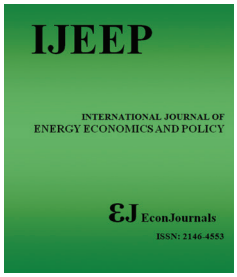

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Long-Term Prospects for the Development Energy Complex of Russia

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ABSTRACT

The article discusses the long-term prospects for the development of the energy complex and its role in the Russian economy in the context of the restructuring of world energy markets and taking into account the draft Energy Strategy of the Russian Federation for the period up to 2035. Using the SCANER information complex, scenarios for the evolution of world energy markets and the corresponding scenarios for the development of the Russian economy and energy have been developed. The dynamics of domestic consumption of the main types of fuel and energy is analyzed taking into account energy conservation, as well as the effective size and direction of export of the main types of fuel. On this basis, the dynamics of the extraction and processing of the main types of fuel, the use of renewable energy resources and the production of electricity by different types of power plants were optimized, the sizes of capital investments necessary for this and the return on the dynamics of domestic prices for fuel and energy were determined. Corresponding to these scenarios, changes in the main macro-indicators of the contribution of the energy complex to the development of the Russian economy indicate the possibility of a relatively rapid reduction in its dependence on energy exports.

Keywords: Energy Export, Energy Efficiency, Energy Saving, Energy Security
JEL Classifications: C30, D12, Q41, Q48

1. INTRODUCTION

Russia, being the world's third producer and consumer of energy resources (after China and the USA) and providing 10% of their production and 5% of consumption, takes the first place in gas export, the second (after Saudi Arabia) in oil export and the third (after Australia and Indonesia) coal export. In the production of 1875 million tons of coal, equivalent Russia exported primary energy by 970 million tons of fuel equivalent, accounting for 16% of interregional trade, which characterizes Russia as an absolute leader in fuel exports (An et al., 2020; An et al., 2019a; An et al., 2019b).

The forecast of world energy markets was developed according to the methodology on the SCANER model-information complex for favorable, probable and critical scenarios. The favorable scenario corresponds to fairly high (on average 3.4% by 2040) global economic growth rates with the successful implementation of national energy policies, the absence of geopolitical conflicts and the free transfer of technology between countries. In a likely scenario, economic growth is restrained (average annual rate is 2.9% until 2040), the goals of national policies are not fully implemented, and technology transfer is limited. In a critical scenario, the slow growth of the economy (an average of 2.1% per year until 2040) reflects various economic and geopolitical risks, the disruption of national plans and the almost complete absence of a global technology transfer (An et al., 2019c; An et al., 2019d; Bansal et al., 2013; Bove and Lunghi, 2006; Moiseev and Sorokin 2018).

2. LITERATURE REVIEW

The global forecast shows large changes in the export markets of Russia and reveals a high uncertainty in the development of its energy and economy. In 2000-2015 Russian energy exports

increased 1.74 times (exceeding its size in the USSR), but continued growth is unlikely. In the critical scenario, due to the weak global and domestic markets, the size of Russian energy exports will gradually decrease: by 2040 by almost 20% to the level of 2015. In the likely scenario, the total export of fuel is expected to increase and stabilize until 2025 with its subsequent decrease 10% below the level of 2015. A favorable scenario implies an increase in export volumes and prices on external energy markets with a successful increase in oil reserves in Russia. This will make it possible to increase Russian fuel export by almost 10%, but it cannot be compared with the "export boom" of the beginning of the 21st century (An et al., 2019c; Denisova et al., 2019; Meynkhard, 2019a).

Expectations (conditionally probabilities) of the implementation of the considered scenarios are estimated based on the principle of maximum entropy and are described by the betas distribution function (Cai et al., 2011). Then, the probability of the size of Russian exports matching the conditions of the critical scenario is from 13 to 24%, the implementation of the conditions of the favorable scenario accounts for 11-35%, and the confidence neighborhoods of the expectations of export conditions for the likely scenario are estimated in the range from 40 to 80% (depending on the asymmetry of beta-functions).

