

TRENDS IN THE NORTHERN RUSSIAN OIL FIELDS IN THE LIGHT OF GLOBAL CHANGES

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Abstract

This article evaluates the latest changes in the oil market conjuncture, fundamental and new factors of determinants are also analyzed. Among them, it is possible to single out the development and implementation of innovative extraction technologies, the appearance of hydrocarbons' substitutes and national policies governing subsoil use. Long-term oil market development will depend on the consumption growth, the presence of oil reserves, their availability, and exhaustion. Growing oil demand will be satisfied using more accessible sources – traditional oil and oil from low-permeable oil reserves including the Northern Arctic deposits. This will be accompanied by the natural decline in oil extraction due to the exhaustion of oil deposits. It is expected that Azerbaijan, Mexico, Equatorial Guinea, Sudan and South Sudan will face a decrease in oil extraction. The Northern Arctic region is viewed as an important area of hydrocarbon extraction. That is why large-scale investment projects are considered for the development of international transport infrastructure in the North. According to the evaluations of American specialists, the amounts of oil in the Arctic Tundra account for more than 2.5 billion tons. For Russia, this region of oil extraction is becoming a priority issue due to the development of several processes. The process of high exhaustion at existing oil fields and the growth of hard to extract oil reserves (their share accounts for more than 60% of reserves) results in the decrease of the oil recovery coefficient. Today it accounts for no more than 30 percent, (in the middle of 1980es it accounted for more than 40%). Another process that activates the exploration of Northern Arctic deposits is the geopolitical, political tension which disrupts the stability of Russian hydrocarbon supplies. However, the development of Northern Arctic fields requires large-scale investments which is problematic due to the current sanctions and limitations restricting Russia's participation in the capital and technological markets. Russian oil companies, which use foreign equipment and technologies, are struggling. "Rosneft" stopped its first offshore exploratory drilling in the Karskoe Sea. This exploration was carried out together with the American company ExxonMobil.

Keywords: Conjuncture of oil market; market development factors; oil reserves and volumes of extraction; forecasts; and evaluations of market development; Northern Arctic deposits; expert-analytical system for analysis.

1. The urgency of the scientific research problem

The major world indicators of the economy, which reflect its state, are prices for resources. Their major economic trend is determined by the prices for raw hydrocarbons. The macro-economic situation on oil markets in 2015 – 2016 was characterized by high volatility [1-3]. After some insignificant growth of oil price quotes in 2015, their descending trend continued as a result of increased misbalance between the supply and demand. In 2015 the average annual price of Brent oil decreased by 47.1 % (up to 52 dollars per barrel), Urals – by 47.3 % (up to 51 dollars per barrel). In the second half of 2015, the level of oil price quotes equaled 45-50 dollars per barrel. The instability of price dynamics observed in 2016 was even higher. The price of Brent barrel decreased to 27.5 dollars which is the negative record of the last 12 years. Today the price of oil is 54-55 dollars per barrel. The dynamics of oil prices are determined by

the influence of fundamental factors and the influence of new determinants. Among them, it is possible to single out the discovery and implementation of innovative extraction technologies, the emergence of new hydrocarbons' substitutes and the government's policy concerning subsurface use. Long-term dynamics will depend on the presence and availability of oil reserves as well as their exhaustion.

2. Brief analysis of the current state of research on the scientific problem

In frames of this research the publications and reports from leading scientific organizations, which form oil market reports and energy development forecasts, have been used. OPEC publishes regular reports concerning the state of the oil market as well as its long-term and short-term development forecasts. The latest documents published by OPEC define the primary trends of the market's development under the influence of such factors as low positive economic growth, weakened growth of developing economies, capital cost reductions in international oil producing companies.

