Prospects of the Russian Coal Industry in the Conditions of Transition to a New Energy Pattern

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Abstract: The article analyzes the prospects for changes in the volume of exports of Russian coal due to the reduction of its consumption for energy production by the importing countries. The importance of Russian power generating coal for the energy supply to the world as a whole and to individual importing regions in particular is shown. It is justified that a radical and abrupt refusal to use coal as an energy source in the next few years would hardly be possible because the per capita and the total electric energy consumption has been growing all over the world. To a large extent, this is due to the increase in the number of data centers around the world, which centers do not yet have enough "green" sources of energy to ensure the uninterrupted operation thereof. Therefore, coal exports from Russia to the European countries, China and DPRK will continue to grow in the years to come; this is confirmed by the forecast models built by the authors, which models consider changes in the coal and electricity consumption by major importers. By the time the conditions are ensured for the majority of countries in the world to abandon coal as a source of electricity in order to stop air pollution, Russia will need to find opportunities for its alternative use, an example of which would be the creation and development of production of competitive products of the coal chemical industry.

Keywords: Coal consumption forecast, export of Russian coal, energy consumption by DPC (Data Processing Center), coal chemical industry, econometric model, global coal consumption, energy consumption growth, closure of thermal power plants.

I. INTRODUCTION

In the world at large and in most of its regions, coal production peaks occurred in 2013-2014.

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The necessity to reduce air polluting emissions has triggered a trend towards shifting from coal, the most important but climate-damaging energy source, to other sources.

For Russia, coal is one of the significant positions of foreign trade, and the prospects for coal export largely determine the future social and economic position of the country, since it directly affects the financial position of miners, the availability of orders from Russian Railways [14], and the return on investment in new coal terminals built for trade with the EU (European Union) near St. Petersburg and Murmansk [1].

In this article, an attempt has been made to analyze to what extent the pessimistic forecasts of a sharp decline in the purchase of Russian coal by the countries of the world are true and, first of all for Europe, as well as to justify the important role of the coal chemical industry in the transition to a "clean" world energy. In particular, the role of the development of digital technologies has been demonstrated as the most important factor that slows down the abandonment of the coal-fired thermal power plants.

II. RUSSIA'S CURRENT POSITION AS THE WORLD'S LARGEST EXPORTER OF THE POWER GENERATING COAL

Coal is the second major energy source in the world (providing 27% of the energy consumed) and the third major energy source in Europe (15%) (Figure 1).

It has been one of the leading energy sources for quite a long time: according to statistics, it has been holding the second position in the world for more than 50 years; in Europe as early as in 1965, coal provided more than 50 percent of the energy consumed and was the dominant source; in 1967 oil got ahead of it, and in 1996 — so did the natural gas. In addition, coal is the main source of electricity in the world (in Europe such order of things was maintained until 2017, after which the leading position was taken by nuclear fuel).

The global consumption of coal has been growing over the last 50 years; however, it has been uneven and heterogeneous. Thus, the decline in consumption observed in the last 10 years in North America and in Europe is compensated for 20 years by the almost exponential growth of such fuel consumption by China in the period of 2000-2013, which has now stabilized and fluctuates at the level of from 1 to 2% per year.

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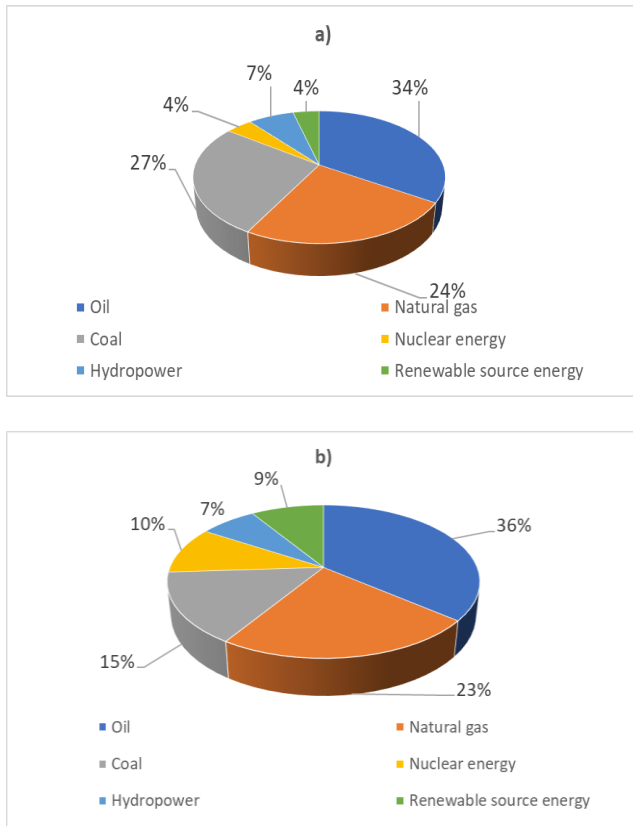
Fig. 1. Structure of sources to ensure the global energy consumption (a) - in the world, (b) - in Europe