After 2020, a decrease in the energy export volumes of Russia is expected in the critical and probable (5 years later) scenarios due to a reduction in the export of oil, oil products and coal. An increase until 2025 and then stabilization of the total fuel export in a favorable scenario will be ensured by a more restrained decrease in oil exports (due to a slowdown in the decline in oil production due to an improvement in the tax regime), with faster growth in gas and coal sales. The share of oil and oil products in Russia's energy exports will decrease in all scenarios (from 63% in 2015 to 48-56% by 2040), which is offset by an increase in the share of gas from 25% in 2015 to 34-37%, but will not compensate for the loss of revenue from a decrease in oil and oil products sales Coal exports in all scenarios are declining (in terms of share and absolutely) due to deteriorating market conditions associated with inhibition of global demand and excess coal supply, as well as rising costs for the extraction and transportation of Russian coal.

Due to changes in global centers of energy consumption growth, the main increase in Russian exports in all scenarios is due to additional fuel supplies to Asia, whose share will increase from 15% in 2015 to 30-32% in the critical and probable scenarios and 41% in the favorable scenario by 2040 (Meynkhard, 2020).

Nevertheless, the European market will remain the main one for Russia in volume, despite a 36% decline in exports in the critical and 26% in the likely and favorable scenarios due to a decrease in energy consumption in Europe.

3. METHODS

Three scenarios have been developed for Russia, which logically correspond to the scenarios of the development of world energy: The critical scenario for Russia involves not only the implementation of the prerequisites of the global critical scenario with low economic growth rates, local conflicts and numerous cross-country barriers, but also stagnation of the effectiveness of the economic system of Russia itself. In this scenario, the country's GDP growth rate does not exceed 1.7% after 2020 at low prices and energy exports (including due to restrictions on imports of Russian hydrocarbons by Western countries), and sanctions continue to limit access to new technologies and cheap capital. Technological progress and growth in labor productivity are inhibited by a combination of institutional factors. The accumulation rate will remain at the current level of 18-19% of GDP. In this scenario, Russia decreases its share in world GDP in 2014-2020. from 3.5% to 2.9% and will not be able to restore it until 2040, since the Russian economy is growing more slowly than the global economy, even taking into account the expected slowdown in its growth in 2030-2040.

A likely scenario for the development of the Russian economy and energy complex is consistent with the prerequisites of a likely global scenario: moderate growth in GDP and energy consumption, increased (but below 2010-2014) export prices for energy resources, maintaining restrictions on access to technology and loans - combined with sluggish growth the effectiveness of the Russian economy. In fact, this scenario assumes the preservation of modern conditions in combination with moderate structural reforms to improve the business climate, reduce the cost of credit and intensify investments, as well as intensify the attraction of national savings and increase costs for the development of social, energy and transport infrastructure. The average annual growth rate of the Russian economy in this scenario after 2020 reached 2.2-2.4%, primarily due to services. The accumulation rate will be about 20% of GDP. In terms of GDP in 2040, Russia in this scenario will rise to 6th place and overtake Japan.

A favorable scenario for Russia includes all global preconditions - high world GDP, active growth in world consumption of all energy resources and, accordingly, greater demand for Russian fuel on world markets, relatively higher world prices for energy resources, the lifting of sanctions and the availability of capital and the latest technologies - combined with a radical increasing the efficiency of the country's economy in three areas:

- Reduction of specific capital costs (multiple times lower cost of loans due to improved investment climate, return to global financial markets and reduction of country risks, bringing the entire regulatory framework in line with international standards);
- Reduction of unit operating costs (reduction of transaction costs by improving regulation, removing bureaucratic obstacles and improving the quality of management);
- A significant reduction in the share of transport costs as one of the most significant components of the price of the final product (an increase in the use of water transport, reform of the railway transport, effective loading of pipeline transport).

Under these conditions, it will become possible to develop new competitive industries that determine Russia's place in the international division of labor as a producer of basic materials

of the third and fourth redistribution, including high-quality products from the timber, metallurgical and chemical industries. The Russian economy will be able to develop, relying on the use of competitive advantages not only in traditional sectors (energy, transport, agricultural sector), but also in new high-tech sectors and the "knowledge economy". This will entail a large-scale change in the structure of Russian exports. Innovative economic development will also be ensured by increasing the share of investment in human capital, which in this scenario will increase to 13% of GDP by 2030. The accumulation rate will increase to at least 22% (as in the period up to 2015). Strengthening the financial sector, cheapening credit, revitalizing small businesses predetermine good conditions for development in the institutional plan (Chiemchaisri et al., 2012; Denisova, 2019; Lopatin, 2019a).