The independent agency of the Ministry of Energy in the USA (EIA) monitors hydrocarbon reserves of all types and regularly publishes statistical reports concerning the ratio between demand and supply on the oil market. According to the EIA data, the growth of world oil consumption will continue together with the accumulation of oil reserves and reduction of oil extraction in Russia and Northern Sea. The American Petroleum Institute (API) performs fundamental research of the oil industry and questions concerning its regulation. Its forecasts show weakening growth of the biggest developing economies (China, Russia, and Brazil), this will eventually lead to excess oil on the market. The same conclusions are given in the reports of the World Bank. The bank's forecasts show that stable growth of oil extraction will continue in USA and OPEC countries. Decreased investments in oil extracting industries are expected in other countries. The Institute of Energy Research of the Russian Academy of Science monitors energy markets, develops forecasts of the market conjuncture as well as regional and country energy, the research is based on regional and macroeconomic tendencies. The Institute has prepared a large-scale scientific project «Forecast of the World and Russian energy industry development until 2040». It provides the analysis of the key drivers that develop the world economy. The forecast presupposes average positive economic growth in the world, slowing down economic growth in China and BRICS countries, transfer of production to other developing countries of Asia, Africa, as well as USA and Russia. This will stimulate the countries' economic growth and additional export of energy.

3. Proposed methods, methods, tools

The informational and empirical basis of research embraces the sources from international statistical organizations (FAOSTAT, OPEC, and EIA), Russian statistical service, scientific and informational resources, reports of oil companies and research organizations. For the analysis a special database of oil volumes and price indexes was formed, it covers an extended period.

The first stage of data processing and analysis was frequency analysis with statistical calculations which took into account oil market indexes, (arithmetic average, dispersion, mean deviation, square deviation, coefficient of variation). At the stage of oil market's quantity index evaluation, different methods of statistical analysis were used (correlation, dispersion, regressive) together with economic and mathematical modeling. In order to process large volumes of data and carry out statistical analysis, SPSS and Statistica software applications were used.

In the second stage of research used the expert-analytical system for analysis and processing of performance factors. Design and approbation of integrated environmental and economic model of development of oil deposits of the European North of Russia in the initial stages will be based on development and production activities.

4. Preliminary results and their discussion

The analysis of oil price dynamics over the last fifty years shows that the recent volatility is determined not only by the established factors but it is also determined by new determi-

nants. The conjuncture of energy markets changes under the influence of fundamental factors. The volumes and amounts of hydrocarbons, the scientific and technological progress of geological surveying, hydrocarbons' field development, government's economic policy concerning subsoil usage have direct effects. At the same time, the balance of supply and demand on the oil market is determined by the development of the global economy as well as economic development in several countries.

Table 1. Fundamental factors

Nº	Fundamental factor	Brief description
1	Demographics (Table 2)	The world population by 2040 will increase by almost 2 billion people, exceeding 9 billion (an average annual increase of 0.9%).
2	Gross Domestic Product (Table 3)	World GDP by 2040 is 2.8 times higher than in 2010 (an annual increase of 3.5%).
3	Energy Policy	Existing priorities of the energy policy of the countries will remain. Measures will be introduced to improve the energy security of energy-importing countries.
4	Technologies	It is expected to gradually increase the competitiveness of new technologies (shale oil), as well as support the current trends in reducing the energy intensity of the world's GDP.

Let us dwell on two fundamental processes ensuring the preservation and increase of the level of consumption of energy resources. According to the United Nations, the world's population should increase by more than a quarter to the level of 2013-2014 and exceed 9 billion people (Table 2). Another important factor having a direct effect on oil consumption is the growth of the gross product (Table 3) [1-2].

