХОДУ УКРАЇНИ НА ЕКОЛОГО-ЕНЕРГЕТИЧНИЙ УКЛАД ЄС

Перехід на еколого-енергетичний уклад є актуальним завданням



для багатьох країн світу, включаючи країни Європейського Союзу та Україну. Це пов'язано з тим, що сучасні виробничі технології, які базуються на використанні вуглеводнів та інших природних ресурсів, негативно впливають на навколишнє середовище та призводять до змін клімату. Стаття присвячена проблемам та тенденціям переходу на еколого-енергетичний уклад країн ЄС та України. Вона розглядає сутність та необхідність такого переходу, а також рівні переходу, на яких знаходяться країни, та відповідні енергетичні кластери. Метою наукового дослідження є проаналізувати рівні енергетичного переходу країн Європейського Союзу, виявити проблеми та тенденції їх розвитку, а також запропонувати можливі шляхи для подальшого вдосконалення енергетичної політики України для досягнення екологічної сталості та енергетичної безпеки. Дослідження виявило, що перехід на еколого-енергетичний уклад є необхідним для забезпечення сталого розвитку та зменшення впливу на навколишнє середовище. Вказано, що країни ЄС вже здійснюють перехід на нову енергетичну систему з низьким викидом вуглецю, а також активно використовують відновлювану енергію. Водночас Україна має значний потенціал для розвитку відновлюваної енергетики та енергоефективності. При цьому виявлена проблема такого переходу, а саме – надмірне перенавантаження податковим тиском споживачів електроструму, що призводить до низького рівня споживання електроенергії на душу населення. Доведено, що для стимулювання розвитку відновлюваної енергетики та енергоефективності, важливо зменшити податковий тиск на споживачів електроструму та надати підтримку розвитку відновлюваних джерел енергії. У дослідженні визначено кластери країн, які знаходяться на різних рівнях переходу на еколого-енергетичний уклад. Ці кластери враховують рівень розвитку відновлюваної енергетики та енергоефективності. Такий аналіз може допомогти країнам у розробці та реалізації національної енергетичної політики.

**Ключові слова:** енергетичний перехід; еколого-енергетичний уклад; відновлювана енергетика; відновлювані джерела енергії; споживання електроенергії; країни ЄС.

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