In this scenario, GDP growth is expected to accelerate by the mid-1920s to 3.4% per year, with an increase in the share of services, communications and innovative manufacturing. Accelerating global economic growth will ensure an increase in volumes and export prices for all goods. However, this will not change the country's position in the world. Russia is moving with the world, improving the quality of growth, and in the 2030s, even slightly ahead of the global average (Moiseev, 2017a,b).

The cold climate, long distances, the hypertrophied structure of raw materials with a noticeable technological lag led to the high energy intensity of Russian GDP - one and a half times higher than the average in the world and in the USA, and two times higher than in leading European countries (Table 1).

For one of the world's most energy-intensive economies, energy efficiency issues are key in predicting the development of the domestic market (Dayong et al., 2019). The main contribution to reducing the increase in energy consumption in all scenarios is made by structural energy saving (changes in the sectoral and product structures of the economy with an increase in the share of non-energy-intensive industries and products) - from 30% in the critical scenario to 47% in the favorable. The next factor in restraining the growth of energy consumption is technological energy saving - from 25 to 30% of all energy saving. As a result, it is expected that by 2040 relative to 2015, the energy intensity of GDP will decrease by 32% in the probable, by 24% in the critical and by 43% in the favorable scenarios, which is much lower than the rates achieved in 2000-2008. Moreover, even with a favorable scenario, it will not be possible to narrow the gap with the leading countries, and in critical situations, it will widen, because the economy does not have the ability to quickly update the assets used and investments in energy conservation. The main barriers will remain the high cost of "long money" and loans for energy-efficient projects (especially for small businesses) and the long-term containment of domestic prices for natural gas and, therefore, for other types of fuel (Lopatin, 2019b; Mikhaylov et al., 2018; Mikhaylov, 2018a; Mikhaylov et al., 2019).

Table 1: Dynamics of energy intensity of the GDP of the world and the largest countries, kg n e. /dollars 2014 year

Index	2005	2015	2025	2040
Russia, a likely scenario	0,22	0,18	0,16	0,13
Russia, favorable scenario	0,22	0,18	0,16	0,11
Russia, critical scenario	0,22	0,18	0,17	0,14
World likely scenario	0,14	0,12	0,10	0,08
USA likely scenario	0,15	0,12	0,10	0,07
EU likely scenario	0,11	0,09	0,07	0,05
China likely scenario	0,25	0,17	0,12	0,09

Electricity consumption will increase by 2040, depending on the scenario, by 23-44% and primary energy by 10-20%, and the structure of energy consumption by types of energy resources will change little (Table 3). Natural gas will remain dominant, providing 51-52% of the total primary energy consumption, the share of liquid fuel will remain within 18-19% in all scenarios, and solid fuel will decrease from 15% in 2015 to 13-14% in 2040. Hydropower will remain at 6%, nuclear energy will increase from 6% to 7%, and only renewable energy will increase the share from 1% at present to 2.5-3.5% of primary energy consumption in 2040.

4. RESULTS

In addition to stabilizing or reducing export volumes, the second most important external factor for the development of the Russian fuel and energy complex is world oil and gas prices (Table 2), which determine the dynamics of export earnings, and also, to a large extent, the level of domestic prices for fuel and energy. In the critical and probable scenarios, export prices in the forecast period do not reach the levels of 2010-2014. Only in a favorable scenario, with the accelerated growth of the global economy and demand, is a noticeable increase in export revenue expected, while in other scenarios their size will decrease. For the Russian economy, this is the most important consequence of changes in world energy markets.

The critical scenario provides for a reduction in energy production in Russia by 2% of the 2015 level by 2040, and in a likely and favorable scenario, their production be expected to grow by 5 and 16%, respectively. Gas and oil will maintain a dominant position in primary energy production while maintaining their total share (79-80%). A decrease in the share of coal from 14% to 11% by the end of the period is offset by an increase in the share of non-carbon energy from 7% in 2015 to 9-9.5% in 2040 (Table 3).

Given the forecasted demand of the national economy for electricity and the expected export, its production in the country

Table 2: Forecasts of world oil and gas prices

Index	2015	2020	2025	2030	2035	2040	2040	2040
Urals Oil, $ 2014 / bbl Gas, $ 2014 / thousand cube m	52,4	60	81	88	94	99	90	107
Europe	243	221	263	304	335	364	331	420
China	287	306	357	366	380	394	327	478
Coal, $ 2014 / t	57	59	63	66	67	68	58	80
Europe	72	74	76	77	78	79	67	92

will increase by 22-48% by 2040 compared to 2015, depending on the scenario (Table 4).

