The role of transport in export development of fuel and energy complex

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Abstract. The development of transport infrastructure is becoming a strategic priority for Russian fuel and energy complex development in aspect of increasing its competitive ability on the world stage. The transport industry is not only the leading consumer of fuel and energy products, it is the most important condition for an effective functioning of fuel and energy complex, participate at all stages of manufacture, starting from mining and ending with the delivery of fuel and energy products to the consumer. The research includes the state of national fuel and energy complex over the past decade, current trends and forecast of development based on power function. The research also includes the role of certain types of transport in the functioning of the fuel and energy complex. The export component analysis of national fuel and energy complex development was done with condition of sanctions restrictions on oil, gas and coal supply, and reorientation of logistic flows to the Asia-Pacific countries.

1 Introduction

The current period of geopolitical transformation, the increasing sanctions on industries and companies of the Russian economy are becoming a vector of new development and reorientation of the processes in foreign economy activity of Russia. A strengthening the international economy integration with countries of the Asia-Pacific region in fuel and energy sector changes the country’s role in global energy trade and requires the search for new strategic solutions for the development of transport infrastructure, requires increasing the capacity of transport routes of the Eastern borders.

The experience of recent years, especially in the context of the current crisis and the ultimatum position of Western foreign economy measures directed against the Russian economy, has shown that statement of M. Porter «Firms, not nations, compete in international markets» has lost its relevance. Can we call the position of Western countries to Russian

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companies as a competitive strategy? Obviously no. At the same time, all Porter's Five Forces are those factors that undoubtedly influence on competitive ability in the industry, reflect the current reality and give the Russian economy the necessary competitive advantages.

The first and important is «Supplier Power». Undoubtedly, Russia is a leading exporter and one of the leading countries in gas, oil and coal production. For example, Russian export accounted about 40% of gas consumed in Europe in 2021. «Buyer Power» also plays a role. As practice has shown, the principles of a market economy are alien to the United States and few European countries. It is obvious that a significant proportion of Russian oil and gas exports, including export to European countries, is critically important for the effective development of such countries, for maintaining the level and quality of life of the population, modernizing and developing production, attracting investment. It turns out that sanctions on the supply of Russian energy resources have negative impact only on the now «unfriendly» consumers. At the same time, Russia increases its supplies to Asia-Pacific countries and diversifying its export flows to other countries. For example, pipeline gas supplies from Russia to China in 2021 increased 2.5 times, exceeding the mark of 7.53 million tons. In value terms, imports of Russian natural gas to China is 1.51 billion dollars, which is 2.4 times higher than last year.

«Threat of New Entry» or those on whom the United States once imposed sanctions are also becoming a lever for diversifying the global structure of the fuel and energy sector. «Competitive Rivalry» is getting tougher and what was the usual norm and stability for the West and a number of European countries a few months ago is now turning into a catastrophic economy shock for the latter.

The fifth force «Threat of Substitution» in the general understanding is modified to «threat of new oil flows and complete reorientation of the structure of foreign trade gas and oil exchange in the world», which, of course, will affect the volume of production and export Russian energy sources, but will also become a new vector of its development.

Summarising the above, we note that for 2021 in the structure of exports of the Russian Federation, the products of the fuel and energy industry occupy the leading position, namely 54.3%.

2 Estimation of the mutual influence of the fuel and energy complex and the transport industry of Russia at the present stage

It should be noted that the fuel and energy complex is the leading consumer of transport services. Thus, the competitive ability and efficiency of the fuel and energy complex and the transport industry of Russia are interdependent.

Transport is a necessary condition for the existence of the fuel and energy complex. Transport is involved in all stages of production, from production to delivery of fuel and energy complex products to the direct consumer. In this case different types of energy are transported. Chemical energy, which can be emitted by oil and oil products, flammable gases, coal, peat, etc. Thermal energy, which is contained in streams of steam, hot water. Electrical energy, which is transported through electricity lines. At the same time, in units of fuel equivalent, gas and oil are transported 10 and 30 times more than electricity, respectively.

