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TRENDS ON THE GLOBAL ENERGY MARKET

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Abstract

World energy consumption has increased in the last years by 2.3%. The high demand is explained by a strong global economy and higher heating and cooling needs in some regions of the globe, rising prices for metals, grain and food. The energy market is contradictory: on the one hand, the demand for energy increases, on the other hand, the acquisition of energy is accompanied by the depletion of natural resources, the elimination of harmful products and greenhouse effects, accidents and disasters. The importance of the issue is confirmed by the Singapore's initiative to launch an energy fund. Not all countries have the necessary resources to meet the demands of society. As a result, there are disparities between countries on energy sources and their efficient use.

Author's research is aimed at ensuring that society focuses on the use of traditional energy sources and non-traditional, renewable energies that have a moderate impact on the environment and society. The aim of the research is to investigate the situation of the energy market at global and regional level, and to select the theoretical and practical ways of applying the vector of state efforts in overcoming the problem of energy shortage, identifying alternative energy routes. Being aware of the major importance of energy in all areas of the economy, there is a need for energy security. In order to achieve these goals, the authors used the method of macroeconomic, geopolitical and geoeconomic analysis, measurement, deductive logic, inductive reasoning, experimental modeling, variable selection, statistical method, forecast, induction, deduction, etc. Research has made it possible to identify global energy sources, their structure, the dynamics of use and prediction of global energy sources, the share of alternative sources for the near future. Identifying opportunities for cheap, safe, efficient, but sometimes risky nuclear energy use. The Republic of Moldova, as a country that does not have its own energy resources, must ensure its energy security, using various sources according to the world trends in this field.

Keywords*: energy, energy resources, alternative energy sources, advantages*

1. Introduction

Recently, the world energy industry has been experiencing transformative changes. The Republic of Moldova, as a country that does not have its own energy resources, should ensure its energy security using various sources according to the world trends in this field.

As a result of enhancing energy efficiency, the use of electricity in developed countries has increased. The process of change has an impact on the environment, contributes to a significant increase in the number of developed countries in the field of energy. But the increase in energy

consumption has bad repercussions on ecology. The leaders in this area are China, India and the United States, accounting for about 86% of their total greenhouse gas emissions. Recently, emissions in Germany, Japan, Mexico, France and the UK have diminished (Europe 2020). Some new trends have emerged in the development of alternative energy sources.

According to numerous forecasts, in the next two decades, considerable changes are expected in the global energy market. They will be brought about by widespread structural and technological changes in the world economy, including a decrease in the intensity of energy use and the harmful effects of economic activity, based on fossil and traditional fossil fuels, on the environment (greenhouse gas CO2 and other gases). The main trends that will determine in this context the development of the global energy market between 2035 and 2050 will be marked by the use of traditional, but less polluted, securitized and alternative sources of energy. We already have world championships with *Electric GT*, *Formula E*.

2. The current investigation of the problem, the purpose of the research

The study of global energy problem has been the topic of numerous studies, theses, articles. We can note the works of the following scholars: Schumpeter J., Ansoff I., Kushlin V.I., Pletnev K.I., Folomev A.N. The problems of innovative economic development of renewable energy were in the center of attention of Heinberg R., Ergin DH, Twidel J., Weir A. As a theoretical and methodological support served the works of scholars in the field of world economy and international economic relations, energy sector in general and energy sector of nuclear and alternative energy sources, including: J. Stein, J. Longenecker, R. Witze, GJ Fox, H. Bacon, J. Valentine, J. Baumier, C. Varley, J. Paffenbarger. Research has focused on processes in energy markets and alternative energy sources. In his research, the authors relied on investigating complex changes in the global energy market, the interaction between traditional sources and energy alternatives. However, many problems have not been found in the research, due to the conjuncture of the world energy market, the efficiency of renewable energy sources and alternative sources. Basically, the issue of qualitative and quantitative trends on the biofuel market, the measures to regulate supply and demand in the world market have not been studied. Particular attention was paid to energy efficiency, preferences and weights of various energy sources on the economic vector.

The aim of the research is to investigate the situation of the global, regional energy market and to select ways (theoretical and practical) to solve the problem of energy shortage.

