

Role of Russia's Asian regions in the energy sector of the country: priorities and prospects for development in the first half of the 21st century

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Abstract. This paper shows the role of Russia's Asian regions in the production and consumption of energy resources for two scenarios (conservative and target) of the economy development in the country until 2035 and for the 2050 perspective. The dynamics and structure for the energy resources supply from the Asian regions to the European part of Russia and for export to the European and Asian countries is presented. The Asian regions are shown to still remain the main suppliers of energy resources in the country. By 2050, about 80% of the energy resources produced in the Asian regions will be resupplied outside their borders, 56-57% of them for export.

1 Introduction

The Draft for the Energy Strategy of Russia [1] pays much attention to the Asian regions (Siberia, the Far East), whose development may provide an added momentum to the energy sector development in the country. The Draft notes that it is these regions, where a more dynamic growth in the energy consumption and production is expected, considering that the main prospects for increasing the export of Russian energy resources to the countries of Northeast Asia are related to them.

The energy sector development in Russia and its Asian regions in the long term will depend on a number of factors, such as the changes in: the economy development forecast and energy consumption levels in the country and its Asian regions; the domestic and export prices of energy resources; the terms and scale of constructing hydro power plants (HPPs), nuclear power plants (NPPs), non-traditional renewable energy sources (NRESs), etc.

Assessment of the impact of these factors on the energy sector development is rather a complicated task. The studies were carried out using the dynamic model (developed with participation of the authors) to optimize the territorial-production structure of the national energy sector [2]. The model describes the process of development of its territorial-production structure up to 2050 with division into 5-year periods and separation of large macroregions and federal districts (FDs) in the territorial aspect.

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The model studies enabled us to form a balanced rational structure of regional energy sectors development for each of the Asian regions (West and East Siberia, the Far East) in dynamics, and to identify their role in the energy sector of the country.

The materials for the Draft of the Energy Strategy of Russia, as well as the authors' studies allowed a number of trends in the energy sector development in the country and its Asian regions until 2035, and for the 2050 perspective to be identified.

2 Results of studies

The paper presents two scenarios of the energy sector development in Russia and its Asian regions: conservative and target. Table 1 shows aggregated macroeconomic indicators of the economy development and the corresponding levels of energy consumption. The left boundary of the range of change in indicators corresponds to the conservative scenario, the right - to the target scenario.

Table 1. Forecast of economy development and energy consumption in Russia

Indicators	2015	Forecast		
		2025	2035	2050
GDP*, \$ billion	1555	1850-2105	2300-2960	3160-4610
GDP growth rates relative to 2015, %	100	119-135	148-190	203-296
Mean annual GDP growth rates, %	-	1.6-2.9	2.2-3.5	2.1-3.0
Population, million	146	146	145-146	145-147
GDP per capita, \$ thousand/capita	10.7	12-14	16-20	22-31
Domestic consumption of primary energy resources, million tce	966	1045-1107	1106-1192	1160-1233
Mean annual growth rates of energy resources consumption, %	-	0.9-1.1	0.6-0.7	0.2-0.3
GDP energy intensity, tce/ \$ 1000	0.62	0.56-0.53	0.48-0.4	0.37-0.27
Energy intensity decline rates, relative to 2015, %	100	92-87	79-66	60-44

* in 2015 prices

Sources [1, 3, 4] and authors' estimates

Table 2 provides the calculated dynamics of the change in demand of Russia and its Asian regions for energy resources which corresponds to the accepted scenarios of the economy development in the country.

Over the considered period, the consumption of energy resources in Russia may increase by 14–23% by 2035, and by 20–28% by 2050, thus reaching 1160–1235 million tce. According to the forecasts, the energy consumption in the Asian regions will grow increasingly, and within the same period, may grow by 18–28% by 2035, and by 28–38% by 2050, thus reaching 360–385 million tce by 2050.