Oil, gas and coal transportation volumes are over 40% of the total cargo turnover which is provided by all types of transport. That’s why the structure of energy balance influence on the development of the transport complex. With its length from east to west (about 10,000 km) and north to south (more than 4,000 km), Russia has a unique system of railways (122,000 km in 2018) and roads (1566,148 km in 2021), which provide the delivery of energy resources from the eastern and northern regions of the country to its european part. Thus, the railway «Urengoy-Pomary-Uzhgorod» which was built in the 80s of the last century is 4.5 thousand kilometres length.
Energy resources are transported by different types of transport, each type of transport
has economic feasibility of use which is due to volumes, distance and cost of transport. The
increased demand for railway transport in transportation of oil and oil products is explained
by a combination of factors: speed of delivery, developed infrastructure, volume of
deliveries, seasonality and efficiency for all participants of the process. At the same time,
refineries, receiving oil from oilfield companies in volumes more then several million tonnes
per year, use pipeline, rail and, less frequently, water transport. Most of the companies have
their own system of loading points for oil products, which increases the efficiency of delivery
of oil products to consumers in smaller consignment, using mixed types of transport as they
are closer to the consumer.

According to estimates of experts petrol consumption in Russia is about 1.5 million
tonnes per day. The consumption is increased by 33% in period of 2015 and 2019 because of
growth of car park. The car park and special-purpose machines of mining companies provides
important production functions: business trips, employee transfers, movement between
objects, road to hard-to-reach places, work special-purpose machines on objects, cargo
turnover.

All this determines using car transport with high technical and economy indicators in
difficult conditions: deep and complex areas of minerals occurrence, works in areas with
limited reserves. The basis of road transport in pits is trucks of different types. Excavation
and transporting machines and lifting and transporting equipment are also used. The mining
industry consumes millions of litres of diesel fuel annually to transport rock mass. One truck
use about 50,000 to 100,000 litres of fuel per year, it depends on using factors. At the same
time, low energy efficiency, low speed of movement, significant amount of maintenance,
high noise level, environmental problems, etc. are disadvantages of using traditional fuels.
One of the priorities in fuel and energy complex and transport industry development in Russia
is to increase energy saving through using the electricity (decarbonisation of the transport
industry) and reduce fuel costs in the aspect of modern regional development concepts [1].

Thus, road transport and road sector consume millions of tonnes of petrol, diesel fuel,
heating oil, and oil bitumen. Recent years have been characterised by growth dynamic in
production, accordingly, growth of demand for energy transportation. This trend reflects the
situation inside the country.

Table 1. Main indicators of the Russian fuel and energy complex in 2012-2022.

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<td>Oil, million</td>
<td>518.1</td>
<td>523.4</td>
<td>526.8</td>
<td>534.3</td>
<td>547.6</td>
<td>546.8</td>
<td>556.0</td>
<td>561.2</td>
<td>512.8</td>
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<td>535.2</td>
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<td>tonnes</td>
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<td>Gas, billion</td>
<td>654.5</td>
<td>667.8</td>
<td>642.0</td>
<td>635.5</td>
<td>640.2</td>
<td>691.1</td>
<td>725.4</td>
<td>737.8</td>
<td>692.9</td>
<td>762.3</td>
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<td>metres³</td>
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<tr>
<td>Coal, million</td>
<td>354.6</td>
<td>352.1</td>
<td>359.0</td>
<td>374.0</td>
<td>386.9</td>
<td>408.9</td>
<td>439.3</td>
<td>441.4</td>
<td>402.1</td>
<td>438.1</td>
<td>443.6</td>
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<td>tonnes</td>
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<td>Electricity,</td>
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<td>1045</td>
<td>1047</td>
<td>1049</td>
<td>1071</td>
<td>1073</td>
<td>1092</td>
<td>1096</td>
<td>1063</td>
<td>1131</td>
<td>1138</td>
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<td>billion kWh.</td>
<td>.0</td>
<td>.0</td>
<td>.4</td>
<td>.9</td>
<td>.9</td>
<td>.7</td>
<td>.0</td>
<td>.5</td>
<td>.7</td>
<td>.0</td>
<td>.7</td>
</tr>
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</table>
3 The methodology for forecasting the volume of transport of fuel and energy products

More than half of such products were exported to non-CIS countries, 26.4% - to CIS countries. All this again the high importance of Russia in the global trade and production of energy resources, gives it a leading role like competing countries.

The analysis of the table shows that the volume of oil production in Russia in general has positive growth dynamics. So, the growth rate of this indicator was 108.3% (or 43.1 million tonnes) in 2012-2019. The coronavirus pandemic made changes in 2020 that also influence on volume of oil production [2]. Since 2021 this indicator was levelling off, and in 2022 there was a significant increasing. At the end of 2022 the volume of oil production in Russia was 535.2 million tonnes (Figure 1).

\[ y = 4E-77x^{23.942} \]

\[ R^2 = 0.9752 \]

For approximation the time series «Volume of oil production» (after smoothing the time series) it is better to use power function (coefficient of determination is equal to 0.9752) [3]:

The graph of the observed values of the indicator «Oil production volume» and results obtained by the model (1) with forecast values up to 2025 is shown on Figure 2.
It should be noted that in 2012-2021 by values of this indicator was no growth in production volume. It levelled off the decrease of this indicator in reporting periods [4].