3. Applied methods and materials

Methodology, concepts and approaches used in such disciplines as "World Economy", "International Economic Relations", "World Economy and Economic Security", "Management and Marketing of International Economic Affairs", "Statistics" and so on in solving specific problems, expert estimation methods, correlation and analysis methods, interactive modeling, etc. were used.

As a theoretical and methodological basis of research, the postulates and paradigms of the scientific and applied theory of the world economy focused on a set of tools specific to the theory of systems, management, marketing, materials in the economic and energy specific literature,

fuels, green energy, presented in the publications of local and foreign researchers, specialists in economics and technical sciences: metaphysics, dialectics, method of scientific abstraction, analysis and synthesis, unity of historical and logical approaches, qualitative and quantitative analysis, induction and deduction, graphics, statistics, methods, mathematical methods, expert evaluation methods, etc.

At the same time, it is necessary to note that the degree of the theoretical and methodological investigation of regional energy problems, national problems in the field of systemic transformations, and diversification of traditional/alternative energy sources requires the use of efficient tools for improvement. Multiple methodologies and tools require careful testing and use, some of which are disputable.

4. Results and discussion

Energy is attributed to industry's basic branches: energy development is conditional on production and progress in all other branches of the economy. Consumers and energy producers must expect further demand for energy resources.

Modern electric power industry is represented by four blocks:

- Countries where the majority of electricity is generated at TPPs. These are the USA, the countries of Europe and Russia.
- States that have relied on nuclear power plants. These include the Republic of South Africa, China, Poland, Australia, as well as Mexico, the Netherlands and Romania.
- Countries that prefer to use renewable water resources. Hydroelectric power plants are popular in Norway, Canada, USA, Russia, Brazil and a number of developing countries.
- States with a high percentage of atomic energy: France, Belgium and the Republic of Korea.

In order for energy companies to achieve the best business results in the new market environment, several trends can be identified that will dominate the global energy market until 2020 (Figure 1) [12].

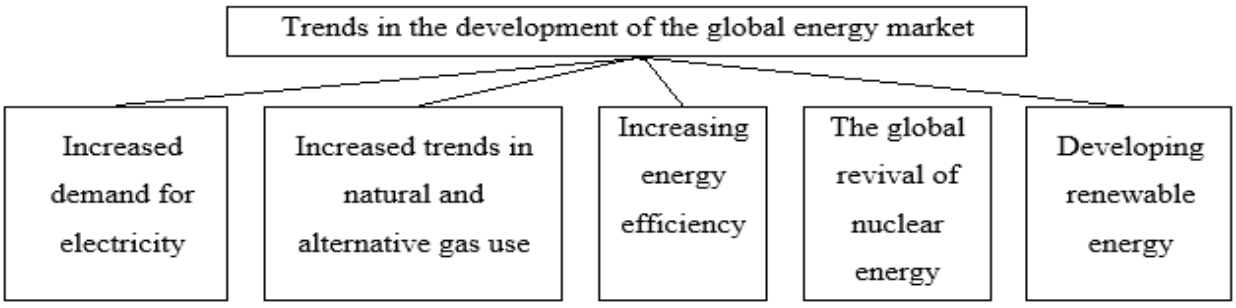

Figure 1. Development trends of the global energy market, 2020

Source: author's research

The first trend is increasing demand for electricity. Global electricity consumption is growing faster than other energy sources, thanks to the electrification of energy consumption. Asia was responsible for much of the increase in global electricity consumption in 2017. As in 2016, the

growth of China's electricity consumption, as a result of industry recovery and despite a sharp increase in energy efficiency, contributed to increasing world electricity consumption by half.

