Trends and Prospects of Energy Market Transformation

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Abstract

Solving the main energy problems requires global political intervention in the world energy market and emphasizes the importance of developing a new energy efficiency strategy, which should be based on monitoring the dynamics of the energy market and identifying trends in its development. The purpose of the article is to analyze the features of the transformation of the energy market. The research methodology is based on the analysis and synthesis of statistical series characterizing the volume and structure of world energy consumption, a retrospective analysis of trends in the dynamics of world energy, the use of the scenario method. The article identifies the main trends in the growth of energy consumption. The factors that determine the transformation of the energy market are identified. It is concluded that the reasons for the transformation of the market each time was the economic feasibility in the new conditions of the development of society. Further scenarios for the transformation of the energy market have been determined. It is assumed that for the first time the transformation of the energy market will take place not on the basis of economic feasibility and technological capabilities, but on the basis of political and ideological requirements.

Keywords: *energy market; transformation; factors; energy consumption; scenarios; economic expediency*

1. Introduction

In the XXI century, world energy has undergone significant changes. The development of scientific and technological progress, driven by a significant increase in energy prices, stimulated competition in energy, as well as fostered competition between traditional and non-traditional hydrocarbon sources, which in turn intensified energy conservation and led to limited growth in world energy consumption. The world community has pointed out that there is an urgent problem to be solved - the prevention of climate change, the solution of which has become the driver of the decision to reduce natural fuel production. At the same time, the architecture of energy markets in the world has changed rapidly, the main participants in the process have redistributed roles, new market players have appeared and new markets have formed in the regions, while the old ones have significantly changed the rules of the game. Therefore, the world's energy is currently in a state of uncertainty. The study of changes in world energy is the main factor in assessing the prospects for the development of fuel and energy complex, as well as working out a strategy for economic development. The global crisis has led to sharp jumps in hydrocarbon prices, declining energy demand, and significant policy interference in the global energy market.

Solving the main problems - preventing climate change, high levels of energy security, ensuring sustainable development while minimizing public spending - is possible through the development of an effective energy strategy. Currently, especially for developed countries, it is important to separate economic growth from energy consumption. This issue is discussed in detail in [1], but despite the findings of research, the issue of energy efficiency remains the most ignored among the main issues of energy policy.

Energy policy issues are also considered in such thorough research as: [2], where in the context of limited budget resources and existing energy market transformations, approaches to the organization of energy efficiency are considered; [3], where the analysis shows that the technologies used to renew energy sources and energy efficiency and their synergistic effect are key elements in the transition to global transformation processes in energy; [4], where a number of effective energy reforms carried out in the European Union are considered; [5], where the issue of renewal of energy sources and energy cycles in deregulated electricity markets has been studied; [6], where a review of renewable and sustainable energy is given and the markets for electricity, gas and heating that are possible in the future are considered; [7], where the issue of consumer adaptation to the use of innovative energy services currently represented in the energy market is studied, as well as barriers and incentives for efficient use of energy services are studied.

For all the significance of the research, the results are non-systematic and should be based on a clear definition of the current prospects for the transformation of energy markets, so the purpose of the article is to analyze the features of the transformation of the energy market.

2. Materials and Methods

The research methodology is based on the analysis and synthesis of statistical series characterizing the volume and structure of world energy consumption. To analyze the main directions and determine the main stages of the transformation of the energy market, we used long statistical series covering information from the beginning of the 20th century. To study the current state of the market and the prospects for its transformation, statistics from the World Energy Agency were used since 1971.

The method of analysis was used to highlight the dynamics of consumption of individual energy resources and compare these dynamics. The synthesis method provides for the consideration of the energy market as a whole with the reduction of each resource to a single physical meter (in this work, to tons of oil equivalent).

To determine the basic prerequisites for the transformation of energy markets, a retrospective analysis of trends in the dynamics of world energy was used. Various information sources, including political declarations, in particular the Paris Agreement, were considered to assess options for further transformation of the world energy based on scenario methods.