The methodology of forecasting transport volumes was used by the authors in different researches, one of the research is «Information systems of passenger transportation forecast in Transbaikal region» published in 2020.

As for gas production, the growth rate of this indicator in 2012-2019 was 112.7% (or 83.3 billion m³) (see Figure 3).

For approximation the time series «Gas production volume» (after smoothing the time series) it is better to use a second-order polynomial function (coefficient of determination is equal to 0.7156) [5]:

\[ y = 1.6458x^2 - 6625.9x + 7E+06 \]  

The graph of the observed values of the indicator «Gas production volume» and results obtained by the model (1) with forecast values up to 2025 is shown on Figure 4.
The dynamics of gas production in Russia during the analysed period has crisis phenomena not only during the coronavirus pandemic in 2020 when this indicator decreased by 6.1% compared to 2019. Crisis phenomena of 2014 also was as negative factor which influenced on gas production volumes and lasted to 2016 (640.2 billion m$^3$ in 2016 in comparison to 667.8 billion m$^3$ in 2013).

In addition, 2022 was not the best period for the industry development. The decrease in gas production volumes was about 100 billion m$^3$. This fact is due to objective reasons: this is rejection of European countries from Russian gas supplies, sabotage on the Nord Stream gas pipelines. At the same time, the forecast indicators show encouraging, the model shows a stable positive dynamics of the industry development [6].

4 The analysis of the export potential of the Russian coal industry

The indicator of coal production in Russia in 2012-2021 also has a growth trend. Thus, in 2012-2019 the growth rate of this indicator in Russia was 124.6% (or 86.8 million tonnes). Although the decrease in coal production in 2020 (-8.9% in comparison to 2019), in 2021 this indicator began to level off and reflected a growth of 8.9%.

If the structure of production Russian main energy is more or less stable, except for crisis periods, the structure of exports shows different dynamics (Table 2).

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<td>236.6</td>
<td>223.4</td>
<td>244.5</td>
<td>254.9</td>
<td>252.6</td>
<td>260.7</td>
<td>267.6</td>
<td>238.6</td>
<td>229.9</td>
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<tr>
<td>billion dollars</td>
<td>180.9</td>
<td>173.8</td>
<td>153.9</td>
<td>89.7</td>
<td>73.8</td>
<td>93.3</td>
<td>129.2</td>
<td>121.4</td>
<td>72.5</td>
<td>110.1</td>
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<tr>
<td>Gas, billion metres$^3$</td>
<td>178.7</td>
<td>196.4</td>
<td>172.6</td>
<td>185.5</td>
<td>198.7</td>
<td>210.2</td>
<td>220.6</td>
<td>219.9</td>
<td>199.2</td>
<td>203.5</td>
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<tr>
<td>billion dollars</td>
<td>62.9</td>
<td>67.2</td>
<td>54.7</td>
<td>41.8</td>
<td>31.3</td>
<td>38.2</td>
<td>49.2</td>
<td>41.6</td>
<td>25.3</td>
<td>55.5</td>
</tr>
<tr>
<td>Coal, million tonnes</td>
<td>130.4</td>
<td>138.9</td>
<td>153.2</td>
<td>152.7</td>
<td>166.1</td>
<td>181.4</td>
<td>199.5</td>
<td>205.4</td>
<td>199.1</td>
<td>210.5</td>
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<tr>
<td>billion dollars</td>
<td>13.0</td>
<td>11.8</td>
<td>11.6</td>
<td>9.5</td>
<td>8.9</td>
<td>13.5</td>
<td>17.0</td>
<td>15.9</td>
<td>12.5</td>
<td>17.5</td>
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5 The analysis of the export potential of the Russian oil and gas industry

The structure of Russian exports in 2012-2021 shows negative dynamics of the indicator. So, in 2012-2014 the growth rate was 93.1% which was due to growing oil production and the difficult economic situation in the world. The total dynamics highest value of this indicator 267.7 million tonnes was in 2019. This indicated that the demand for Russian oil remained stable [7]. The price environment of external markets also contributed to the preservation of the dynamics of growth in the volume of oil production in Russia and its rates outside the Russian Federation.