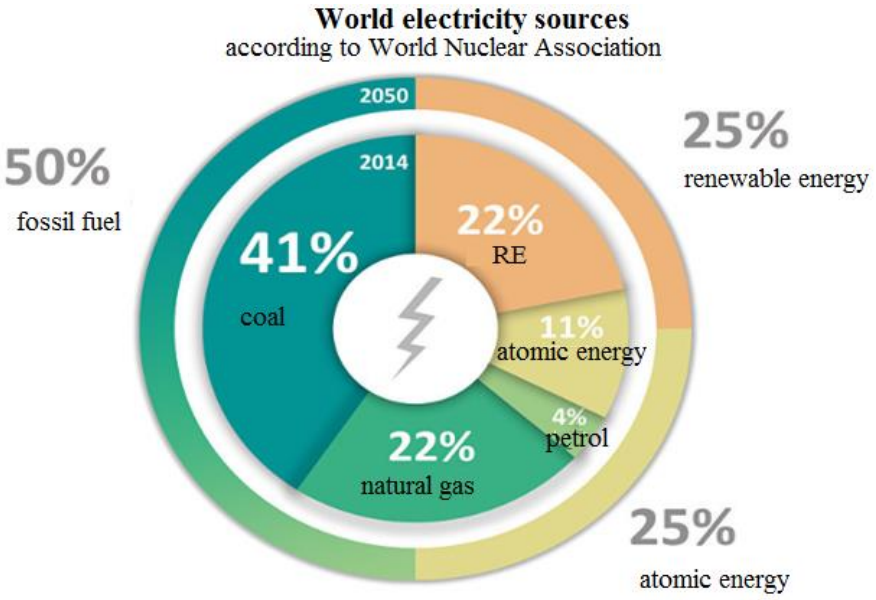

Figure 2. Alternative energy sources in the world and their importance [18]

The demand for electricity has also grown in Japan (for the first time since 2013), in India, Indonesia and South Korea (Figure 2) [3]. Electricity consumption in the United States, which has generally remained stable since 2011 as a result of energy efficiency improvements, has been declining for the second consecutive year, whereas in Canada it has been growing. It remained stable in the European Union (growth in Italy, Poland, Germany and Spain, decline in the UK) and grew in Turkey. Electricity consumption has also increased significantly in Iran and Egypt [4].

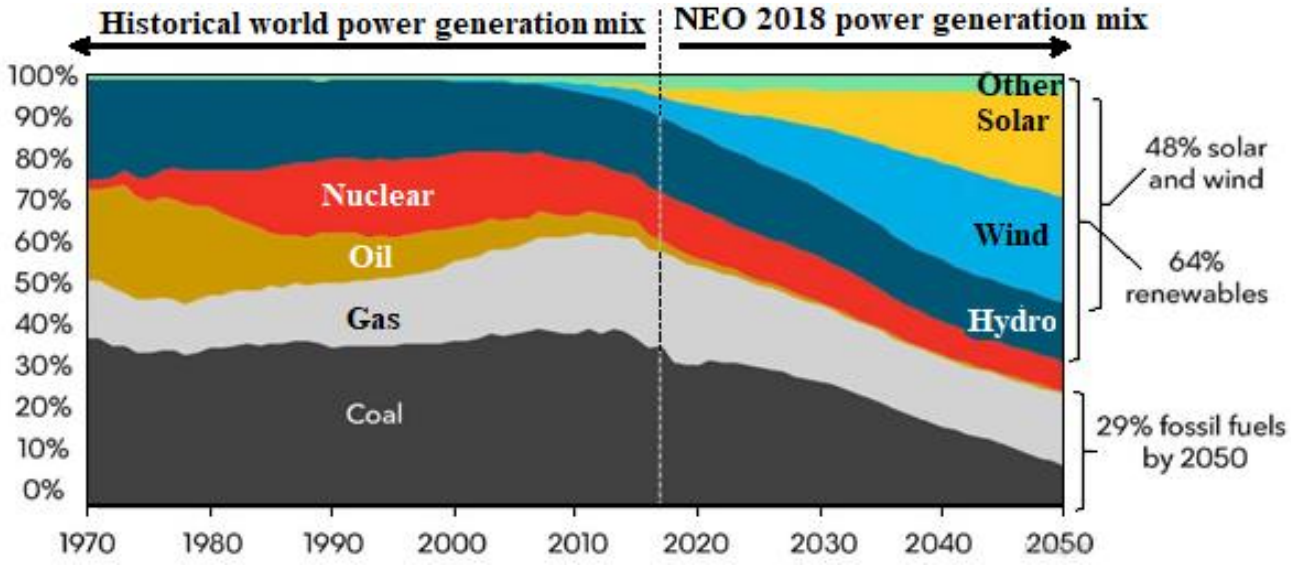

Figure 3. Dynamics of using energy sources 1970-2050 [4]

The average annual growth rate of the world population was estimated at 1.4% in 1991-2010.