3. Results

Let us analyze the change in the level of energy consumption during the previous century and at the beginning of the current one, which is necessary to determine the main trends in the growth of energy consumption and the dependence of its level on two main factors: economic growth and population growth. The latter factor is valid even if the economy is shrinking, since on the one hand, an increase in population requires at least a proportional increase in energy supplies and on the other, the specific energy consumption in everyday life is constantly increasing as a result of the use of more energy-consuming equipment. For the analysis, all primary energy, regardless of

the source, is given in a single unit - tons of oil equivalent (t.o.e), most common in the energy community. The data from 1973 were taken in accordance with the data of INTERNATIONAL ENERGY AGENCY [8], up to 1973 they were reconstructed by the authors based on the data [9].

Data on the population up to 2008 and the volume of the world economy up to 2003 were taken based on the statistics of A. Medisson Groningen Growth and Development Center [10]. As a measure of measuring the world economy, gross domestic product (GDP) was taken at purchasing power parity (PPP) in 1990 prices. To determine the volume of the economy after 2003, the indices of annual GDP growth were used [11]. The population size after 2008 was adopted on the basis of [12].

Data on the level of energy consumption, the volume of the economy and the population in the world are given in Table. 1. The data in the table are rounded, however, for further calculations, non-rounded data are used.

Table 1. Energy consumption, GDP and world population.

Year	Energy consumption bln. t.o.e.	GDP growth in PPP, $ mln. дол. (1990)***	World population, million people
1900	0,6	1974	1583
1913	1,4	2733	1791
1938 (1940)*	2,4	4502	2295
1950	3,2	5366	2525
1960	3,8	8434	3040
1970	5,4	13771	3686
1980	7,2	20042	4433
1990	8,7	27136	5257
2000	10,0	36703	6061
2010	12,8	53905	6896
2018 (1017)**	14,3	67222	7504

Over the past century (1990-2000), while the economy grew 18,59 times, energy consumption increased 17,69 times, i. e. the growth rate of energy consumption was only 5% lower than the growth rate of the economy, but in the next period (2000-2018), with the economy growing 1,83 times, the growth in energy consumption was only 1,42 times, which indicates a constant change in the ratio between growth rates energy consumption and economic growth. As for the world's population, during the periods under consideration, it increased by 3,82 and 4,74 times, respectively, which is an unprecedentedly high indicator from a demographic point of view, but several times lower than the Tindicators of economic growth and energy consumption. To clarify the situation with how the ratio between the growth rates of energy consumption changed within the studied period, we will make a special calculation given in Table 2.

Table2. The ratio of the growth rates of energy consumption and the economy and the change in the energy supply of a person.

*For energy consumption 1913-1938, for GDP and population 1913-1940.

**For energy consumption 1938-1950, for GDP and population 1940-1950.

***For GDP 2010-2017, for energy consumption 2010-2018

****At the beginning of the period

*****At the end of the period

Years	Energy consumption growth, times	Economic growth, times	Population growth, times	Average annual growth in energy consumption,%	Average annual GDP growth in PPP,%	Energy Consumption Growth to GDP Growth Ratio	Energy supply, kilo of fuel equivalent per person****
1900-1913	2,42	1,38	1,13	7,0	2,5	2,8	358
*1913-1938(1940)	1,76	1,64	1,28	2,3	1,8	1,3	769
**1938(1940)-1950	1,30	1,18	1,10	2,2	1,7	1,3	1059
1950-1960	1,21	1,57	1,20	1,9	4,6	0,4	1250
1960-1970	1,41	1,63	1,21	3,5	5,0	0,7	1252
1970-1980	1,35	1,46	1,20	3,1	3,9	0,8	1450
1980-1990	1,20	1,45	1,19	1,8	3,8	0,5	1624
1990-2000	1,15	1,35	1,15	1,4	3,0	0,5	1660
2000-2010	1,28	1,46	1.14	2,5	3,9	0,6	1655
***2010-2018(2017)	1,12	1,26	1,09	1,4	3,4	0,4	1858/1903*****