Russia, the world's second-largest country in terms of proven coal reserves (only the US is ahead of it), provides 15% of the global exports. This is a significant volume. For reference: Australia and Indonesia export more (29% and 25% respectively), the share of each of other exporters does not exceed 6%. In 2018, Russia exported 136.2 million tons, and approximately half of this volume (66 million tons) it exported to European countries, 62 million tons — to the countries of the Asia-Pacific Region in which the main buyers of the Russian coal are South Korea and China (17.8 and 17.1 million tons respectively). It is worth noting that for Europe Russia is the main supplier of coal since it provides 44% of all supplies (the USA holds the second place with 28%). Based on the study of the existing situation, let us discuss the prospects for possible changes in the volume of exports of the Russian coal.

III. FORECASTING

As rightly been noted by [2, P.36-38], the production of electricity by coal-fired power plants in Europe is declining; the decrease can be seen in the number and production capacity of such plants. Without denying this fact, let us turn to statistics. According to the Annual Report of British Petroleum [3], 70% of all coal consumed by Europe is consumed by 6 countries (Table 1). Among them only Spain showed a significant reduction in consumption in 2018. These data, as well as information from open sources [4, 5] confirm that the above mentioned countries make up a shortfall in production of their own coal for account of Russian supplies

and, consequently, are more (like Germany and Turkey) or less (Poland, Czech Republic) dependent on them.

In addition, according to [6], the total reduction in capacity of coal-fired power plants in these countries announced for 12 July 2019 will be in the coming years as follows: 13% — in Germany, 7% — in Spain, 5% — in the Czech Republic, and 3% — in Poland. For reference: Sweden and Finland announced a 100% capacity reduction, Denmark — a 69% reduction. However, today the consumption of coal by these countries is insignificant. Turkey, on the contrary, plans to put new power plants into operation while the reduction of capacities is not planned at all. It should also be noted that despite the reduction in total consumption of coal, the volume of imports of this energy carrier by the European countries is growing by an average of 2.3% annually (in 2018, the growth was 6.9%).

The reason for the abandonment of the coal-fired power plants around the world is the significant harm caused by the emission of waste from their activities into the atmosphere [12, 13, 15]. The reason why such abandonment is not radical and fast is the widespread growth of demand for electric power. Thus, according to the International Energy Agency, the average per capita consumption of electric power for the last 20 years has grown as follows: by 45% — in the world, by 14% — in Europe, and by 411% — in the DPRK. The total electricity consumption in the world has grown by 80% over these years. The development of digital technologies, in particular the increasing cloud-storage capacity, crypto currency mining leads to the need to increase the capacity of data processing centers and allows us to say with certainty that the growth of energy consumption will continue. "According to experts' estimates, by 2025 the DPCs may need up to 20% of all electric power produced in the world" [7]. For example, in the USA alone the data processing centers consume 90 billion kilowatt hours of electricity per year; this is enough to satisfy 40 percent of the annual energy requirements of the United Kingdom [8]. The issues of improving the energy efficiency and environmental friendliness of DPCs have no simple solutions at present. In particular, according to [7], the problem arising from using wind and solar power is the instability of such sources. In addition, despite the increasing contribution of alternative sources to electricity generation, it is likely that the annual growth of demand will significantly outpace the growth of generation. The existing renewable energy facilities can in no way be expected to meet future demand on the part of the data processing centers. This means that countries will have to generate electricity using more traditional sources, including coal [8]. All this suggests that the rapid reduction in coal consumption by the European countries due to the closure of coal-fired power plants is not likely.

A well-defined and less contradictory trend i.e. growing coal consumption and imports in the past 20 years is typical for the coal-consuming countries of the Asia-Pacific Region.

Figure 2 shows the dynamics of consumption and import of coal by the regions that are key importers of Russian coal.