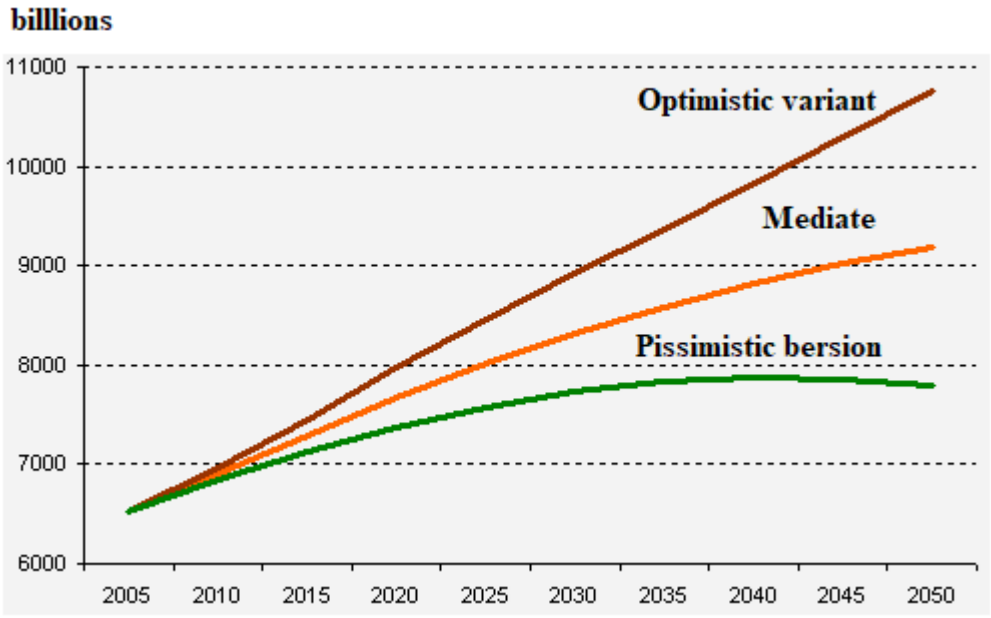

Figure 4. Increase in the number of populations around the globe, billions [5]

The highest rates of average annual population growth are expected in Africa - 2.8% and in the Middle East - 2.4%. All other regions are below 1.4%. Developed countries provide a population growth of 0.4%. By 2020, the increase in consumption of primary energy resources will be 6.6 billion tons of fuel equivalent. The result is 18.5 billion tons, of which 2/3 of consumption refers to developing countries, including 1/5 in China. The smallest needs for primary energy resources are expected for the region, including the countries of Central and Eastern Europe, Eastern Russia and the CIS countries. Based on data of the International Energy Agency, it is possible to calculate the growth rate of world energy production using the formula (1):

$$Gr = Ibp / Iep; \qquad (1)$$

where:
G_r is the growth rate;
I_{bp} - indicator of the beginning of the period;
I_{ep} - an indicator of the end of the period.

Almost all published forecasts take into account the fact that the growth rates of production and energy consumption in the world will be faster than the growth rates of primary resources, i.e. every year an increasing amount of resources extracted will be converted into energy. In accordance with the most probable forecast, the world demand for electricity at the level of 2020 is estimated at 23 trillion kW (Table 1).

Table 1. Growth rate of global energy production, %

	Years	
	2000	**2020**
World production	23000	35000
Growth rate	270	50
Per period, %	13,5	11

For the period 2019 - 2030 the amount of consumed energy will increase by 44%, as predicted by the US Energy Information Agency [2]. According to estimates of Frost & Sullivan experts [7], Europe, with its aging generating capacities, will need to commission approximately 25 GW of additional capacity annually until 2020. The demand for electricity in Africa, China and India will increase as rural areas become electrified. By promoting the expansion of the segment of electric vehicles and hybrid cars, developed countries will also make a significant contribution to increasing global electricity demand. By 2020, the level of electrification in the world will reach 80% [1; 4].

