

# Analysis of the global energy resource market

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**Abstract.** The paper analyses the global demand for various energy resources in recent years. Nowadays, qualitative and quantitative changes in structure of distribution and consumption of energy resources take place. The paper has reviewed a number of papers predicting two-fold increase in the global energy production market by 2040. A number of other papers also predict the shift of energy demand from the USA and EU countries to the Asian market. The paper presents percentage distribution of world's energy requirements satisfied by the six types of resources among which oil, gas, and coal are still predominant. Some papers have stated that the demand for natural gas will continue to grow faster than the demand for oil or coal in the future. To confirm or deny this theory the authors have designed the mathematical model showing trends in demand for gas compared to the total demand for oil and coal; as a result, two different polynomial functions have been obtained with almost the same probability confirming this prediction. Trends in energy production and change of global energy demand across regions over the past twenty years have been studied. The studies show that, in general, energy production has been increased for the last decade. However, due to economic crises fluctuations, energy production in EU countries has abruptly decreased; it results in displacement of the EU countries from the market by the countries of the Middle East and the Near East. The paper also notes such important factors as decrease in solid fuel production in Great Britain; steady increasing importance of renewable energy sources for the last few years; reducing of the rate of nuclear energy development by some key countries; general lack of energy resources in EU countries, etc.

## 1 Introduction

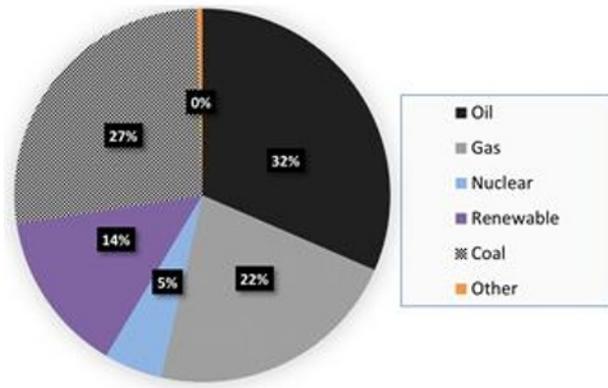
In the XXI century, the advent of new technologies in production results in qualitative and quantitative change in structure of distribution and consumption of energy resources. In global economy, the majority of countries tend to reduce domestic energy consumption. They actively employ local kinds of conventional fuel that should be necessarily renewable one in industry [1]. During 2015-2019, increase in production of the main kinds of products was relatively small in most countries due to political instabilities. Besides, imposing sanctions on our country also influenced the structure and pattern of growth of production rate [2].

Over the next twenty years, in the world market, the bulk of the demand for energy resources is expected to shift from the USA and the EU countries to the Asian markets, which are rapidly developing now. According to this expectation, the global energy production market should almost double by 2040. This prediction is based upon the positive trend of economic indicators of the countries with developing economies. In general, they display a three-percent economic growth annually and are capable of doubling these indicators in the future

(under favorable projections) [3]. However, these growth rates are compensated to a considerable extent by the improved energy efficiency. Thus, the demand for energy consumption in the world as a whole should not grow by 100 % but only by 30 %. At the same time, oils, gas, and coal will remain predominant sources of energy, while new renewable sources of energy alongside with nuclear and hydroelectric power will provide only a half of the expected 30 % of energy. Despite that, conventional sources of energy (oil, gas, and coal) will remain predominant. In 2040, they are expected to account for more than 75 % of supplies (in comparison with 81 % ones in 2018) (figure 1).

In 2018, six types of resources satisfied global energy requirements. The basis of demand was represented by hydrocarbons (81 %): oil (32 % of total consumption), gas (22 %), and coal (27 %). In the coming decades, this raw material, as earlier, will remain the basis of energy supply for the world's economy. Meanwhile, the proven oil and gas reserves will be sufficient at the current level of production for the next fifty years, as for the coal, its reserves will be sufficient for the next 150 years.

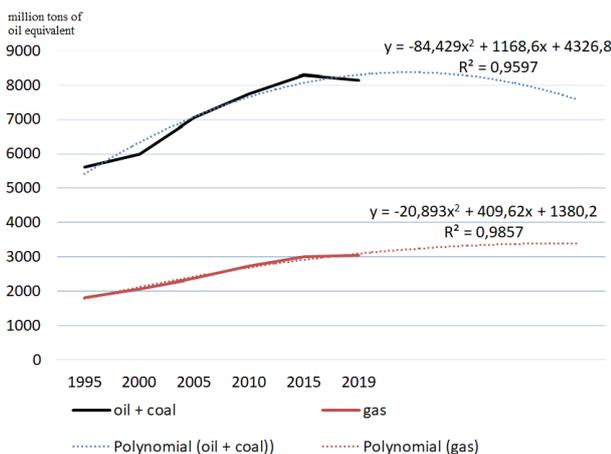
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**Fig. 1.** Global requirement (demand) for various sources of energy in 2018.