As follows from the above calculations, to ensure 1% of economic growth, it is currently required to increase the production of energy resources by only 0,4%, while up to the middle of the twentieth century an outstripping growth in the production of energy resources was required to ensure the growth of the economy as a whole. This trend is stable, although some temporary fluctuations are possible. Several factors can be distinguished due to which it is possible to achieve a reduction in the energy intensity of GDP, most of which are of a technological nature: – improvement of structures and the use of less energy-intensive materials; – reduction of energy consumption by the offered products (starting with the consumption of electricity by refrigerators and ending with the level of fuel consumption by cars, however, it should be noted that this process is rather slow due to a sufficiently large number of obsolete products due to a long service life);– improvement, including from the point of reducing energy consumption, of the technological processes themselves. Technological factors operate constantly, but the development of energy-saving technologies naturally intensifies during periods of high prices or increases in energy prices. However, the decrease in the energy intensity of GDP is associated not only with technological, but also with structural factors, namely, with an increase in the share of new industries with low energy intensity in the economy (for example, IT companies, producing a significant part of their products in developed countries, use energy resources at a minimum level). This thesis is confirmed by comparing changes in energy consumption across groups of countries with different levels of economic development. The territories shown do not include the OECD countries as a separate group (Table 3).

Table 3. Comparison of energy consumption (mln. t.o.i).

Territories	2000	2007	2012	2018	2018 to 2000, %	2018 to 2012, %
Africa	491,0	626,4	725,6	836.7	70,4	15,3
USA	430,6	526,4	598,3	599,0	39,1	0,1
Asia	1037,6	1321,7	1602,6	1925,0	96,2	20,1
China	1143,4	2111,8	2834,1	3210,6	180,8	13,3
Europe and Eurasia	993,0	1107,2	1150,4	1159,2	16,7	0,8
Near East	353,2	522,1	655,0	759,9	115,1	16,0
OECD	5311,7	5584,6	5299,8	5369,4	1,1	1,3
incl. USA	2703	2828,7	2645,2	2748,2	1,6%	1,7
incl. Europe	1758,3	1857,6	1768,6	1740,6	-1,1	-1,6

Calculated according to [8]

For OECD countries, it can be concluded that a modern economy can develop practically without increase in energy consumption. The maximum level of energy consumption was recorded in Europe and America in 2007. Since then, energy consumption has even slightly decreased, and it does not seem realistic to expect its increase in the near future. It should be noted that the average annual growth in European countries was 1,5-2%, in America 2,5-3%, there was also a population growth in these countries. The growth of world energy consumption was due to the countries of Asia, China and the Middle East. Growth rates in these countries were 6-7%, but the growth in energy consumption in these countries was determined primarily not by high growth, but by the fact that this growth was due to energy-intensive industries, which is determined by the stage of economic development. In the future, if we follow the conservative scenarios [13-15] with an expected average annual economic growth of about 3%, we should expect an increase in energy consumption at the level of 1% per year [16]. A 1% GDP growth will require an increase in consumption and, accordingly, energy production by 0,35% - 0,4%. At the same time, this indicator will decline after 2030, and by the middle of the century, world energy consumption will practically stabilize. With the continued growth of the world population, an increase of 0,1-0,2% is possible, used mainly for household consumption. Resource and environmental factors are usually cited as the reason for the stabilization of energy