The second trend is the growth in natural gas consumption and the rapid increase in unconventional gas extraction. Global demand for gas, which has increased since 2014, has accelerated its growth in 2017, helped by Asia, which accounted for ⅓ of the demand. China has become the largest contributor to increasing gas consumption, which is in line with its policy of replacing coal with gas. Economic growth has also contributed to increased gas demand in India, Japan and South Korea (low availability of nuclear energy for the latter two countries). The economic growth and increased heating requirements led to an increase in Russian gas demand, which accounted for almost ¼ of the world's demand.

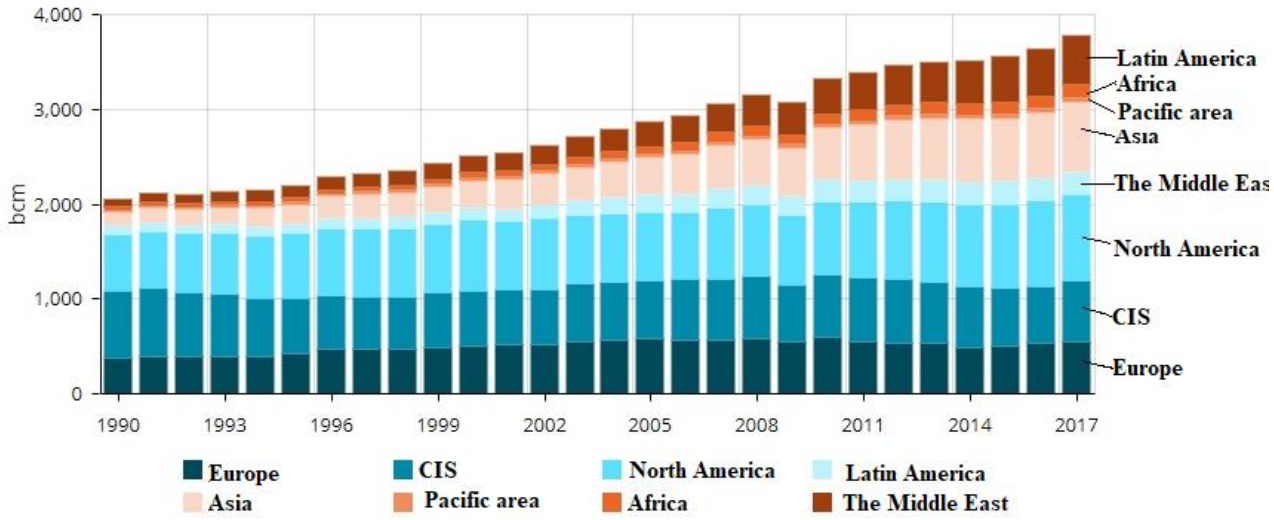

Figure 5. Consumption of natural gas by regions and continents, 1990-2017 [4]

Authors' research denotes that gas consumption continued to grow steadily in the Middle East, especially in Iran and Saudi Arabia, as well as in Africa, mainly in Egypt (due to increased domestic production) and in Nigeria [9]. Improving economic conditions and reducing the availability of nuclear and hydro power in Europe contributed to increased gas consumption, especially in Germany and southern Europe (Turkey, Italy, Spain and Portugal). In the United Kingdom, it has decreased due to the softer temperature and fierce competition with renewable energy sources in electric ventilation [13]. Gas consumption, for the first time in seven years, was reduced in the United States, the reasons were the decline in electricity demand, competition with renewable sources and relatively high hydrogeneration. In Canada, gas consumption has increased.

The *third trend* is the development of renewable energy. The share of renewable energy sources (including hydropower) in the global power generation system, which in turn has grown rapidly since the late 2000s, has grown by almost 1 percentage point in 2017, reaching almost 25%.