Thermal power plants will remain the backbone of the Russian electric power industry (about 62% of total electricity production in 2040 in all scenarios compared to 66% in 2015), with faster growth in the production of condensing power plants with a moderate increase in electricity production by heat and power plants due to the slow growth in demand for electricity supplied they are warm. Hydroelectric power generation will increase markedly: by 28-45%, the "champion" of growth acceleration will be the generation of electricity from alternative renewable energy sources: 19-32 times from 2015 to 2040, but their share in electricity production will be 3-4%. Nuclear power plants - will provide a significant increase in electricity production by 26-51% by 2040, depending on the scenario.

Unlike most developed countries in Russia, the features of the territory (long distances), climate (long heating season with sharp temperature fluctuations) and resource base (relatively cheap hydrocarbon resources) determine the specifics of the development of electricity and heat supply systems. Progress in the use of renewable energy is constrained by their lack of competitiveness in the area of operation of energy systems and with low-power power generation using cheap fuel, but they will be able to actively develop in areas with low population density,

Table 3: The balance of primary energy in Russia, million tons of fuel equivalent

Index	2015	2020	2025	2030	2035	2040	2040	2040
Primary energy consumption								
million tons of equivalent fuel	972	1000	1039	1069	1096	1119	1073	1164
%	100	103	107	110	113	115	110	120
Including:								
Power plants	409	424	451	471	489	505	461	541
Boiler rooms	101	97	88	79	73	68	88	67
Production needs	126	128	130	133	135	136	134	140
Raw material needs	62	63	68	74	77	82	78	89
Transport	149	161	172	178	184	190	177	189
Housing and communal services	125	127	131	134	137	137	134	139
Of total consumption:								
Gas fuel	503	505	538	560	570	573	546	588
Liquid fuel	187	194	199	198	205	206	197	213
Solid fuel	147	148	145	148	146	148	148	153
Electric power	57	64	64	63	64	70	64	70
Atomic Energy	60	68	68	67	71	77	67	77
Alternative Renewable Energy Sources	10	13	14	19	25	27	36	33
Export of energy resources including:	971	962	986	944	916	872	789	1059
Natural gas	242	254	302	294	305	297	269	391
Oil and oil products	620	624	594	567	533	503	455	561
Coal	136	108	112	104	97	89	83	119
Total consumption	1943	1962	2025	2012	2012	1991	1862	2223
Fuel imports including:	52	32	36	31	23	16		16
Natural gas	35	20	25	20	15	15		15
Primary energy production	1875	1924	1981	1971	1976	1961	1835	2178
%	100	103	106	105	105	105	98	116
Of total consumption:								
Gas fuel	728	765	843	863	890	886	829	1005
Liquid fuel	759	778	754	729	704	681	629	731
Solid fuel	257	233	233	225	215	211	205	242
Electric power	57	64	64	63	64	64	64	70
Atomic Energy	60	68	68	67	71	77	67	77
Alternative Renewable Energy Sources	15	17	20	25	32	42	41	53

Table 4: Electricity generation and fuel consumption by Russian power plants

Index	2015	2020	2025	2030	2035	2040	2040	2040
Power plants, total								
TWh	1064	1111	1184	1252	1330	1405	1300	1580
% by 2015 of which:	100	104	111	118	125	132	122	148
Thermal	697	686	751	802	844	870	800	974
Atomic	195	221	223	229	250	280	245	294
Hydroelectric power stations	170	193	195	199	207	217	217	247
New renewables	2	11	16	22	29	38	38	65
Fuel consumption, million tons of fuel equivalent t	289	286	280	281	283	288	314	370
% by 2015, including:	100	99	97	97	98	100	108	128
Gas	217	207	203	202	202	203	217	262
Solid fuel	67	74	70	73	74	78	94	105

especially with the progress of energy storage (favorable scenario). Large non-carbon and nuclear power plants will remain the backbone of Russia's non-carbon electric power industry, while maintaining their share in total electricity production at 15.5-16.5 and 18-19%, respectively. The share of electricity production by thermal power plants will decrease slightly; fuel consumption by 2040 will increase to 0-28%, depending on the scenario, with a decrease in the share of gas from 75 to 69-71% and an increase in the share of coal from 23 to 27-30% (Table 4) mainly in the Asian part of the country (Denisova, 2019; Milbrabdt et al., 2014; Morgan and Yang, 2001).