consumption [17]. However, the assessment of the level of resource availability over the past 50 years has remained practically unchanged (in other words, the increment in reserves corresponds to or is close to the level of their production), and environmental factors are largely political in nature, and their importance can be overestimated). In our opinion, first of all, the reduction in energy consumption is associated with the outstripping growth of prices for energy resources relative to the general level of inflation, which stimulates the financing of energy saving programs. As a rule, the assessment of changes in prices for energy resources is made on the basis of exchange prices for oil, considering them to be the most objective indicator. Despite the extreme price volatility, it can be argued that oil prices are rising somewhat faster than prices for other products. Speaking about a sufficiently high estimate of the resource potential, it should be considered that its increment takes into account the increase in the availability of resources associated with the use of new, usually more expensive technologies (for example, technologies for shale oil and gas production). Despite the decrease in the cost of resources obtained by using these technologies, objectively, the cost of production of resources will grow. The same can be said about renewable resources, the production of which, even with the improvement of technology, remains extremely expensive. Thus, even with the stabilization of energy consumption in physical terms, the assessment of the global market in value terms will increase. The degree of this growth will largely depend on the share of renewable resources in the energy balance. The second most important issue in assessing the transformation of the energy market is the change in the structure of this market by the types of use of various resources. This issue is not only economic, but also political and even ideological in nature. However, before considering the structure of the market today, it is necessary to consider the transformation in historical perspective. The structure of the primary energy market is constantly changing, but this change, despite its clear direction, is relatively slow due to the size of the market and its inertia. Historically, the development of the primary energy market can be divided into three stages:

1.Until the middle of the 18th century: the prevalence of organic energy resources such as firewood, peat, straw, etc. The market at that time was fragmented, the use of energy resources was local, and the volume of consumption was insignificant due to the minimum level of industrial development. Moreover, a significant part of the consumed energy resources was not marketable.

2.Until the 1930s, coal was the predominant energy resource. Coal was the energy basis for the emergence and development of industrial production and railway transport. The advantages of coal, among other things, were determined by the wide distribution and, accordingly, the relatively small scale of transportation. The maximum share of coal consumption fell on 1910 and amounted to more than 65% [18]. However, among the market energy resources, coal accounted for up to 90%.

3.Since the 1930s, the main and defining kind of energy resource is oil. In quantitative terms, the share of oil exceeded the share of coal in 1960, and in total, together with natural gas in 1950 (gas, like oil, is a hydrocarbon and for a long time was generally considered as a by-product of oil production) [18]. The maximum share of oil in the energy balance was about 46,2% in 1973, during the same period the total share of oil and gas was 62,2%. Currently, the share of oil is 32%. The importance of oil, however, is determined not only by its share, but also by the fact that the production of some chemical goods and motor fuels is economically efficient only from this resource. Finally, oil is the only energy resource that is priced on the exchange and therefore forms the basis for pricing for other primary and secondary energy resources.

Here it is necessary to make two essential remarks: first, the change of stage, accompanied by a change in the dominant energy resource, has always been determined by economic feasibility and technological capabilities; second, the share of the dominant energy resource at each subsequent stage was lower than the share of the previous dominant energy resource. In other words, at each subsequent stage, the market was less consolidated, reflecting the more diverse needs of a more developed economy. Finally, the achievement of the maximum share of the dominant energy resource was accompanied by the appearance on the energy market of a substitute with significantly higher profitability, which made the companies producing this energy resource much richer and more competitive (the world's largest company at the beginning of the 20th century was Standard Oil, at the time when the share of oil in energy consumption did not even reach 10%).

4.Transition from the third to the fourth stage. To consider this issue, it is first necessary to analyze the changes in the structure of world energy consumption in the period 1971-2018.

Data on the structure of energy consumption in physical terms are given in Table 4.

Table 4. Power consumption comparison (mln. t.o.i).