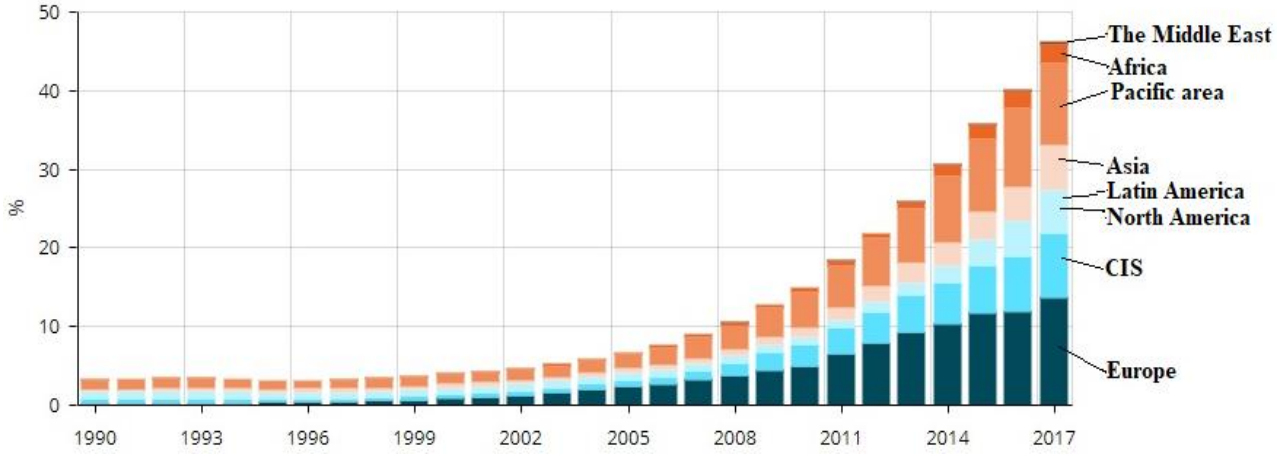

Figure 6. Share of alternative sources in electricity generation, % [15]

Wind and solar energy are gaining popularity at this point, helped by ambitious policies on climate in the European Union, the United States, China, India, Japan and Australia, as well as a sharp drop in the cost of building solar and wind installations, which allowed developing countries to expand their renewable capacities. In 2018, as in 2017, the total use of renewable energy sources was about 180 gigawatts (GW). According to the IEA, the volumes on a yearly basis have not increased for the first time since 2001 [3]. Solar stations are responsible for 20% of additional electricity generation in 2017, and wind farms - for 30%. Renewable energy sources now cover ⅓ of the energy mix in Europe, 1/4 in China and ⅙ in the United States, India and Japan.

Table 2. World Energy Production, mil t c. [8; 15]

Indicators	2016	2017	Average annual variation, 2016-2017, %
Production	13014	13323	2,4
Petrol	4377	4387	0,2
Gas	3052	3165	3,7
Coal	3664	3769	2,9
Hydro-powers	913	919	0,7
Nuclear power plants	591	596	0,5
Alternative energy sources	417	487	17
Consumption	13258	13511	1,9

Table 3. Electricity consumption from alternative energy sources, 2017, mil t. [8; 15]

Indicators	2016	2017	The annual growth rate,%		Consumption structure in 2017, %
			2016 / 2017	2006 / 2016	
Total	417,4	486,8	17,0	16,2	100,0
Asia-Pacific	140,8	175,1	24,7	21,9	36,0
Europe	144,2	161,8	12,5	13,8	33,2
North America	96,8	109,5	13,5	13,6	22,5
Central and South America	28,6	32,6	14,3	17,7	6,7
Africa	5,2	5,4	7,4	17,8	1,1
Other regiuns	1,8	2,4	-	-	0,5
OECD countries	270,1	304,9	13,2	13,6	62,6

In the European Union, the share of renewable energy sources remained stable in 2017, since a significant increase in the production of renewable energy in Germany and the UK was offset by unfavorable hydraulic conditions in southern Europe (France, Italy, Spain) [1]. The European Union intends that by 2020 the share of renewable energy sources will account for 20% of all generation volumes; the US target is 10–20% of renewable energy production, while China expects to get 100 GW of renewable energy in 2020. These efforts, combined with the development of technology, will eventually lead to the achievement of grid parity: that means the moment when the cost of electricity production based on fossil fuels is equal to or lower than the cost of electricity production from renewable sources. Most likely, this phenomenon will occur for the first time in those countries whose significant share of the energy balance falls on renewable energy sources. However, countries whose economies are mainly dependent on fossil fuel will reach parity much later [9].