Table 2. Forecast of demographic world development

Region	Population, million people		Share of able-bodied population, %		Level of urbanization, %	
	2010	2040	2010	2040	2010	2040
Europe	611	643	67	59	73	81
North America	464	578	66	62	81	87
Asia (Australia, Korea, New Zealand, Japan)	203	203	66	56	88	94
Asia (China, India)	3 632	4404	68	66	40	57
South and Central America	478	605	65	65	79	85
Near East	216	332	65	68	68	74
Africa	1 031	1 999	55	61	39	53
World	6 915	9 051	66	64	52	64

Table 3. Regional dynamics GDP

Region	2015	2020	2025	2030	2035	2040
Europe	17.9	19.8	21.8	23.8	25.8	27.9
North America	20.2	23.6	26.9	30.0	32.9	35.6
Asia (Australia, Korea, New Zealand, Japan)	7.5	8.2	9.0	9.6	10.2	10.7
Asia (China, India)	26.5	36.1	47.6	61.3	77.5	96.2
South and Central America	5.7	6.9	8.1	9.4	10.8	12.2
Near East	3.5	4.2	5.1	5.9	6.9	7.9
Africa	3.7	4.8	6.1	7.7	9.6	11.9
World of everything	88.7	108.0	129.7	153.7	180.5	209.8

Taking into account the forecast of the presented fundamental factors, the trend of primary energy consumption in the world has a positive trend with an annual increase of 1.3% - 1.5%.

At the same time, regionally, energy consumption has a multidirectional dynamics with the shift of the growth center to developing countries. Developed countries by 2040 will increase their consumption by 4.5%, due to active energy saving. Part of the regions (developed countries of Asia and Europe) will be reduced by 2040 and absolute volumes of energy consumption (Table 4) [1-2].

Table 4. Forecast of regional primary energy consumption

Region	2015	2020	2025	2030	2035	2040
Europe	1 956	1 986	2 003	2 014	2 018	2 016
North America	2 738	2 832	2 901	2 948	2 966	2 964
Asia (Australia, Korea, New Zealand, Japan)	900	910	913	908	897	880
Asia (China, India)	5 021	5 744	6 402	70 008	7 577	8 094
South and Central America	695	767	840	912	981	1 047
Near East	766	856	941	1 020	1 097	1 172
Africa	789	887	993	1 103	1 217	1 334
World of everything	13 970	15 130	16 194	17 150	18 025	18 815

The new determinants of the development of the oil market today are the processes that are taking place in Iran, which will allow it to enter the world oil and gas markets, and in combination with the continued growth in shale oil production, expectations for an excess supply and falling oil prices form. Another new factor was the increased tensions between the EU and Russia, which affected their energy relations, and a change in the EU's energy policy would lead to significant shifts in the European energy balance, which would lead to a change in the direction of hydrocarbon supplies. An analysis of new factors in the development of world energy indicates a change in the world market conditions due to the maximization of coal production in China and India, which will not be able to meet the domestic energy requirements of these countries, which will lead to additional energy supplies. This circumstance will change the volume of international energy trade. All these processes will inevitably affect Russia, for which additional risks will arise so that new export opportunities will open. The agreements of OPEC and non-OPEC countries concerning their temporary reductions of oil extraction as well as the plans of the Federal Reserve System of the USA Central Bank have turned into new determinants of the oil market development [4]. In 2014 the world oil extraction increased by 1.8% which is the highest index of the last ten years.

World oil production in 2014 increased by 1.8%, which was the highest in the last decade. If from 1920 to 1970 the world oil production actively grew (almost twice every 10 years), then since 1980 the growth rate has been slowing down, and in some years there is a decrease (Table 5) [1-3].

Table 5. Forecast of oil production in the regional context

Region	2020	2025	2030	2035	2040
Europe	163	155	140	133	132
North America	862	951	962	956	956
Asia	387	381	363	343	341
South and Central America	471	515	522	533	541
Near East	1 466	1 519	1 643	1 715	1 755
Africa	465	516	521	543	527
World of everything	4 487	4 708	4 834	4 921	4 964