At the same time, the consumption of oil products in the Asian regions may grow by 31–38%, natural gas – by 40–48%, coal – by 5–25%, non-fuel energy resources (HPPs, NPPs, NRESSs) by 47–59% over 2015–2050.

Within the considered period, the structure of energy resources consumption in the Asian regions may change significantly: the gas share will increase from 35% in 2015 to 37–38%, the coal share in consumption will decrease from 33% in 2015 to 27–30%, and the consumption of non-fuel energy resources will increase by 2% (Fig. 1).

Table 2. Forecasted dynamics of the demand for energy resources in Russia and its Asian regions***

Indicators	2015	Forecast		
		2025	2035	2050
Russia, total, million tce/%	<u>966</u> 100	<u>1045-1107</u> 108-115	<u>1106-1192</u> 114-123	<u>1160-1233</u> 120-128
Including:				
Oil products, million t	129	148-152	160-163	159-152
Natural gas, billion m ³	454	487-527	524-570	548-566
Coal and others, million tce	147	155-163	150-164	159-198
Non-fuel energy resources, million tce**	116	125-127	133-147	151-175
Asian regions, total, million tce/ %	<u>280</u> 100	<u>306-321</u> 109-115	<u>330-358</u> 118-128	<u>358-386</u> 128-138
Including:				
Oil products, million t	39	44-45	50-51	54-51
Natural gas, billion m ³	85	100-107	110-119	119-126
Coal and others, million tce	93	88-93	91-100	97-116
Non-fuel energy resources, million tce**	34	42-43	44-50	50-54

* 2015=100%

** HPPs, NPPs, NRES

***Asian regions: Siberia (including Tyumen Region) and the Far East

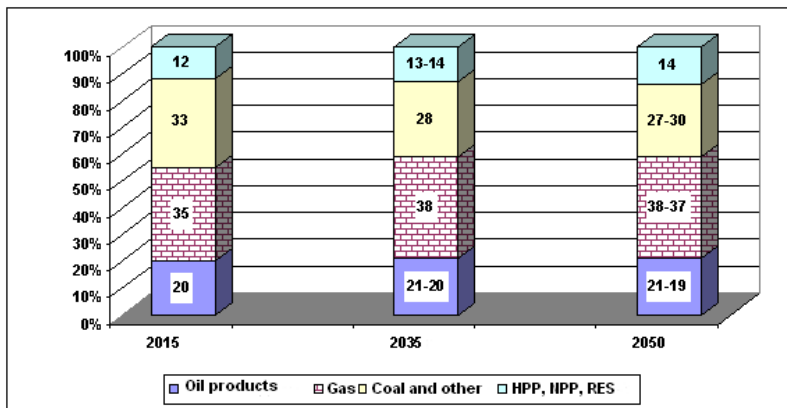


Fig.1. Structure of energy resources consumption in Russia's Asian regions (in tons of coal equivalent) NRES

At present, Russia has the status of the world's largest exporter of energy resources, whose volumes are a little lower (by 3%) than their domestic consumption.

In the considered future, the export volumes and structure will be determined mainly by the economic expediency factors, and will depend not only on fuel prices in the world energy markets, but also on the prices and production volumes from Russian producers. Table 3 presents the dynamics (that is assumed in the calculations) of the world prices of energy resources. Table 4 demonstrates the dynamics of the domestic prices of gas and coal.

Table 5 shows the authors' forecasts for the export of Russian energy resources which were obtained based on the accepted world and domestic bid prices of energy resources.

It follows from the Table that over 20 years, the export of Russian resources may increase by 1–6% and by 2035, it may be equal to 950–1000 million tce with a further decrease to 865–960 million tce (by 4–10%) by 2050.

In the considered time horizon, the European vector of energy resources export will remain dominant for Russia (Fig. 2), but its share in the total export in the long term will decline: to 65–67% by 2035, and to 61–63% by 2050 (versus 80% in 2015).