## 2 Research results

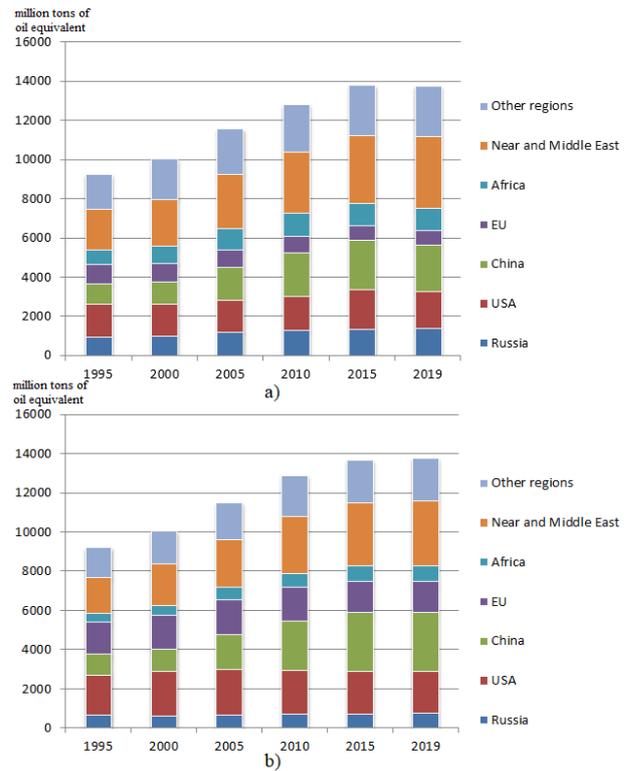
Some scientific papers [4, 5] express the opinion that the demand for natural gas will continue to grow faster than the demand for oil and coal in the future. Larger volumes of liquefied natural gas production facilitates this process, as it is becoming available all over the world. In designing the mathematical model showing trends in demand for gas compared to the total demand for oil and coal, two different polynomial functions have been obtained with almost the same probability (97,96 % and 99,28 %), confirming the given forecast by 2040.



**Fig. 2.** Forecast of trends in demand for gas in comparison with the total demand for oil and coal.

Figure 2 shows that even without the data of the last drop in demand for oil (March-April 2020), which occurred due to a recession in the oil market caused by the Covid-19 pandemic in the world, according to the designed mathematical model  $y = -84.429 \cdot x^2 + 1168.8 \cdot x + 4326.8$ , minimum demand for oil and coal in 2020 was supposed to remain at the level of 2019 without a considerable growth. It is impossible to access the scope of the current drop of demand for oil within all the countries if only fluctuations of spot prices per a barrel of oil are taken into account. Nevertheless, after quarantine as early as in April 2020, China reduced its oil consumption by 17 % in comparison with the same period in 2019 [6].

Trends in energy production (supply) and energy requirement (demand) in definite regions of the world are shown in figure 3.



**Fig. 3.** Trend in energy production (a) and change of global energy demand (b) across the regions over the past ten years.

In 2018-2019, oil production increased by 0.5 % due to the countries of the Middle and Near East, at the same time the volume of production of these raw materials reduced in China and the USA [7]. In general, for the past ten years, increase in energy production has been evident. However, due to economic crisis fluctuations energy production in the EU countries has abruptly decreased. Countries of the Middle and Near East have displaced them. Meanwhile, gas production has increased approximately by 0.5 %, it became one of the lowest indicators of the growth rate for the last three decades [8]. Australia contributed to some revival in the development of the gas sector, as it began to operate new facilities for the production of shale gas, which facilitated the increase in volume of interregional supplies of this type of fuel by 4.8 % [9].

In the structure of energy consumption of the economies of developing countries, the share of hydrocarbon energy approaches 12 %, but in developed capitalist countries, this indicator approximates 20 % taking into consideration more intense use of nuclear energy and energy from renewable sources [10].

Increase in energy consumption in the developing countries mainly witnesses the development of transport infrastructure and an industrial sector as well as improvement of living conditions of the population. Nowadays their share accounts for about 60 % of the global demand [11].

In the course of cooperation with developed countries, which took place through the opening of production subsidiaries of transnational corporations on the territory of underdeveloped countries, these countries adopted modern energy-intensive technologies and moved to a higher level of energy development [12].

The data characterizing the production and the consumption of the main types of energy in the world are shown in table 1.