Along with the world's growth in oil production, reserves are growing. From 2014-2015 the highest growth of reserves was observed in Saudi Arabia (1.1 billion barrels). OPEC countries continue to control the greatest share of the world reserves which accounts for 71.6% of the global volume [4]. Today's world reserves account for approximately 1 660 billion barrels. More than 18% of the world oil reserves are concentrated on the territory of Venezuela (298.4 billion barrels). Since year 2000 this country has managed to increase its oil reserves four times thanks

to heavy and super-heavy oil. Big oil reserves are stored in Saudi Arabia (around 268 billion barrels or 16% of oil reserves). Russia and USA have average proven oil reserves (80 billion barrels, 5% of the world reserves and 36.5 billion barrels, 2.2% of the world reserves) [5]. Despite the oil price reduction, USA has been increasing the volumes of oil extraction thanks to the exploration of shale deposits and increasing the existing production. Iraq is an OPEC country with the highest volume of oil extraction growth. After the uplifting of sanctions introduced in 2012, it has strengthened its market position while experiencing the financial burden of fighting with ISIS.

Since 2000 - 2001 Russia has had a positive trajectory of oil extraction (see Table 7). However, the record level adopted by the RSFSR in 1987 (569.5 million tons) has not been reached (Fig.1).

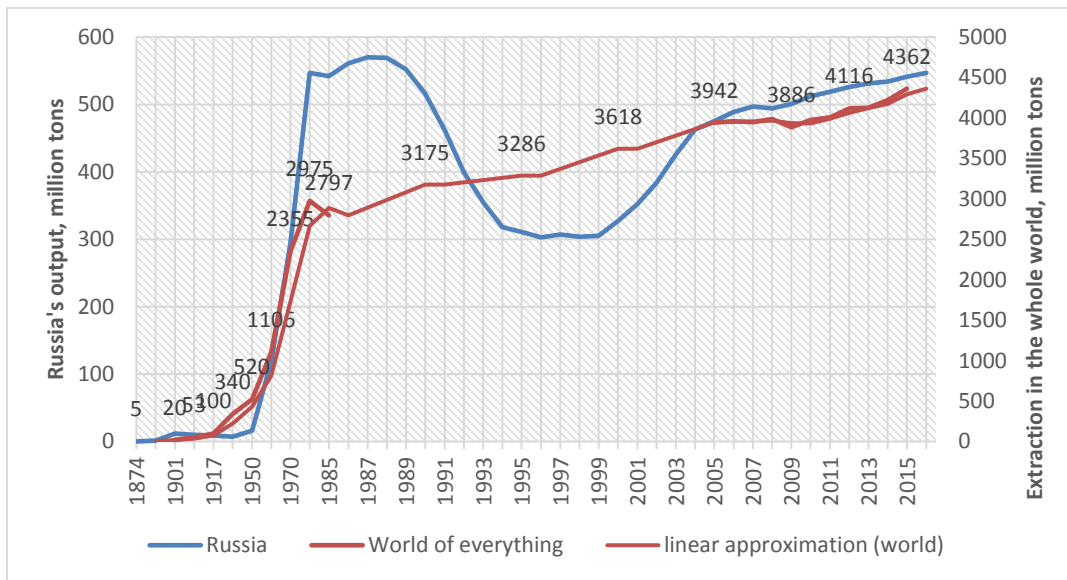


Fig. 1. Dynamics of oil production in Russia and the world as a whole

In 2016, a new record was set. It produced 547 million tons of oil (1.3% higher than 2015). The leaders of the oil industry in Russia for oil production are Rosneft and Lukoil (Fig.2).