In centralized heat production, cogeneration looks most attractive in Russian conditions. The market and consumer demand contribute to the development of decentralized heat supply by launching the transformation of a traditional centralized heat supply system. Since the demand for heat remains practically unchanged during this time period (the increase in demand due to an increase in GDP, population and heated areas is almost completely compensated by the improvement in the quality of materials, buildings and special measures for energy conservation), as the co-generation grows, boiler houses are actively displaced.

Nuclear power. Russia is traditionally one of the leaders in the global nuclear industry and considers the development of this sphere as its strategic priority. The effective and safe development of the nuclear energy industry in Russia provides for the decommissioning of first-generation reactors and an increase in the total capacity of nuclear power plants by 5 GW by the critical scenario in 2040, and by 11-13 GW in the likely and favorable scenarios.

Hydropower. The development of water resources in the eastern part of the country will increase the capacity of hydropower plants in critical and probable scenarios by 18% by 2040. In a favorable scenario, because of accelerating the development of energy-intensive industries in these areas, the commissioning of new capacities will amount to 15 GW with an increase in the total capacity of hydropower plants by 30% by 2040.

Low hydrocarbon prices. The spread of the potential of renewable energy throughout the country, as well as the lack of its own effective technologies, in most cases hinder the development of these sources in Russia and are not the most favorable for use. Nevertheless, on the part of the state and many consumers (especially decentralized ones), interest in renewable energy sources is growing. Development went along the path of mastering and localizing existing technologies produced by other countries, with their adaptation to Russian conditions and needs. The use of all types of renewable energy will grow at the fastest rate compared to other energy resources, but from a very low base, and will increase by 20–3 1.6–3.3 times depending on the scenario (Jaramillo et al., 2005; Morris and Barlaz, 2011).

However, if their share in energy consumption increases to 2.5-3.5%, they will be able to play only a local role in the energy sector of Russia. In recent years, Russia has been increasing volumes of oil and gas condensate production, despite the changing pricing environment and growing difficulties with investments. An analysis of the current resource base (already developed fields, new fields and projects being prepared for commissioning) performed in shows that the country could provide consistently high production until 2020-2025. Regardless of market prices and taxes: major investments have already been made, and companies will in any case produce oil from these fields (An et al., 2019c; Nyangarika et al., 2019a).

In the critical scenario, the increase in reserves should amount to 4 billion tons. The main constraints will be technological restrictions on the part of Western countries, which will delay the localization of advanced oil production technologies in Russia and increased development efficiency. In addition, the unfavorable economic situation and relatively low oil prices will limit investment in exploration, restraining production growth due to new reserves. The rapid development of reserves at the beginning of the period with insufficient growth will lead to the fact that by 2040 production will decrease to 440-445 million tons (Mikhaylov, 2019; Mikhaylov, 2018b).

In a likely scenario, the increase in recoverable reserves, mostly provided by the reproduction of the raw material base of the distributed subsoil fund, by 2040 should be at least 6 billion tons (about a third of the current level of Russian recoverable reserves), despite the fact that for 1991-2013. Reserves growth in Russia amounted to 10 billion tons, but mainly due to changes in the categories of reserves growth and development of deposits discovered back in Soviet times. Until 2040, the main sources of reserves growth will be additional exploration, increasing development efficiency and putting prospective reserves into development. Oil production after growth to 560 million tons/year in 2020-2025 reduced to 480 million tons in 2040 (Moiseev, 2017c; Nyangarika et al., 2019b; Nyangarika et al., 2018).

In a favorable scenario, an increase in reserves of more than 10 billion tons over 25 years will be required, which implies intensive development and implementation of new production technologies that can provide an additional increase in average recovery factor by another 2-3% (increase in recovery factor by 1% is commensurate with an increase of 1 billion tons of new reserves), as well as active exploration. In this scenario, by 2040, annual production will decline to 515 million tons.

No changes are expected in the geography of Russian oil production - the Ural Federal District will remain the key region, whose share will even increase from 59% in 2013 to 70% of total production by 2040. At the same time, the share of Eastern Siberia and the Far East will decrease as their reserves are exhausted.