Year	Coal	Oil	Gas	Nuclear	Hydro	Bio and loss	Other	Total
1971	1437	2436	893	29	104	615	4	5518
1973	1496	2818	977	53	110	638	6	6098
1975	1534	2754	999	100	124	662	7	6180
1980	1788	3105	1231	185	148	738	13	7208
1985	2006	2903	1410	387	170	823	21	7720
1990	2221	3233	1622	526	184	904	37	8727
1995	2208	3373	1807	608	216	967	43	9222
2000	2317	3669	2071	675	225	1015	62	10034
2005	2991	4010	2360	722	252	1089	71	11495
2007	3339	4097	2527	709	265	1128	83	12148
2010	3650	4127	2736	719	296	1205	111	12844
2012	3859	4176	2838	642	316	1242	143	13216
2015	3843	4328	2929	670	335	1271	259	13635
2018	3838	4497	3262	707	362	1327	289	14282

The structure of world energy consumption in relative terms is shown in Table 5.

Table 5. Structure of world energy consumption in relative terms, %

Yaer	Coil	Oil	Gas	Nuclear	Hydro	Bio and loss	Other	Total	Gas+ Oil
1971	26,0	44,1	16,2	0,5	1,9	11,2	0,1	100	60,3
1973	24,5	46,2	16,0	0,9	1,8	10,5	0,1	100	62,2
1975	24,8	44,6	16,2	1,6	2.0	10,7	0,1	100	60,8
1980	24,7	43,1	17,1	2,6	2,1	10,2	0,2	100	60,2
1985	26,0	37,6	18,3	5,0	2.2	10,6	0,3	100	55,9
1990	25,4	37,1	18,6	6,0	2,1	10,4	0,4	100	55,7
1995	23,9	36,6	19,6	6,6	2,3	10,5	0,5	100	56,2
2000	23,1	36,6	20,6	6,7	2,3	10,1	0,6	100	57,2
2005	26,0	34,9	20,5	6,3	2.2	9,5	0,6	100	55,4
2007	27,5	33,7	20,8	5,8	2,2	9,3	0,7	100	54,5
2010	28,4	32,1	21,3	5,6	2,3	9,4	0,9	100	53,4
2012	29,2	31,6	21,5	4,8	2,4	9,4	1,1	100	53,1
2015	28,2	31.7	21,5	4,9	2,5	9,3	1,9	100	53,2
2018	26,9	31,5	22,8	5,0	2,5	9,3	2,0	100	54,3

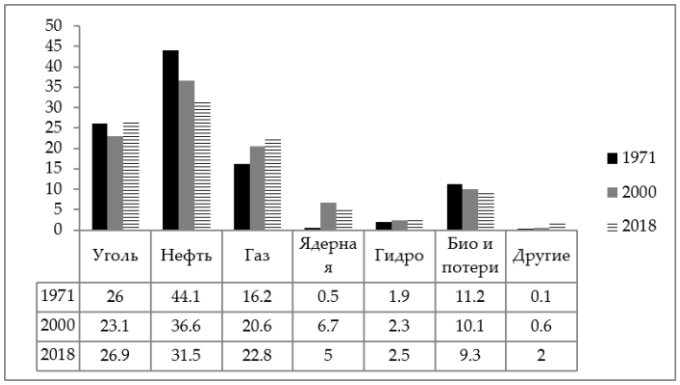

Figure 1. Structure of world energy consumption in 1971, 2000 and 2018, %

If we follow the logic of the transformation of the energy market in previous periods, up to the middle of 1970s, the following model seemed logical. Having reached its maximum value in 1973, the share of hydrocarbons should have begun to decline gradually, and the share of coal should have continued to decline at an outstripping rate, which by 1971 had dropped to