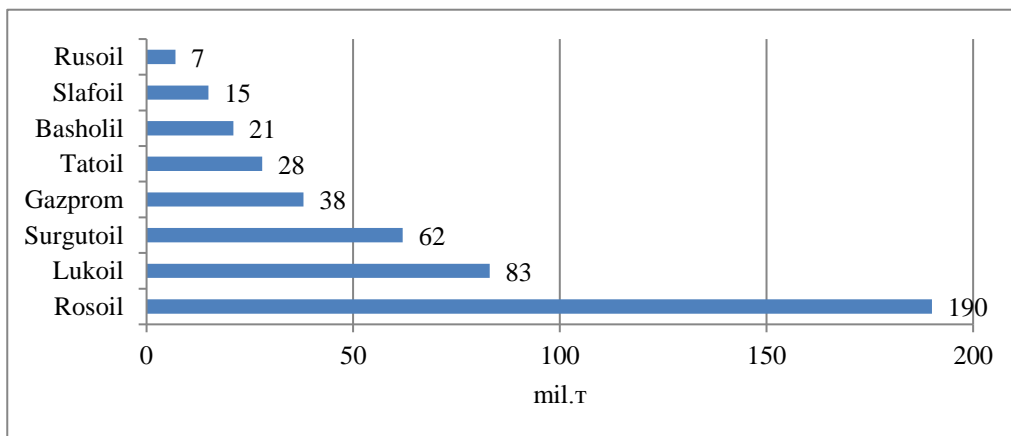


Fig.2. Oil production by Russian companies in 2016

According to forecasts of analysts, Russian oil exports will decrease and will amount to approximately 185 million tons in 2040 [1-2]. This trend is due to a reduction in Russian oil production and an increase in refining volumes. The regional structure of Russia's oil exports will be transformed (Fig. 3).

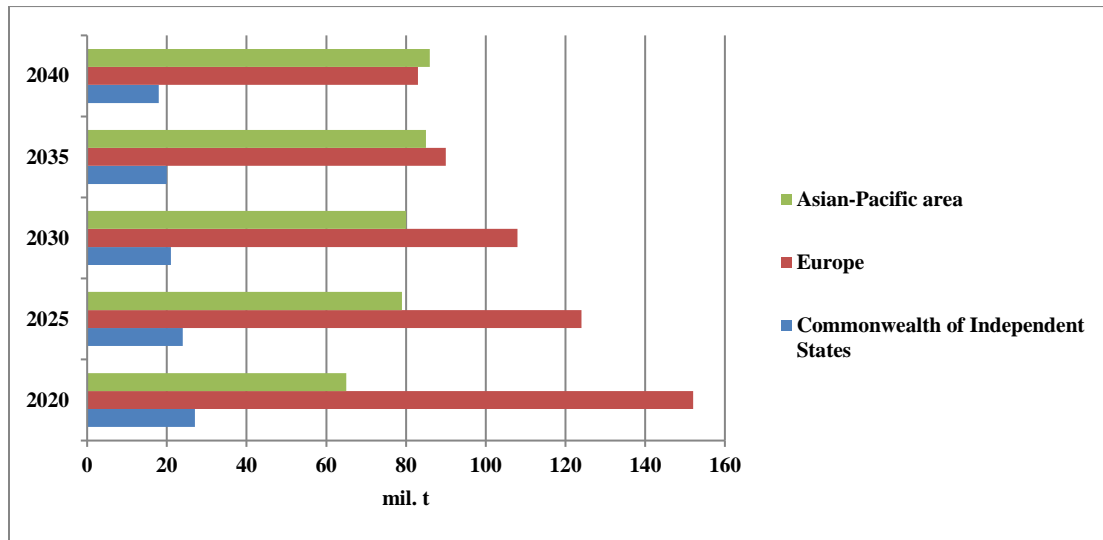


Fig.3. Forecast dynamics of Russia's oil export sales, Million tons

The greater part of exported Russian oil goes to Europe. European export flow of oil of Russia in the future will begin to cede market share to the Middle East suppliers with cheaper resources. The drop in exports of Russian oil to Europe will begin in 2020. By 2040, the volume of consumption of Russian oil to Europe will be about 14-15%, which is less than two times to the present period [1-3].