4.1. Recycling

After several years of active investment in expanding the capacities of modernizing motor fuels and deepening oil refining, the Russian oil complex received production facilities to supply domestic products with petroleum products and export deliveries of high-quality diesel fuel. In a critical scenario, the lack of investment in the industry until 2020 amid low prices will lead to the cancellation or postponement of most modernization projects

until 2025 (Moiseev and Akhmadeev, 2017). The need to meet domestic demand for gasoline - will slow down the reduction in primary processing volumes - they will amount to 233 million tons by 2040. In a likely scenario, despite the decrease in primary processing volumes to 213 million tons by 2040, the rates laid down in agreements with business modernization of secondary processes will increase the production of light petroleum products by 10% compared to 2015. This is enough to meet domestic demand for gasoline and ensure a stable export of diesel fuel, primarily in Europe direction. In a favorable scenario, the highest rates of modernization are expected. At the same time, growth in global and domestic demand creates prerequisites for maintaining relatively high volumes of refining: at the level of 248 million tons in 2040. The production of motor fuel in this scenario will be 18% higher than in the likely scenario.

The export of oil and oil products in all scenarios increases until 2020, and then, as oil production decreases, it decreases. The decline in exports by 2040 will be: from 27% to the level of 2015 in the critical scenario to 9% in the favorable scenario - with an increase in the share of Russian oil exports to Asian markets from 15% to 20 and 45%, respectively. On the contrary, due to a decrease in demand for petroleum products, Russia's share in the European oil market will decrease from 33% in 2015 to 20-23% in 2040. Thus, reorienting oil export directions is becoming the main way to curb the decline in its volumes.

After 2008, in the gas industry, all production and export indicators fell below the 2005 level. Until 2015, these indicators were not restored. The slow growth of the Russian economy in the critical scenario determines a very modest increase in domestic gas demand: by 8-9% until 2040. In the likely and favorable scenarios, gas consumption will increase by 14-18% over the same period, and the main sectors of growth will be the electric power industry production and raw materials needs, transport and housing and communal services with a decrease from 56.4 to 51-55% of the share of domestic gas consumption by power plants and central boiler houses (Table 5).

4.2. Export

The main development potential of the industry is associated with foreign markets. An analysis of the prospects for the global gas market shows that under critical and probable scenarios, the export of Russian network gas to Europe will decrease by 25 and 11% by 2040, respectively, compared to 2015, and under favorable scenarios, growth is expected to be no more than 10%. In the absence of the potential to increase Russian gas exports to the CIS countries, the main opportunities for increasing its supplies to foreign markets are associated with Northeast Asia (China, Japan, the Republic of Korea, etc.). However, there is high uncertainty regarding the further development of these markets and the competitiveness of Russian gas in them. Although a five to six-fold increase in its exports in this direction is expected during the period under review, even in a favorable scenario, absolute volumes of supplies will not reach half of the current volume of exports to Europe by 2040. Great expectations are associated with the development in Russia of a more flexible industry for the production of liquefied natural gas (LNG), which, depending on the scenario, will increase its export by 2.6-4.6 times by 2040. However, in absolute terms, even in a favorable scenario LNG production growth, by 2040, its exports will amount to only 40% of modern Russian exports to Europe (Table 5).

4.3. Production

By 2015, gas production in Russia was already approaching the level of pre-crisis 2008. In the likely scenario, by 2040, natural and associated gas production will increase by 20%, in critical - by 12% and in favorable - by 36%. In principle, the state of the resource base and the scale of existing reserves allow the gas industry

Table 5: Balance of natural gas of Russia, billion cubic meters m

Index	2015	2020	2025	2030	2035	2040	2040	2040
Domestic consumption	452	454	483	502	512	516	491	534
%	100	100,4	107	111	113	114	109	118
Including:								
Power plants	189	177	194	205	205	214	188	217
Boiler rooms	66	64	58	53	53	48	64	51
Production needs	52	58	63	68	68	72	69	76
Raw material needs	22	21	24	29	29	29	24	27
Transport	28	35	40	41	41	42	42	46
Housing and communal services	81	85	91	93	93	95	93	95
Export Total Including:	210	221	263	256	265	258	34	340
LNG	15	25	40	40	40	40	40	69
Network to Europe	163	149	150	142	152	145	121	180
Network to Asia		8	38	38	38	38	38	48
Total consumption	662	675	746	758	777	774	725	874
Import	97	97	97	97	95	97	98	96
Production	634	665	730	745	766	761	712	864
%	100	105	115	117	121	120	112	136
Including:								
Eastern Siberia	9	12	22	33	42	45	42	47
Far East	33	45	76	83	91	88	66	88
Nadym-Pur district	463	397	361	350	339	314	315	319
Ob-Taz Bay	45	43	45	53	65	83	73	90
Yamal Peninsula	33	110	165	165	170	178	167	235