The *fourth trend* is increasing energy efficiency. Energy efficiency is the effective (rational) use of energy resources [11]. The use of a smaller amount of energy means to provide the same level of energy supply of buildings or technological processes in production. For the second year in a row, China has been the most attractive country to invest in renewable energy. In China, solar energy is growing at an incredibly high rate. Only in the first three months of 2017, new solar power plants and solar panels for home, with a total capacity of 7.21 GW, were commissioned in China. During this period, the country produced 21.4 billion kWh/h of solar energy, which is about 80% more than in the first quarter of last year. Currently, China is building the largest solar power plant in the world, which consists of 6 million solar panels with a capacity of, at least, 2 GW [10].

Most developed countries are actively designing and implementing solutions to improve the energy efficiency of household electrical appliances, establishing control over their minimum energy efficiency and introducing appropriate operational standards for an increasing number of household appliances. Technologies aimed at reducing the amount of fuel consumed and reducing carbon dioxide emissions, such aspects as energy control, green buildings and clean transport will be key technological tools that contribute to improving energy efficiency and reducing CO_2 emissions [6].

The fifth trend is the global revival of nuclear energy, led primarily by China, India and Russia. Nuclear power is one of the most profitable technologies that can meet the ever-growing demand for electricity, which also makes a huge contribution to achieving energy independence and security of supply. Among the most powerful nuclear power plants are: Wintersburg (Arizona, USA) with a capacity of 3942 MW, Ohi (Japan) - 4693 MW, Cattenom (France) - 5200 MW, Paluel (France) - 5320 MW, 5460 MW, Yeonggwang (South Korea) - 5875 MW, Zaporijjea (Ukraine) - one of the largest nuclear objects in 6 reactors with a capacity of 6000 MW, Kashiwazaki-Kariwa (Japan) - 7965 MW, Fukusima I, II with 88414 MW (but reactors 4 and 6 were deteriorated). The largest capacity is recorded in Belgium with a capacity of 5918 MW (49.9%), UK - 8918 MW (19.3%), Germany - 10799 (11.6%), Canada - 13554 MW (14.6%), China - 34514 MW (3.9%), Russia - 26142 MW (17.8%), Romania - 1300MW (17.7%), USA - 99952 MW (20% %), Sweden - 9102MW (39.6%), total - 394054MW (10.9%) [14]. In the entire industrial chain within the nuclear energy sector, the number of partnerships and cooperation agreements is increasing, which helps to keep up with high global demand.

5. Conclusion

As a result of the research, the authors came to the conclusion that the country that intends to become a leader in the production of electricity needs to develop alternative energy, look for new fields for natural gas extraction and unconventional gas extraction, and also pay attention to the dominant trends in the global energy market. The energy industry throughout the world is experiencing revolutionary changes associated with the rapid development of an alternative, "green" sector. The turning point in this area was 2015, when the global input of renewable energy sources (RES) for the first time exceeded the input of traditional energy facilities. Over the past 10 years, the installed capacity of "green" generation in the world has grown nine times to 917 gigawatts. All these trends will allow in the future to significantly reduce energy costs — on the one hand, and to improve the quality of life of the population, on the other, also they will ensure a good position in the global energy market, and in the future, the leading role.

Researching the world energy market, we can outline some major trends:

- The main consumers in the future will be China, India and Africa,
- By 2030 global energy consumption will increase by 44%. Increasing electricity consumption will grow due to the electrification of agriculture and rural areas as well as electrification of car transport.
- Extending the use of natural gas and alternative sources. Works are taking place in Europe, China, USA.
- Marketing of coal use technologies, reducing CO2 emissions.
- Expanding the use of nuclear energy (pioneers in the field are China, India, Russia).
- Implementation of intelligent technologies and devices for energy efficiency and reduction of polluting substances.
- Development of efficient energy storage systems.
- Liberalization of the energy market, development of competition and the possibility of consumers to choose a supplier.