At the same time, the growth rate of the indicator was 95.8% in comparison 2012 to 2021. The dynamics of income for this type of indicator for the analyzed period 2012-2021 is rather chaotic (Figure 5).
Fig. 5. Dynamics of oil exports in Russia in 2012-2021.

Thus, the growth rate of oil export incomes revenues over 10 years was 60.9 percent. This decline is due to a number of factors, including a decrease in export volumes, the volatility of the dollar exchange rate, and the cost of a barrel of oil. The current geopolitical situation and sanctions imposed by Western countries will lead to a decrease in energy exports in both in value and in quantity.

There is a general growth dynamics for gas exports in period 2012-2021 with obvious fluctuations in export volumes in the crisis periods of 2014, 2019. Thus, the growth rate of this indicator for 10 years was 113.9% or 24.8 billion m3. Gas exports during 2022 decreased by 25.1% to 184.4 billion m3. At the same time, it should be noted the growth of Russian gas exports to China. Through the gas pipeline «Power of Siberia», gas supplies increased by 48% and was about 15 billion m3.

By order of the Russian President is currently being worked now the accelerated construction of the Far Eastern route and the gas pipeline «Power of Siberia 2». The potential of gas supplies to APR countries activate diversification of the gas industry's export infrastructure [8]. The research in technological development of the industry, the creation of national gas liquefaction complexes (exports of which increased by 7.9% to 45.7 billion m3) are in progress. Liquefied gas is becoming more and more popular in the world. In this regard, there is attention to the development of the Northern Sea Route.

Fig. 6. Dynamics of gas exports in Russia in 2012-2021.
The period 2012-2021 is characterized by growth rate of that indicator, it is 88.2% or 7.4 billion dollars. The main periods of decreasing indicator are from 2014 to 2016, also in 2020, it is associated with global crises and the coronavirus pandemic (Figure 6).

6 The analysis of the dynamics of the export potential of the Russian coal industry

The coal industry was one of the first to face the restrictive measures against Russia. In 2022, exports fell by 7.5% or 210.9 million tonnes. However, supplies to the national market increased by 12.2%, which amounted to 172.4 million tonnes. The analyze of Table 2 and Figure 7 show that in the sector of coal exports in Russia for 10 years there is a positive growth dynamics. Thus, from 2012 to 2021 the growth rate of this indicator was 161.4%. The growth rate of income from this indicator for the analysed period was 134.6%, respectively.

![Fig. 7. Dynamics of coal exports in Russia in 2012-2021.](image)

The coal industry is one of the key sector of Russian exports, it faces a number of internal difficulties [9]. The great distance between companies of coal industry from transport and logistics ports and borders leads to increase in the cost of coal products; however, as the analysis of the structure and dynamics of exports has shown, this industry reflects a loyal rate of growth and development.

The Eastern polygon of railways is being modernized now, according to expert forecasts, it will increase the throughput capacity of BAM and Trans-Sib for export to Asia-Pacific countries to 180 million tonnes annually.

As it was noted by the authors in the work «Directions for the development of transport and logistics infrastructure of the Transbaikal region», the competitive ability of international transport corridors, which are acting as an element of the regional transport and logistics system and a catalyst for strengthening economy, including foreign trade processes, determines the economic indicators of development of the country and its regions.

The main foreign trade partners of coal exports are China and India. Coal exports in 2021 amounted to 59.5 million tonnes and 16.7 million tonnes, respectively [10]. At the same time, the increase in coal exports to India was 147%. According to experts estimates, coal exports to APR countries will increase 1.5 - 2 times by 2030, which will become an impulse for the development of transport infrastructure and diversification of transport and logistics flows.
7 Conclusion

The analysis shows about the significant role of Russian fuel and energy complex in the global market, despite sanctions and ultimatum embargoes - Russia has been and now one of the leaders who can influence on the foreign economy situation. Since the Federal Customs Service of Russia has stopped publishing official statistics on exports since February 2022, it is difficult to predict what awaits us at the end of the reporting year. At the same time, it should be noted that Russia's contribution to the global economy is obvious.

At the same time, the development of the transport sector should be oriented both to meet national demand, the needs of the country's fuel and energy complex, and to create new infrastructural opportunities for the development, diversification and strengthening of Russian position in the global energy market. As one of the world leaders in this area, the current situation in the FEC presents only a challenge, opening up new infrastructural and economy opportunities with countries friendly to Russia.

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References

10. N.L. Nikulina, L.M. Averina, Theory and methodology for modelling the spatial development of territories (Yekaterinburg, Institute of Economics of the Ural Branch of the Russian Academy of Sciences, 2020)