(unlike the oil industry) to increase production more than in the proposed scenarios, which are calculated based on demand, and not on production capabilities. Against the background of a decrease in production in traditional gas producing regions (primarily in Nadym-Pur-Tazovsky), the main increase in production will come from the deposits of the Yamal Peninsula, the Ob-Taz Bay, as well as Eastern Siberia and the Far East (Table 5).

Against the background of moderate economic growth and the continued maintenance of underestimated domestic gas prices, stagnation of solid fuel consumption in the critical and probable scenarios is expected with an increase of only 5% in a favorable scenario: solely due to the demand of power plants in the eastern part of Russia in large part for the export of electricity, with a 35–40% reduction in coal consumption by other sectors of the economy (Table 6).

Russia's coal industry even more than gas depends on the situation in foreign markets: their capacity and Russian transport infrastructure, and not restrictions on coal reserves or mining capacities, are the main constraining factors for further growth of the industry. The processes taking place on the global coal market, in particular, the struggle of many countries (especially the EU and China) with environmental pollution, create the highest uncertainty for this industry in Russia (Lopatin, 2019a).

The main problem of Russian coal, which undermines its competitiveness in foreign markets, is the considerable remoteness of coal suppliers from seaports with a long range of coal transportation by rail. In 2015, the devaluation of the ruble sharply increased the efficiency and attractiveness of export deliveries, this effect, according to our estimates, can last until 2020-2025, but it is during this period that the greatest slowdown in the growth rate of global demand for coal is expected. Increased supplies to Asia will not quickly offset the sharp decline in exports to Europe. In the critical and probable scenarios, the size of coal exports is reduced by 35-39% by 2040, and only in the favorable scenario is a moderate increase in coal export expected until 2025-2030, but by the end of the period, its volumes will be 12-13% below the level of 2015 (Table 7).

Coal production in physical terms will decline by 2040 by 20-18% in the critical and probable scenarios and will be 5% less than the level of 2015 in a favorable scenario. The main basin of the country will remain Kuznetsky with an increase in the production of Kanskachinsky and Far Eastern coals. An important feature of the development of the industry should be an increase in the sorting and standardization of thermal coal, which are mandatory for their export. This raises the problem of using and (or) neutralizing large volumes of waste generated.

In Russia, the problem of climate change and the special measures resulting from it to diversify the energy sector and increase the energy efficiency of the economy are ambiguous. However, given the low rates of economic growth, maintaining greenhouse gas emissions at 75% of 1990 volumes does not require significant efforts: until the end of the 2030s, in any case, there will be a slow increase in emissions from burning fossil fuels. It differs by scenario only by 3-4% and without special measures, emissions in the critical and probable scenarios will increase relative to 1990

Table 6: Balance of solid fuel of Russia, mln. t.

Index	2015 г.	2020 г.	2025 г.	2030 г.	2035 г.	2040 г.	2040 г.	2040 г.
Domestic consumption	147	148	145	148	146	148	146	153
%	100	101	99	101	100	101	100	105
Including:	67	78	83	89	91	94	94	105
Power plants	18	17	15	13	11	10	10	7
Boiler rooms	39	34	31	30	28	26	26	24
Production needs	21	17	14	14	15	18	18	17
Housing and communal services	136	108	112	104	97	89	83	119
Export Total Including:	89	69	70	61	53	49	33	47
to Europe	38	30	37	40	43	40	50	71
to Asia	283	256	257	252	243	237	229	272
Total consumption	12	10	10	10	8	0	0	0
Import	372	337	338	325	312	307	298	367
Production, mln. Tons Including:	37	35	36	37	38	42	36	55
Far East	55	54	54	55	55	56	53	58
Eastern Siberia	216	189	180	174	161	155	166	193
Kuznetsk pool	37	35	36	38	39	42	36	45