26%. The decline in the share of these resources is offset by an increase in the share of nuclear energy, which was gradually supposed to take a dominant position in the market, displacing coal and hydrocarbons, primarily as a resource for electricity generation. As a resource for the production of motor fuels, oil retained its position for a long time, until the beginning of the gradual replacement of cars with electric vehicles. To what extent these views correspond to reality, we will consider on the basis of the data in Tables 4-5 for the period 1971-1980. During this period, coal consumption increased from 1437 to 1788 mln. t.o.e. or 1,24 times (24,4%), oil from 2436 mln. t.o.e. up to 3105 mln. t.o.e. or 1,27 times (27,5%), gas from 893 mln. t.o.e. up to 1231 mln. t.o.e. or 1,38 times (37,8%). At the same time, the production and consumption of nuclear energy increased from 29 to 185, or 6,4 times, and its share in world energy consumption increased from 0,5 to 2,6%. At the same time, the indicators for developed countries are even more impressive. It should be noted that the rate of decline in the share turned out to be lower than expected, which was caused by a sharp rise in oil prices (up to 5 times) during the energy crisis of the 1970s. However, the decline in oil prices in subsequent periods should have corrected the rate of change in the share of energy resources. Nuclear energy consumption in 1980 remained insignificant in relation to the consumption of coal and hydrocarbons, however, exactly the same ratio was observed at the beginning of the century, when oil accounted for only 3% of the total energy balance, but the growth rate of its production was several times higher than the growth rate of coal production, which ultimately led to the dominance of oil on the energy market. In the next decade (1980-1990), the share of nuclear energy in the total energy balance increased to 6%. Nuclear energy has a number of significant advantages over the use of hydrocarbons and, moreover, coal. The electricity received at nuclear power plants has a significantly (several times) lower cost, the reserves of uranium raw materials are practically unlimited, and there is no need to alienate huge territories for the extraction of energy resources. It should also be noted that the technical reasons associated with the construction of nuclear power plants were gradually eliminated. It became possible to build them not only in developed but also developing countries. In other words, all the prerequisites existed for the transformation of the energy market into one in which nuclear energy becomes dominant. In the implementation of the scenario, the probability of which is confirmed by the statistical data of the period 1971-2000, by 2020 the share of nuclear energy was supposed to be 25-30% and exceed the share of oil in energy supply, the share of coal should have dropped to 10-15%, and its production and consumption should have been concentrated in developing countries and constantly decline. In subsequent periods, the share of nuclear energy should have increased at a slower pace due to an increase in electricity consumption in transport (transition from internal combustion engines to electric motors with the creation of an appropriate network of electric filling stations). From the point of view of economic feasibility, the considered transformation appeared to be the most probable and corresponded to the previous stages of the transformation of the world energy market. However, the economically feasible scenario was not destined to come true due to psychological, political and ideological factors that began to determine the further development of the energy market. Let's turn to the statistical data for the subsequent periods (Tables 4-5). In the period 1990-2000 nuclear energy production is growing at a much slower pace, primarily at the expense of developing countries. In developed countries there is practically no increase in nuclear energy production. In 2000 the share of nuclear energy in the global energy balance is maximum – 6,7%, after which it begins to decline down to 4,9% in 2018, i.e. to the share of 1985. The maximum volume of nuclear energy production is 722 million t.o.e. observed in 2005, after which there is stagnation in production with a slight downward trend. Everything suggests that the scenario discussed above will not be implemented, and the transformation of energy consumption will go the other way. Obviously, the reason for this was people's fear of nuclear power, which arose after two accidents, at the Chernobyl station in 1986, and at Fukushima 1 in 2011. And although the consequences of these accidents are still not clear enough; their scale has a paralyzing effect. It is completely unimportant that over the past period there have been hundreds or even thousands of accidents at other energy facilities, which may have entailed more significant consequences, but they were not concentrated and did not make a similar impression. There is no objective evidence that nuclear energy carries higher risks than the extraction of natural resources and the operation of thermal power plants, but there is a belief that this is so. For the first time in history, noneconomic (at the same time, not proven factors) determine the directions of the transformation of the power system. However, if the obvious direction of accelerated development of nuclear energy is impossible, then the transformation of the energy sector will go in other directions, of which there may be several at the moment, of which we will consider two, reflecting