Table 3. Forecast of energy resource prices in the world markets*

Indicators	2015	Forecast		
		2025	2035	2050
Oil, \$/barrel	45	50-60	50-65	65-80
Natural gas, \$/1000 m ³				
Europe	240	250-270	250-290	300-350
Northeast Asia countries:				
China (piped)	250	275-290	300-345	330-380
Japan (LNG)	310	340-30	380-450	430-500
Steam coal, \$/t	63	60-70	60-75	60-80

*In 2015 prices.

Sources [4,5] and the authors' estimates

Table 4. Forecast of bid fuel prices in Russia's markets*

Indicators	2015	Forecast		
		2025	2035	2050
European market				
Natural gas, \$/1000 m ³	90-105	120-130	120-150	125-185
Steam coal, \$/tce	45-50	50-60	50-75	65-80
Asian market				
Natural gas, \$/1000 m ³	95-100	120-135	145-170	170-200
Steam coal, \$/tce	35-45	50-60	50-60	55-65

* In 2015 prices.

Sources [6-9] and the authors' estimates

Table 5. Forecast of the export of energy resources from Russia

Indicators	2015	Forecast		
		2025	2035	2050
Export*, total, million tce	940	945-1026	950-1000	865-960
Including:				
Oil and oil products, million t	406	348-379	316-338	280-310
European vector	324	246-272	208-221	180-190
Asian vector	82	102-107	108-117	100-120
Natural gas, billion m ³	200	268-291	311-324	295-340
European vector	185	196-204	221-226	200-235
Asian vector	15	72-87	90-98	95-105
Coal, million tce	131	141-152	146-149	135-130
European vector	76	82-78	82-74	75-60
Asian vector	55	59-74	64-75	60-70
Electricity (balance), billion kWh	13.5	21-23	30-40	70-80
Asian vector	3.6	9-11	20-30	55-65
Import, total, million tce	38	37	19	1
Oil, million t	2	4	1	1
Natural gas, billion m ³	22	20	16	-
Coal, million tce	10	10	-	-

*Russian energy resources

At the same time, the availability of economically efficient energy resources in Russia's Asian regions, and the growing demand for them in the Asian-Pacific Region make the Asian export vector increasingly promising. According to the authors' estimates, in the considered period, the export of Russian energy resources in this vector may increase by

factor of 1.7–2 and amount to 325–375 million tce. Herewith, the export of oil and oil products will increase by 22–46%, natural gas – by factor of 6–7, coal – by 10–30%, electricity – by factor of 15–18 (Table 5).

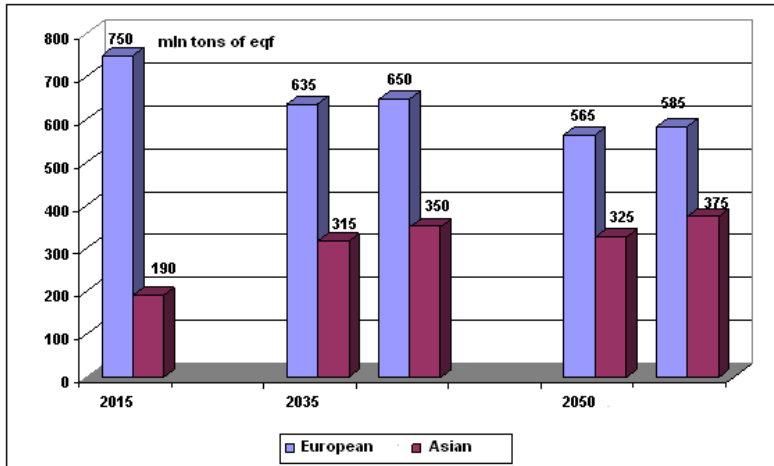


Fig. 2. Forecast of the export of Russian energy resources by vector, million tce

The calculated production of energy resources in Russia is presented in Table 6, and that in the Asian regions – in Table 7.