Table- I: Coal consumption by Europe

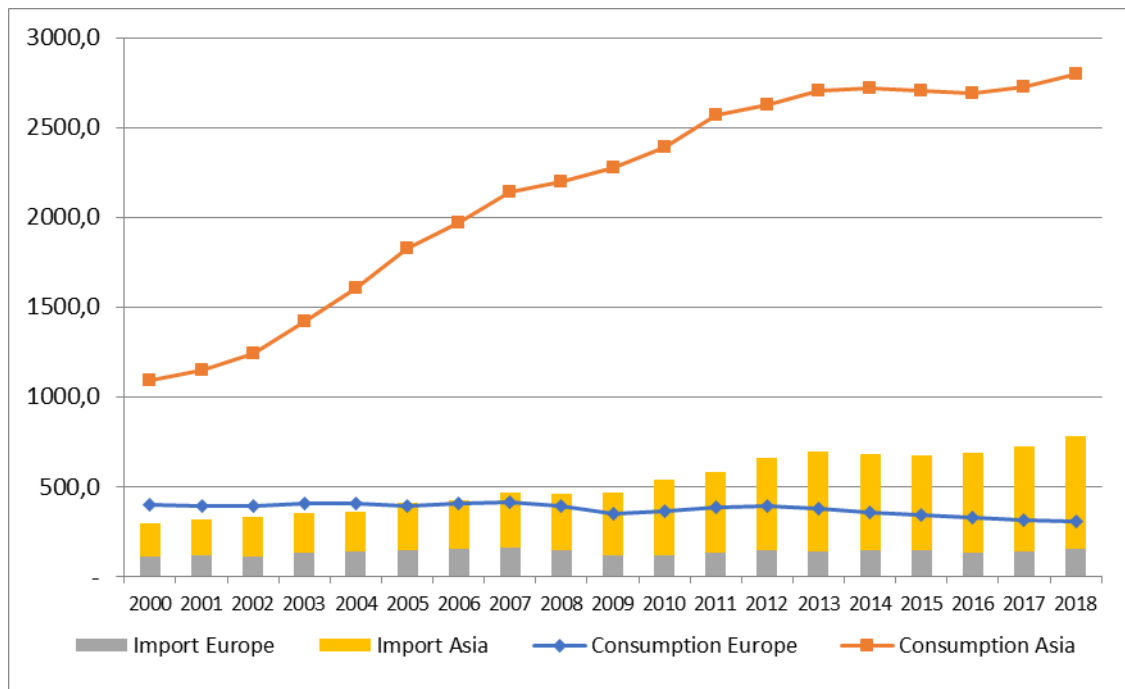|	Reserves, million t	Production, million t in oil equivalent	Percentage of consumption independently provided by the country, %	Consumption, million t in oil equivalent	Change of consumption for the period, %	
					2018	2007-2017
Germany	36103	37,6	57	66,4	-7,2	-1,9
Poland	26479	47,5	94	50,5	1,5	-1,2
Turkey	11526	17,0	40	42,3	7,2	3,0
Ukraine	34375	14,5	55	26,2	2,0	-4,3
Czech Republic	2657	14,6	93	15,7	1,0	-2,8
Spain	1187	2,7	25	11,1	-17,3	-3,9

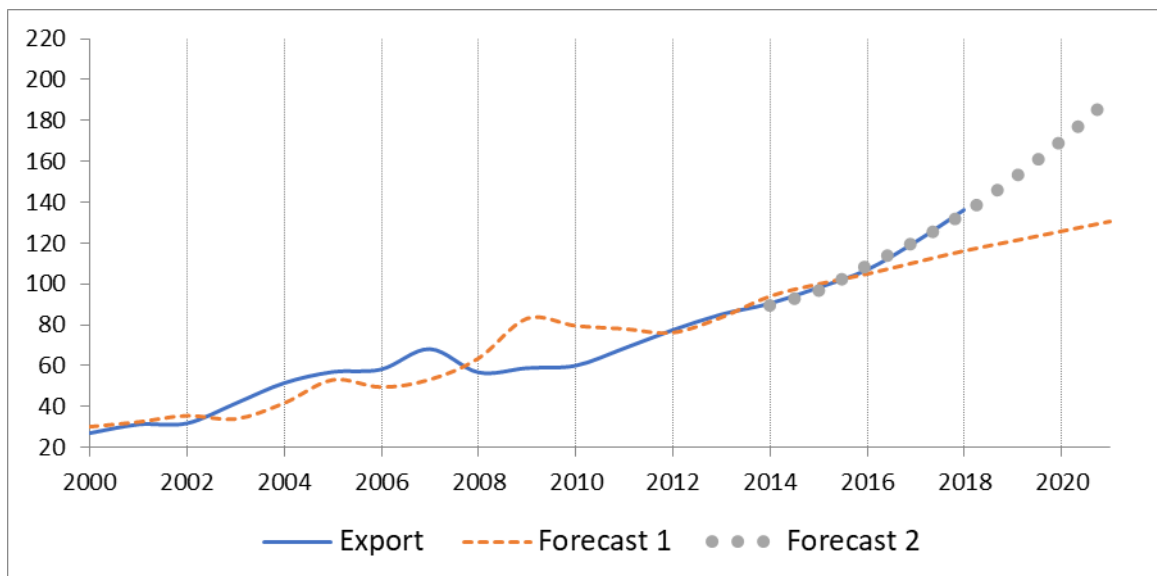**Fig. 2. Dynamics of coal import and consumption by the European and Asian countries**