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Rezumat

Consumul global de energie a sporit în ultimii ani cu 2,3%. Cererea avansată se datorează unei economii globale puternice și a necesităților mai mari de energie pentru încălzire și răcire în unele regiuni ale Globului, creșterii prețurilor la metale, grâne și produse alimentare. Piața energetică este contradictorie: dintr-o parte crește cererea pentru energie, din altă parte dobândirea energiei este însoțită de epuizarea resurselor naturale, eliminarea produselor nocive și cu efecte de seră, accidente și dezastre. Importanța problemei este confirmată de inițiativa Singapore de a dezvolta inițierea unui fond pentru energie. Nu toate țările dispun de surse necesare pentru a face față cerințelor societății. Ca consecință apar decalaje între țări privind sursele de energie și utilizarea ei eficientă.

Cercetările autorilor se axează pe accentele puse de societate privind utilizarea surselor tradiționale de energie și celor netradiționale, regenerabile, cu efecte blânde asupra mediului și societății. Scopul cercetării constă în investigarea situației pieței energetice la nivel global, regional și selectarea căilor (teoretice și practice) al aplicării vectorului efortului statelor în depășirea problemei insuficienței energetice, identificarea unor rute energetice alternative. Fiind conștientizată importanța majoră a energiei în toate domeniile economiei, apare necesitatea securității energetice. Pentru realizarea acestor deziderate, autorii au apelat la metoda analizei macroeconomice, geopolitice și geoeconomice, măsurare, logica deductivă, raționamentul inductiv, modelare experimentală, selectarea variabilelor, metoda statistică, previziunii, inducției, deducției etc. Cercetările au permis identificarea surselor de energie pe glob, structura lor, dinamica utilizării și previziunea surselor energetice pe glob, ponderea surselor alternative pentru viitorul apropiat. Identificarea oportunităților utilizării energiei nucleare, ieftină, sigură, eficientă, dar uneori riscantă. Republica Moldova, ca țară lipsită de propriile resurse energetice, trebuie să-și asigure securitatea energetică, utilizând diverse surse conforme tendințelor mondiale în acest domeniu.

***Cuvinte-cheie**: energie, resurse energetice, surse alternative de energie, avantaje*

Аннотация

Мировое потребление энергии увеличилось на 2,3% за последние годы. Повышенный спрос на энергию обусловлен сильной мировой экономикой и более высокими потребностями в отоплении и охлаждении в некоторых регионах земного шара. Важность вопроса подтверждается инициативой Сингапура по разработке запуска энергетического фонда. Однако не все страны имеют необходимые ресурсы для удовлетворения потребностей общества. Из-за различий в обеспечении источниками энергии

между странами возникают торговые отношения, а иногда напряженность и воины.

Авторские исследования направлены на изучение опыта использования традиционных и нетрадиционных источников энергии, возобновляемых источников энергии, оказывающих воздействие на окружающую среду и общество. Целью исследования является изучение ситуации на энергетическом рынке на глобальном, региональном уровне и выбор теоретических и практических способов применения вектора государственных усилий для преодоления проблемы нехватки энергии и выявлении альтернативных источников энергии. Осознавая важность энергетики во всех сферах экономики, возникает потребность в обеспечении энергетической безопасности. Для достижения этих целей авторы использовали метод макроэкономического, геополитического и геоэкономического анализа, измерения, дедуктивной логики, индуктивного мышления, экспериментального моделирования, выбора переменных, статистического метода, прогнозирования, индукции, дедукции и др. Исследования позволили определить мировые источники энергии, их структуру, динамику их использования и глобальный прогноз источников энергии, удельный вес альтернативных источников на ближайшее время. Определена перспективность дешевого, безопасного, эффективного, но иногда рискованного использования ядерной энергии. Республика Молдова как страна, не имеющая собственные энергетические ресурсы, должна обеспечивать свою энергетическую безопасность, используя различные источники в соответствии с мировыми тенденциями в этой области.

Ключевые слова: *энергия, энергоресурсы, альтернативные источники энергии, преимущества*

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