According to the results of oil processing on the internal market, the Russian export of liquid hydrocarbons in 2016 accounts for 255-260 million tons. According to the forecasts of VYGON Consulting in 2017, the export of oil to external markets will account for 270-275 million tons [6-7]. The needs of oil consumption must be satisfied not only by oil extraction but also by the growth of its storage. World oil reserves in 2015 -2016 accounted for 1 657-1 700 billion barrels, and according to the data of many research, these reserves are significantly reducing. The existing and proven oil reserves can satisfy world human needs within forty years. The greatest oil reserves are concentrated on the territory of Venezuela (298 billion barrels) and Saudi Arabia (268 billion barrels). Russian oil reserves account for 80 billion barrels (5% of world reserves). The factor-driven decrease of oil prices affects not only the stability of sales and their increase in order to maintain the same profit level. It also slows down the development of new projects, causes cancellations of increased extraction and productivity plans. It is especially relevant for expensive projects. The question of natural decrease in oil extraction due to the exhaustion of oil deposits and growing oil demand is becoming more and more topical for many oil-extracting countries. It is expected that Azerbaijan, Mexico, Equatorial Guinea, Sudan and South Sudan will face the problem of reduced oil extraction [8-9]. The question of continuous oil extraction and reservation is also topical. During a long period Russia had a decrease in volumes of oil extraction and nothing was done to compensate it. The quality of raw material is getting worse because the share of hard to extract oil resources has increased to 55%. One-third of oil reserves have a high degree of exhaustion (70-80 %). It is mainly relevant for the European region where one-third of the Russian oil and gas is extracted (around 155 million tons): Ural and Povolzje, Northern Caucuses, Timano-Pechorskoe deposit. Oil extraction in the European part of Russia is gradually decreasing [10-11]. All this is happening because Russia is reaching the plateau stage of its oil extraction and the share of hard to extract oil reserves is increasing. The decline in oil production occurs in Western Siberia, even with the introduction of the development of the last large deposits. The increase in oil production in Russia in 2011 - 2016 was provided at the expense of projects in the east of the country (the Republic of Sakha, Irkutsk region, the shelf of Sakhalin), in the north of Western Siberia (Yamalo-Nenets Autonomous District), on the shelf of the seas (Table 6). The increase in oil production in the Volga-Ural

and Timan-Pechora provinces is ensured by the active application of technologies for the methods of intensification of oil production, as well as by the involvement of small fields to compensate for the decline in production at the large average deposits in the region.

Table 6. Regional oil extraction in Russia

Region	2009	2010	2011	2012	2014	2015	2016
European Part	149.2	152.3	152.7	151.6	155	158	154
Western Siberia	322.1	318.2	316.3	317.2	313	312	322
Eastern Siberia	7.5	19.7	27.2	35.1	41.1	63.5	68.0
Far East	15.4	14.8	15.2	14.2	12.4		