Table 7: Key indicators of the contribution of the energy sector to the development of the Russian economy, %

Index	2015	2040		
		Critical scenario	Likely scenario	Favorable scenario
Contribution of the fuel and energy complex to generated GDP	31	15	14	13
Share of fuel in revenue from total exports of goods	56	29	26	22
Contribution of energy exports to GDP	16	7	6	6
Contribution of the fuel and energy complex to the consolidated budget	30	18	14	14
The share of investment in the fuel and energy complex in GDP	5	3,9	3,7	3,8
The share of investment in the fuel and energy complex in the total investment in the national economy	24	11	14	13

Table 8: Capital investments in the energy complex of Russia, billion dollars 2014

Sectors/types of generation	2011-2015 гг.	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040 гг.		
Oil	244	180	216	226	227	226	182	307
Gas	148	139	186	208	224	235	201	263
Coal	16	16	17	17	17	16	14	17
TPP and networks	78	54	49	88	97	72	56	90
Nuclear power station	25	39	37	33	28	30	22	40
Hydroelectric power station	12	10	7	8	12	15	12	21
Non-traditional (renewable) energy sources	2	4	4	7	10	15	10	26

Table 9: Domestic fuel prices by Russian regions, thousand rubles 2015 y/t

Регион	2015			2025			2035-2040		
	Motor fuels	Gas	Coal	Motor fuels	Gas	Coal	Motor fuels	Gas	Coal
European part of the russian federation	19-20	3,7-4,0	2,9-3,1	25-27	4,7-5,8	3,6-3,8	33-38	4,7-8,5	3,4-3,8
Ural, Siberia	17-18	3,16-3,4	2,1-2,8	23-25	4,0-4,8	3,2-3,4	31-36	4,0-7,0	3,0-3,3
Far East	20-21	3,0-3,3	2,3-2,7	26-28	3,6-5,1	2,7-2,8	35-40	5,6-8,6	2,6-2,8

from 72% in 2015 to 73-80% by 2040, and in a favorable scenario, the introduction will be feasible greenhouse gas emissions.

The role of the fuel and energy complex in the Russian economy can hardly be overestimated, although its indicators have declined from the maximum in 2012-2013. As a result of the crisis and falling world prices for hydrocarbons. Nevertheless, in 2015, the complex provided more than 30% of the country's GDP and consolidated budget, 56% of foreign exchange earnings from exports, and almost a quarter of the total investment in the national economy. He will still be able to play the role of the main factor in the growth of the Russian economy in the current decade, but in the future, by 2040, his contribution to GDP will be reduced by about half - from 31% in 2015 to 13-17%. Table 7 demonstrate the changing role of energy in the country's economy in 2040 relative to 2015:

- A decrease in the contribution of energy to the produced GDP by 1.8-2.4 times;
- Almost halving the share of fuel in revenue from total exports of goods and more than halving the share of energy exports in GDP;
- A decrease in the share of capital investments in the fuel and energy complex in GDP by 1.1-1.3%. p. and their share in the total investment in the country: 1.7-2.2 times.

At present, with the export orientation of the energy sector (up to half of the produced energy is exported) the investment load of the fuel and energy complex on the economy is several times higher than the global average: capital investment in the energy sector is 5% of Russia's GDP, with 1-1.5% in the world as a whole. Economic downturn 2015-2016 slowed down investment processes due to stagnation of domestic demand, however, already after 2020, in order to maintain stable operation of the energy complex, it is necessary to bring investment volumes to the pre-crisis level in the likely scenario and significantly increase them in the favorable scenario (Table 8).

To ensure the volume of investments, the energy strategy of Russia provides for tax reform in the fuel sectors (replacing the mineral extraction tax with a tax on the financial result of the activities of extractive organizations) and a phased increase in gas prices until 2030 reaches the same efficiency as with its export (Table 9).

5. CONCLUSION

The coming quarter century will not be easy for the Russian economy and energy. Serious changes in the situation in foreign markets, combined with the numerous accumulated problems of the Russian economy as a whole and the energy sector in particular, put them in rather severe conditions. Unfortunately, it's impossible to assume that even with the implementation of the favorable scenario, the tasks of increasing the energy efficiency of the national economy, diversifying the structure and expanding the affordability of energy supply to consumers, reducing the cost of fuel and energy sectors and projects, and especially environmental management and protection, are successfully and adequately paced the environment.

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