Table 6. Forecast of energy resources production in Russia

Indicators	2015	Forecast		
		2025	2035	2050
Production, total, million tce/%	<u>1868</u> 100	<u>1953-2096</u> 105-112	<u>2038-2174</u> 109-116	<u>2023-2192</u> 108-117
Including:				
Oil and gas condensate, million t	533	496 - 530	476 - 502	445-465
Natural gas, billion m ³	633	735-800	819 -878	842-907
Coal, million t	372	375-400	390-420	365-405
Other solid fuels, million tce	11	15-16	17-20	22-26
Hydro energy, TWh	170	209-210	226 -244	276-295
Nuclear energy, TWh	195	201-209	233-265	290-380
NRES, TWh	2.4	9-10	23-29	54-55

*2015=100%

The studies have showed that to meet the domestic demand for energy resources and their export, the production of energy resources in Russia should increase (as compared with 2015) by 8–17% by 2035, and equal 2040–2175 million tce, remaining at about this level until the considered period end (Table 6). In the calculations, the maximum possible production of energy resources in the country was assumed from the forecasts by the leading energy institutions and organizations of the country [1, 6–12].

The production of energy resources in the Asian regions should increase (as compared with 2015) by 14–22% by 2035, and equal 1700–1825 million tce, and decrease to 1635–1760 million tce by 2050 (Table 7).

At the same time, the share of Asian resources in the country's total production of energy resources may increase up to 83–84% by 2035 (versus 80% in 2015), and then decrease to 80–81% by 2050 (Table 8).

Siberia's share is expected to reach 66–68% of the oil produced in the country by 2050, with the share of the Far East being 10–11%.

Table 7. Forecast of the energy resources production in Russia's Asian regions

Indicators	2015	Forecast		
		2025	2035	2050
Production, total, million tce	1496	1589-1730	1700-1825	1635-1760
<i>Including: West Siberia*</i>	1250	1213-1308	1260-1350	1182-1263
<i>East Siberia</i>	151	194-225	235-260	240-272
<i>Far East</i>	95	182-197	205-215	213-225
Of which:				
Oil, total, million t	375	350-386	345-378	340-368
<i>Including: West Siberia*</i>	312	263-293	245-270	238-258
<i>East Siberia</i>	37	45-50	55-60	55-60
<i>Far East</i>	26	42-45	45-48	47-50
Natural gas, total, billion m ³	587	685-750	770-832	732-787
<i>Including: West Siberia*</i>	557	590-635	650-700	605-645
<i>East Siberia</i>	8	35-45	50-60	55-65
<i>Far East</i>	22	60-70	70-72	72-77
Coal, total, million t	352	352-377	372-402	354-394
<i>Including: West Siberia</i>	216	200-210	200-210	185-200
<i>East Siberia</i>	96	89-100	106-116	104-120
<i>Far East</i>	40	63-67	66-76	65-74
Hydro energy, billion kWh	108	138-139	152-170	185-204
<i>Including: Siberia</i>	93	114-115	119-125	133-143
<i>Far East</i>	15	24	33-45	52-61
Nuclear energy, billion kWh	0.2	0.8	0.8	0.8
<i>Including: Far East</i>	0.2	0.8	0.8	0.8
NRES, billion kWh	0.8	2.5-3	8-10	18
<i>Including: Siberia</i>	0.1	0.4-0.9	3-5	8
<i>Far East</i>	0.7	2.1	5	10

* including Tyumen Region

Table 8. Share of the Asian regions in domestic total production of energy resources, %

Indicators	2015	Forecast		
		2025	2035	2050
Energy resources, total	80	81-82	83-84	80
<i>Including: Siberia</i>	75	72-73	73-74	70
<i>Far East</i>	5	9	10	10
Oil	70	70-73	72-75	77-78
<i>Including: Siberia</i>	65	62-64	63-66	66-68
<i>Far East</i>	5	8-9	9	11-10
Natural gas	92.5	93-94	94-95	87
<i>Including: Siberia</i>	89	85	85-87	78
<i>Far East</i>	3.5	8-9	9-8	9
Coal	95	94	95-96	97
<i>Including: Siberia</i>	84	77	78	79
<i>Far East</i>	11	17	17-18	18
Hydro energy	64	66	67-70	67-69
<i>Including: Siberia</i>	55	55	52-51	48-49
<i>Far East</i>	9	11	15-19	19-20

At present, the main oil production region is West Siberia. However, the oil production in West Siberia is forecasted to probably decrease by 40–65 million t (13–21%) by 2035 (relative to 2015), and by 55–75 million t (17–24%) by 2050.