the "progressive" and "conservative" scenarios. The "conservative" scenario envisages that the existing structure of energy consumption will change slowly, hydrocarbons will occupy a dominant position, however, due to the need for a sharp increase in electricity generation due to the replacement of cars with electric vehicles, the production and share of natural gas will grow during stagnation or even a decrease in oil production (as discussed above, an increase in electricity production at nuclear power plants is not possible in the near future). The share of coal will constantly fall; the share of renewable sources (excluding biofuels) will increase by 2030 to 3,5%, by 2050 to 5% [13-15]. Even such increase would require an additional increase in compensation, which would require very significant resources. It should be noted that compensation for green tariffs, even with the current 2% share of renewable resources, causes serious problems in some countries, in particular in Ukraine in 2020, a decision was made to reduce the size of green tariffs and invest in green energy. This was preceded by a significant increase in the share of renewable sources in the country's energy balance. It should be noted that an increase in the share of renewable resources not only increases the size of compensation payments, but also reduces the base of budget revenues due to the tax on other energy resources, the share of which is gradually decreasing. The "progressive" scenario provides that, depending on its options, the share of renewable energy resources will increase from 10 to 30% [13-15]. Accordingly, the share of all other energy resources will decrease. This is a completely different economy, requiring multi-trillion-dollar costs and sharply increasing the cost of energy resources and the production of all goods in general. The economic feasibility of such scenarios is highly questionable; however, their high public and political support does not exclude the likelihood of these scenarios being realized. At the moment, due to the large number of uncertainties, it is very difficult to predict what kind the energy sector will be like even in 10 years, but it should be noted that for the first time, economic feasibility may not have a decisive impact on the real trend.

4. Discussion

The modern economy does not require an outstripping growth in the production of energy resources. If at the beginning of the twentieth century, to ensure GDP growth by 1%, an increase in energy production by 2,8% was required, then at present the percentage growth of GDP requires an increase in energy production by only 0,4%. This trend is sustainable and reflects both technological improvement and, first of all, a change in the structure of the economy as a whole. In recent years, the energy consumption of developed countries, with moderate economic growth, practically does not change, this, along with the study of world consumption in previous periods, suggests that the growth of world energy consumption in the near future will be insignificant, and by 2050 it will stabilize. At the same time, a slight increase in energy consumption at the level of 0,1-0,2% after this period cannot be ruled out, with a steady population growth. Throughout its history, the energy market has been constantly transforming in terms of energy resources used. Analyzing the structure of the market, we can distinguish three main stages: the first one until the middle of the 18th century, when biofuel was the prevailing energy resource, and the market was of a limited local character; the second - until the middle of the twentieth century, when coal was the defining energy resource - the energy basis of the industrial revolution; the third - when the main energy resource is oil. The reasons for the transformation of the market each time was the economic feasibility in the new conditions of the development of society.

The energy market is currently in the process of transformation. However, the main direction of transformation associated with the dominance of the nuclear energy market (which meets the principles of economic expediency) seems to be impracticable. For the first time, the market transformation will take place not on the basis of economic requirements and technological capabilities, but on the basis of political and ideological requirements. In this regard, the development of the market can occur both conservatively and revolutionary with the dominance of renewable energy sources. In any case, the real vector of market transformation will be a compromise between economic and technological capabilities, on the one hand, and political will, on the other.

5. Conclusion.

Thus, the transformation of the energy market is due to the peculiarities of the use of types of energy resources, structural and environmental factors, as well as economic feasibility and technological capabilities. Changes in the structure of world energy consumption are taking into account concerns about the use of nuclear energy, therefore, in developed countries, an increase in nuclear energy production is practically not observed. Further possible scenarios focus on the economic inexpediency of their implementation. The conservative scenario puts countries with a transformational economy in difficult conditions, but the progressive scenario provides for

significant changes in the structure of the economic system as a whole, which will entail an increase in the cost of energy resources and the production of all goods. In these conditions, most likely, the economy will drop out of the number of key factors in the further transformation of the energy market.

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