Keeping Russia's oil extraction at the level of 10.8 million barrels per day and increasing it to 565 million tons per year will be possible with the implementation of new projects and development of new oil deposits. This is the direct interest of the state as the owner of natural resources. According to the forecasts from the Ministry of Nature, by the year 2035 Russia will be able to enlarge its oil reserves by 13-15 billion tons and gas reserves by 25-27 trillion cubic meters using geological surveying ^[10]. It will be possible to maintain oil extraction not only using more available sources but also using oil from low-permeable reservoirs which include the Northern Arctic deposits. The Northern Arctic region is considered to be one of the most important centers of hydrocarbon extraction. It requires large investments into its infrastructural development and the development of Northern transportation routes. The volumes of oil in Arctic tundra, according to the evaluations of American specialists, increase 2.5 billion tons ^[9]. It is emphasized that the Northern Arctic region of oil extraction is becoming a priority due to the development of several processes. The process of great exhaustion at the existing oil deposits and the growth of hard to extract reserves (their share accounts for more than 60%) reduces the coefficient of oil recovery which does not exceed 30% (in the middle of 1980 it increased 40%). The increase of oil recovery demands investments and the usage of more expensive innovative technologies. The growth of investments from Russian oil extracting companies is becoming more and more problematic due to continuing sanctions and limitations restricting Russia's access to capital markets. In 2015 investments into the production of oil products reduced by 9 billion roubles. Investments in oil transportation through pipelines reduced by 15 billion roubles. Most Russian oil companies have been using ready-made foreign equipment and technologies. Access to these technologies and equipment was denied in 2015 when the United States of America introduced strict limitations prohibiting American companies to participate in the extraction of hard access oil in Russia (deep sea areas, Arctic offshore). As a result, the first exploratory drilling of Rosneft in Karskoe Sea was stopped. This project was carried out together with the American company ExxonMobil. Despite the growing tension in the Russian oil market Russian oil extracting companies are expanding their activities in Timano-Pechorskaya oil and gas province, which is located on the territory of the Nenets autonomous area in the Republic of Komi (350 thousand square kilometers). At the present moment Timano-Pechorskaya oil and gas province has more than 180 deposits, 136 deposits contain oil, 4 deposits contain gas, 2 contain oil and gas, 13 deposits are oil and gas condensates, 12 deposits are gas condensates, and 16 have gas. Lukoil and Rosneft have been developing and using the Timano-Pechorskaya oil and gas province since years 1998 and 2003.

Further development and implementation of new projects depend on the development of the transport infrastructure. High ecological and economic risks of the macro-region demand precise systems of risk assessment before the exploration the deposits mentioned above. It is also necessary to develop efficient routes of oil transportation. The next stage of research is to carry out factor analysis to select the indexes which are needed for the elaboration of models. These models are part of the expert and analytical system for the creation of transport infrastructure in the Northern Arctic Region. The development of Northern Arctic deposits is topical and timely; it requires precise evaluation methods and models optimizing the transport infrastructure taking into consideration the current situation on the oil market.

Table 7. Oil extraction in Russia and Timano-Pechora deposit «Lukoil»

Year	Overall, million tons	Growth tempos to the previous period %	Timano-Pechora, %	Million tons	Growth tempos to the previous period, %
1998	67 600		0	0	
1999	79 800	118.0	10.6	10.4	102.9
2000	77 741	97.4	13.7	10.7	98.1
2001	78 322	100.7		10.5	100.0
2002	79 800	101.9		10.5	102.9
2003	81 500	102.1	13.7	10.8	108.6
2004	86 200	105.8	13.6	11.73	106.4
2005	90 158	104.6	13.8	12.48	109.0
2006	95 235	105.6	14.3	13.60	107.1
2007	96 645	101.5	15.1	14.57	114.5
2008	95 240	98.5	17.5	16.68	129.9
2009	97 615	102.5	22.2	21.66	97.7
2010	95 922	98.3	22.1	21.17	82.9
2011	90 917	94.8	19.3	17.55	89.1
2012	89 856	98.8	17.4	15.63	100.0
2013	89 856	100.0	17.4	15.63	102.0
2014	9 7208	108.2	16.4	15.94	170.6
2015	100 700	103.6	27.0	27.19	102.9
2016					98.1

Currently produced the primary selection factors about the conditions of the Northern Timan-Pechora province and the group of experts they are ranked based on importance and influence on the final results of the study. The main tasks of the current phase of work are the formation of an integrated ecological-economic model, which will allow you to perform a system analysis to assess, to forecast the state of the main factors in the development of oil resources of the territory. Seven groups of factors were chosen (Fig.4, Table 8), for each of which matrices were made for the determination of priority external factors.