Within the considered period, the oil fields in East Siberia and the Far East may contribute significantly to the domestic oil production, with a production increase of up to 60 million t in East Siberia and up to 50 million t in the Far East by 2035–2050.

By 2050 the share of the Asian regions in the country's gas production may decrease to 87% (versus 92.5% in 2015).

According to the forecasts, West Siberia will remain the country's main gas producing region in the studied time horizon. The gas production in West Siberia may grow from 555 billion m³ in 2015 to 650–700 billion m³ by 2035, and then decrease to 605–645 billion m³ by 2050. Amid the production decline in the Nadym-Pur-Taz District in West Siberia, the gas production will grow in Yamal, in the Ob-Taz Estuary, and in the Bolshekhetskaya Depression.

The promising regions for gas production in the country in the studied time horizon will be East Siberia (based on the development of the hydrocarbon fields in the Irkutsk Region and Krasnoyarsk Territory) and the Far East (based on the development of the gas condensate fields in the Sakha Republic (Yakutia), and the Sakhalin offshore fields). Under the favorable state of foreign markets in the Asian vector, the gas production in East Siberia may increase up to 60–65 billion m³ by 2035–2050 and up to 70–75 billion m³ in the Far East. The coal production in West Siberia is forecasted to remain at 200–210 million t until 2035 and then it will gradually decrease, reaching 185–200 million t by 2050.

East Siberia and the Far East will provide the main growth in coal production. The coal production in East Siberia is forecasted to possibly grow by 8–25% by 2050 and by factor of 1.6–1.9 in the Far East. As a result, their share in the country's coal production will grow from 37% in 2015 to 46–48% by 2050, and amount to 170–195 million tce (of which 105–120 million t in East Siberia and 65–75 million tce in the Far East).

In the considered time horizon, the Asian regions will remain the main suppliers of energy resources both to the domestic market and for export (Table 9).

In 2015 the Asian regions of Russia supplied 1218 million tce of energy resources (or 81% of their production), of which 44% were supplied to the European part of the country and 56% for export. According to the authors' estimates, within 2015–2035 the supplies will grow, and by 2035 will reach 1380–1480 million tce (growth by 13–22%). In the subsequent period, the supplies will gradually decrease, and by 2050 will amount to 1285–1390 million tce (78–79% of production).

The share ratio will also change in the vectors of supplies (Table 9):

- the share of the energy resources supplies from Russia's Asian regions to its European part in the total supplies will decrease and by 2035 will make up 39–40% (versus 44% in 2015), and then by 2050 it will grow to 43–44%. Within this period, the natural gas supplies to the European regions will increase by 70–80 billion m³, and the oil and coal supplies will decrease (oil – by 10–20 million t, coal – by 8–24 million tce);

- the share of the energy resources export from the Asian regions of Russia in the European vector in the total export will decrease from 40% in 2015 to 35–37% by 2035, and to 30–31% by 2050. At the same time, within the considered period the export of West Siberian oil will reduce by 45–50 million t, and the export of West Siberian gas and Kuznetsk coal will increase by 2035, and then by 2050 will decrease;

- the share of the energy resource export from Russia's Asian regions in the Asian vector (APR countries) will increase from 16% in 2015 to 24–25% by 2035, and to 25–27% by 2050. In this period, the export of oil and oil products will grow from 80 million t to 100–120 million t, the export of natural gas – from 15 to 95–105 billion m³, the export of coal – from 55 to 60–70 million tce.