Fig. 3. Russian coal export volume in 200-2018 and forecast for 2019-2021

In order to identify the most significant factors that determine change in Russian coal exports, a correlation analysis was performed. The results are as follows:

1) In the long-term retrospective, coal exports are most closely correlated with consumption by major importing regions (Asia (excluding Australia and New Zealand) and Europe),

2) In the last 5 years, there has been an even closer correlation between the export of Russian coal and electricity consumption in the consuming regions.

IV. RESULT AND DISCUSSION

A Regression Model (1) was built based on the data on consumption and export of Russian coal:

$$Y = 167.72 + 0.03X_1 - 0.43X_2 + \varepsilon \quad (1)$$

where Y — amount of coal exports by Russia

X_1 — consumption of coal by the countries of the Asia-Pacific Region (excluding Australia)

X_2 — consumption of coal by the countries of Europe

A Regression Model has been built (2) based on the data on total electricity consumption by the main regions that are importers of Russian coal and on exports:

$$Y = -1888.6 + 0.02 \cdot X_3 \quad (2)$$

where Y — amount of coal exports by Russia

X_3 – total electricity consumption by the countries of the Asia-Pacific Region (excluding Australia) and Europe.

Both models have good accuracy (determination coefficient was 0.87 and 0.99, respectively) and reliability (p-value for each parameter does not exceed 0.005). The negative coefficient in front of the variable that indicates coal consumption by the European countries in Model 1 may be due to the fact that despite the decrease in consumption in these countries, their coal imports are increasing. Model (1) was used for the forecast which considers the persistence of the rate of change in coal consumption by regions (average for the modeling period). The forecast made with the use of Model 2 considers the trend of change in total electricity consumption formalized as a slowing growth: $y = 1514.3t^{0.2841}$. The results of the forecast are shown in Figure 3.

Both forecasts made using Regression Model 1 and Regression Model 2 show an ascending tendency for the next two years that is favorable for the Russian coal industry. And Forecast 2 is more optimistic, according to it, Russia's coal exports will amount to 191.3 million tons of coal (in oil equivalent) by 2020. The above models confirm the conclusion made earlier that a sharp decline in export volumes due to the closure of thermal electric power plants should not be expected to happen in the next 2 to 3 years. Model 2 confirms the assumption that the importers' demand for power generating coal is closely related to the growth of power consumption.

However, the transition from predominantly coal-fired energy industry to cleaner energy is inevitable even in the medium term if not in the short term [15]. Russia, which has the richest coal reserves in the world, needs to spend the time required for such transition in order to develop the coal chemical sector as a branch of industry. Already today, Russian scientists have developed the coal gasification and coal liquefaction technologies associated with lower emission of gaseous pollutants as compared to direct coal combustion [9]. Speaking of the advantages of the coal chemical industry, we can cite as an example the statement of Alexander Kozlov, Director for Science at the Institute of Coal Chemistry and Materials Science: "More than 180 types of chemical products can be produced as a result of deep processing of coal and technogenic waste. And they, in turn, can be used to produce thousands of products of related industries" [10].

V. CONCLUSION

Total and per capita consumption of electricity continues to grow despite the downward trend in energy costs per unit of GDP in all industrialized countries. One of the main reasons for this is the worldwide growth in the number of the data processing centers driven by the development of digital technologies the functioning and the maintenance of uninterrupted operation of which is associated with significant electrical energy consumption. Thus, despite all efforts to reduce the use of air polluting energy sources, a categorical abandonment of coal-fired power plants in the next few years appears highly unlikely, and this is confirmed by the forecast models. However, it is inevitable in the medium term. Therefore, in order to preserve the coal industry and to use the competitive advantage of Russia as the owner of the world's richest coal reserves, at the present time the efforts should be focused on creating, implementing and commercializing the results of use of coal deep processing technologies.

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