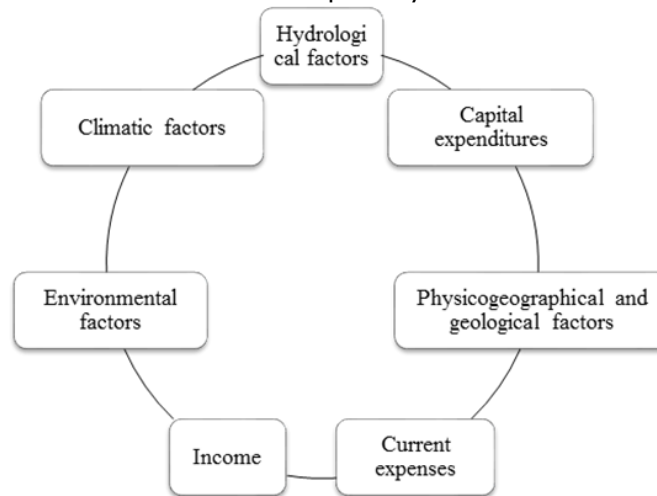


Fig.4. Groups of factors of the inert model

At this stage, the coefficients of intercorrelation were determined, which made it possible to exclude dependent factors from the model, since the independence of the factors is an important condition for the development of the model. Expert analysis of the matrices reveals the planned probability of the appearance of data from external strategic factors and the degree of their potential impact on the development of deposits. As a result of this analysis, we will be able to identify potential opportunities and threats.

Table. 8. Factors of the integrated model

Groups of factors	
Environmental factors	Specially protected natural areas. Water protection zones of watercourses and reservoirs. Areas of increased bioproductivity Degree of pollution of the natural environment.
Climatic factors	Wind regime. Temperature regime. Precipitation mode. Dangerous hydrometeorological phenomena.
Hydrological factors	Wetlands of the territory. Transitions through waterways and reservoirs. Level mode. Ice regime.
Physicogeographical and geological factors	Relief. Soil conditions and soils. Resource potential. Cryogenic processes. Exogenic processes. Seismicity.
Capital expenditures	Cost of equipment Cost of construction and installation works and services * Fees for imported equipment * Cost of credit resources * Access to sources of raw materials
Current expenses	Tariffs for electricity for transportation * Freight cost * Cost of main pipeline services * Some excises, customs duties, and taxes
Income	The price of oil Taxes, fees to off-budget funds Exchange rate

At present, we are working on an algorithm for calculating the influence of factors by an integral method. The integrated model for the development of the transport infrastructure of the fields will make it possible to make a forecast about the average values of the most important factors that will determine the logistic directions of oil transportation in the development of oil fields. The application of the integral method makes it possible to obtain unambiguous results of calculations of the influence of factors on the change in the effective index.

The need for further development of theory and methodology of integrated estimation and forecasting based on the construction of models applied to the conditions of the European North of Russia determine the practical importance and relevance of made in the research.

5. Concluding conclusions and plans for research of this problem

Thus, the world oil market is currently experiencing economic crisis, and in the period up to 2040, it expects a significant transformation. The market changes will occur under the influence of increased self-sufficiency in North America thanks to the production of unconventional oil and gas resources, rising energy consumption in developing Asia, which will require an increase in supply in the Pacific and Indian oceans. Energy imports to Europe increase slightly, this changes the structure of import of oil and gas. Russia by 2040, will not significantly reduce oil exports but will increase natural gas exports. Under these conditions, the development of the oil market the process of maintaining production and reserves of oil for our country is relevant because in Russia for a long time there was a decline in oil reserves. Despite the growing tension in the oil market Russian oil companies expand their activities in the Timan-Pechora oil and gas province, located in the Nenets Autonomous district and the

Komi Republic. Further promotion and implementation of new projects associated with the development of transport infrastructure in conditions of high environmental and economic risks of the Northern macro-region, requires the improvement of methods of estimation of ecological and economic risks of future exploitation, development of algorithms to determine efficient routes of transportation of oil. The main tasks of the current phase of work, to foster integrated ecological-economic model, which will allow you to perform a system analysis to assess, to forecast the state of the main factors in the development of oil resources of the territory. The conducted research will allow using the main scientific positions and conclusions as a theoretical and methodological basis for the development of new oil fields, taking into account significant factors.

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