Table 9. Export of energy resources from Russia's Asian regions

Energy resources	2015	Forecast		
		2025	2035	2050
<i>Supplies, total, million tce/%</i>	<u>1218</u> <u>100</u>	<u>1284-1415</u> <u>100</u>	<u>1380-1480</u> <u>100</u>	<u>1285-1390</u> <u>100</u>
<i>Including:</i>				
<i>- to Russia's European part, million tce/%</i>	<u>534</u> <u>44</u>	<u>500-555</u> <u>39</u>	<u>540-595</u> <u>39-40</u>	<u>560-600</u> <u>44-43</u>
of which:				
oil, million t	81	57-66	57-62	60-70
natural gas, billion m ³	323	335-370	368-405	395-405
coal, million tce	50	37-39	40-44	26-42
<i>- for export, total, million tce</i>	<u>684</u>	<u>784-860</u>	<u>840-885</u>	<u>725-790</u>
including:				
<i>European vector, million tce/%</i>	<u>493</u> <u>40</u>	<u>493-532</u> <u>38</u>	<u>515-525</u> <u>37-35</u>	<u>400-415</u> <u>31-30</u>
of which:				
oil, million t	176	150-170	140-150	125-130
natural gas, billion m ³	165	177-185	205-210	125-150
coal, million tce	54	80-76	80-70	75-60
<i>Asian vector, million tce/%</i>	<u>191</u> <u>16</u>	<u>291-328</u> <u>23</u>	<u>325-360</u> <u>24-25</u>	<u>325-375</u> <u>25-27</u>
of which:				
oil and oil products, million t	82	102-107	108-117	100-120
natural gas, billion m ³	15	72-86	90-98	95-105
coal, million tce	55	59-74	64-75	62-70
electricity, billion kWh	4	9-11	20-30	55-65

3 Conclusions

The conclusions based on the conducted studies are as follows:

1. According to the authors' forecasts for the considered time horizon (2015–2050), the energy resources consumption in the country may increase by 20–28%, while the energy resources consumption in the country's Asian regions will grow by 28–38%. As a result, the share of the Eastern regions in the total consumption of energy resources in the country will increase from 29% in 2015 to 31–32% by 2050.
2. For the studied period the Asian regions will remain the main suppliers of energy resources both to the domestic market and for export.
 In 2015, Russia's Asian regions supplied 1218 million tce of energy resources (or 81% of their total production), of which 44% were supplied to the European part of the country, and 56% – from. According to the forecasts, within 2015–2035, the supplies will grow by 13–22%, but then it will decline and by 2050 will equal 1285–1390 million tce.
3. The share ratio in the vectors of supplies will also change.
 - the share of the energy resources supplies from the Asian regions of the country to its European part by 2035 in the total supplies will decrease to 39–40% (versus 44% in 2015), and then, by 2050, will grow to 43–44%;
 - the share of the energy resources export of Russia's Asian regions in the European vector will decrease from 40% in 2015 to 35–37% in 2035, and to 30–31% by 2050.

- the share of the energy resources export in the Asian vector will increase from 16% in 2015 to 24–25% by 2035, and to 25–27% by 2050.
4. According to the authors' estimates, despite the absolute growth in the export of oil (oil products) and coal, their share in the structure of energy resources export in the Asian vector will decrease: from 61% in 2015 to 44–45% of oil, from 29% to 19% of coal by 2050.
At the same time, the share of gas in the structure of energy resources export will grow from 9% in 2015 to 32–33% by 2050.
 5. To meet the domestic demand for energy resources and their export, the energy resources production in Russia's Asian regions should grow by 14–22% by 2035 (versus 2015), and equal 1700–1825 million tce, and then, by 2050, it should decrease by 3.5–4%. By 2050, the share of the Asian regions are expected to reach 76–79% of the produced oil in the country, 87% of the produced natural gas, 97% of the produced coal, and 67–69% of the electricity produced by HPPs.

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