**Table 1.** Global production of main types of energy in 1995-2019, in mln. ktoe.

Types of Energy	1995	2000	2005	2010	2015	2019
Coal	4996	6001	7331	8660	9552	9594
Oil	1237	1212	1135	974	973	931
Gas	2116	2747	3701	4810	5552	5794
Nuclear	2332	2591	2768	2756	2570	2606
Renewable	2636	2836	3294	4200	5536	5939
<i>including hydro</i>	2479	2618	2935	3445	3905	4061
<i>sunny</i>	33	55	141	408	1132	1330
<i>windmill</i>	130	164	226	360	517	571
Other	40	52	58	68	80	82

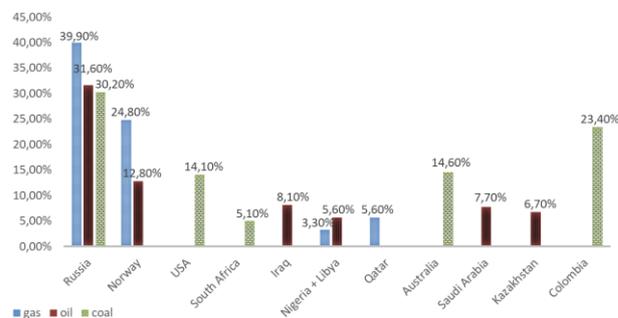
Therefore, over the past ten years, the main increase in global demand for energy was provided China as well as India and Brazil (about 56 %). Since 2016, demand for primary energy in total consumption of these countries has exceeded 30% compared to 23 % in 2005. However, one should notice, that after stagnation caused by the pandemic of coronavirus at the beginning of 2020, the situation will change in the direction of a decrease in natural indicators and an increase in relative ones with regard to such countries as the USA, Russia, and EU countries. To compare: in the USA this indicator has increased by 21.3 % for 15 years; however, globally the demand decreased from 20.2 % in 2005 to 15.7 % in 2019 of total world energy consumption [13].

It should be also noted that Great Britain reduced solid fuel production (in 2006 – 11,4 mln. ktoe, in 2016 – 2,6 mln. ktoe) and closed the last mines in April 2017. As a result, this branch of industry – one of the major ones in the past – completed its more than two hundred-year-old journey (1815-2017) [14].

During the past several years, importance of electric energy generated by renewable sources is increasing. Its generation in 2006-2016 increased by 29 %. To compare: at the same period of time the production of basic types of hydrocarbon fuel increased by half – about by 15 %. Nowadays, the main sources of energy generation are nuclear power plants and large hydropower stations (with power more than 10-25 MW) [15–17].

Leaders on a scale of productivity of nuclear energy remain the USA (32,4 % of global generation) and France (15,4 %). Germany continues to adhere to the pace of drawdown of nuclear energy. Japan that had had 54 nuclear reactors decommissioned after the accident at NPP “Fukushima-1” (March 2011) did not re-established

its facilities in their former extent. In 2015, they began disassembling of units that had been maintained for more than 40 years. However, annual purchase of coal and gas with 30 billion dollars complicated the country’s balance of payment, and currently, a revival of the national nuclear industry has been outlined (till 2011 its share accounted for to 30 % of electric energy production). Japan will be able to increase production after completing complex works to improve safety of NPP according to the requirements of IAEA.



**Fig. 4.** Structure of import of hydrocarbon fuel in 2016 to the EU countries.

In the global energy economy, the greatest progress is made in the field of renewable sources (in 2016 – increase by 14,4 %). The leader of the segment is Holland. Last year its share accounted for about 50 % of energy generated in such a way, while the relative importance of solar power was 18 %. Nevertheless, the EU countries experience a general shortage of energy resources that is compensated by import from other countries. At the same time, Russia remains the main importer. The structure of import is shown in figure 4. It illustrates that the Russian Federation supplies the EU countries with all types of hydrocarbon fuel.

### 3 Conclusion

In general, over the past twenty years the efficiency of the used energy resources increased and energy consumption decreased. In 2005-2015, with the growth of GDP by 26,5 % (at constant prices) global energy consumption increased by only 19 %.

In the recent years, energy efficiency has increased amid falling consumed energy losses [18–20]. In the period from 2006 to 2010 with the growth of global GDP by 26,5 % (at constant prices) global energy consumption increased by only 17,8 %. Therefore, in 2006-2010 energy consumption rate of growth was more than 2 %, and the first half of the last decade was characterized by a steady lack of energy resources that was 130 million tons in average [20].

In 2011-2015 the situation started to change in reverse. Rates of growth of energy consumption of all types have decreased to 1 % for the recent three years, and the lack turned into excess. Thus, oil production exceeded the demand almost by 90 million tons per year back in 2018, while oil prices fell approximately by three times compared to the record levels in 2008 and 2012. At the beginning of 2020 before the beginning of the

world crises, the exporters of fuel and energy products did not respond appropriately to stabilize the market in spite of the obvious production costs and losses of national budgets caused by the coronavirus pandemic.

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