Implementation of the Energy Strategy of the Republic of Sakha (Yakutia): Trends and Prospects

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Abstract: The paper presents the results of studying the functioning and development of the branches of the fuel and energy complex (FEC) of the Republic of Sakha (Yakutia). The republic is the largest constituent entity of the Russian Federation in terms of area. The economy of the republic specializes in the extraction of minerals (including hydrocarbons), which directly affects the FEC efficiency. Severe climatic conditions, complex and long-term schemes for the transportation of energy resources for the needs of the economy and the population, and the special geostrategic position of the region determine the research relevance of this subject area. As part of the research work, the authors conducted a retrospective analysis of the features of the functioning of industries and enterprises according to the main FEC components: (1) extraction of energy resources (oil, coal, and gas); (2) electric power industry; (3) heat power industry; (4) renewable energy; and (5) environmental protection. Within the research, the authors assessed the current trends in retrospect and analyzed the current state. In addition, the authors determined the prospects for developing FEC sectors according to the forecasts and scenarios of the socio-economic development of the republic. As a result, the authors obtained the applied knowledge necessary for the effective implementation of long-term prospects for the FEC development of the Republic of Sakha (Yakutia). The research allowed identifying the problems and formulating tasks requiring solutions to improve the FEC efficiency and ensure energy security, efficient use of natural resources, and modernization of the FEC sectors. Based on the results of the research work performed in the subject area of strategizing the development of the regional FEC, the authors propose to implement the main strategic directions for elaborating FEC sectors according to the development priorities of the national and regional economy.

1 INTRODUCTION

Russian energy policy aims at the most efficient use of natural energy resources and the potential of the energy sector for sustainable economic growth, improving the quality of life of the population of the country, and strengthening its foreign economic position. The implementation of energy policy at the sub-federal level affects the objective processes of socio-economic development of regions, including the Republic of Sakha (Yakutia) (Ivlev, 2020). At the same time, abrupt changes in external and internal factors, emerging challenges, and growing macroeconomic uncertainty significantly influence the main parameters of the functioning of the fuel and energy complex (FEC) of the country and its regions.

The Republic of Sakha (Yakutia) is distinguished by harsh natural and climatic conditions, the presence of an impressive mineral resource base, low population density, and a raw-material economy in the production of oil, gas, diamonds, and coal. As an object of ensuring energy security, the Republic of Sakha (Yakutia) is a complex and specific region. A distinctive feature of the energy system of the republic is the synthesis of large and small energy industries. It is characterized by a rare combination of centralization and decentralization properties. In particular, there are isolated energy regions on the territory of the republic, a set of local (small) energy facilities, and energy regions connected to the Unified Energy System of the Russian Federation. The centralized power supply of the republic covers 36%

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of the territory, where 85% of the population of the Republic lives. The small energy industry in the republic is the only energy base that provides livelihoods in the decentralized energy supply zone (mainly in the Arctic zone) (Kiushkina, 2019). The republic is characterized by the territorial remoteness of a significant number of settlements and an undeveloped transport infrastructure, which determines the presence of a decentralized energy system in the Arctic regions of Yakutia (Marinychev, 2015).

At the same time, a large fuel and energy base including all FEC sectors (except for the nuclear one) has been created in the Republic of Sakha (Yakutia): coal, oil, and gas industries, as well as electricity and heat. The FEC of the republic fully satisfies the internal needs for coal, natural gas, electricity, and heat, except for oil products imported into the republic from outside (Ivanova, 2017; Ivanova, 2019; Voropai, 2014).

The prerequisites for changing the trajectory and content of the further FEC development of the Republic of Sakha (Yakutia) are of external economic, national, and intraregional nature (Ivlev, 2020). Some of them have already appeared and determined the nature of the formation and development of the industry. The manifestation of others should be expected in the coming years. The development strategy of the regional FEC should form new guidelines for the elaboration of the energy sector, considering the current economic situation in the FEC of the republic, the Far East of Russia, and the Asia-Pacific region.

2 MATERIALS AND METHODS

The authors identified the following objects and processes to ensure the consistency of research:

- FEC of the Republic of Sakha (Yakutia) as a component of the economy (energy industry) of the Far Eastern Federal District and the Russian Federation;
- FEC resource potential of the Republic of Sakha (Yakutia);
- Effects of realizing the FEC potential of the Republic of Sakha (Yakutia);
- Processes determining the FEC development of the Republic of Sakha (Yakutia):
  - Socio-economic development of the Republic of Sakha (Yakutia);
  - Introduction of modern technologies for producing and distributing energy;
  - Macroeconomic dynamics and new priorities for the spatial development of Russia;
  - Implementation of national projects.
- Prerequisites and priorities for further FEC development of the Republic of Sakha (Yakutia).

The purpose and tasks of the study imply the use of an integrated, interdisciplinary approach to the analysis of the research object, which is a multiplicative set of complex objects characterized by emergence, synergy, and heterogeneity. The authors used general scientific methods to achieve the goal and solve the tasks set in the study.

The general theoretical aspects of solving such tasks were well studied and described in the scientific works of researchers of the Siberian and Far Eastern branches of the Russian Academy of Sciences (Kryukov, 2020; Saneev, 2018). When solving this problem, one should consider many exogenous and endogenous factors, including the existing asymmetry of the socio-economic development of territories. The quality of solving the task can be affected by significant uncertainty arising from the lack of reliable information characterizing the economy of a particular territory at the subregional level.

The research methodology is based on the following set of interrelated processes:

- Improvement of the methodology for studying factors and trends affecting the development of regional socio-economic systems in current conditions;
- Analysis of prerequisites and conditions for potential development in the future;
- Determination of trends characterizing the trajectory of realizing the potential of the research object;
- Prospective analysis of the directions for the development of the potentials of the research object (including in the context of the implementation of the Strategy of socio-economic development of the Republic of Sakha (Yakutia)).

3 RESULTS

The monitoring of the results of implementing the current *Energy Strategy of the Republic of Sakha (Yakutia) Until 2030* confirmed the adequacy of most of its statements to the real state of the regional energy sector. At the same time, the FEC development in the region does not ensure the full achievement of some strategic goals due to a slowdown in economic growth with an increase in long-term structural and

institutional development constraints in the republic and the whole country.

The authors considered the current situation at the end of 2022 and the actual implementation of measures for all FEC segments of the republic separately.

The authors analyzed some of the main socio-economic indicators of the Republic of Sakha (Yakutia) according to Territorial body of the Federal State Statistics Service for the Republic of Sakha (Yakutia) and made the following conclusions:

- The population increased by 4% from 2008 to 2022.
- The gross regional product production increased by 6.5 times from 2008 to 2022 and exceeded one trillion rubles for the first time (in 2022).
- Electricity consumption increased by 59.5% from 2008 to 2022 (including by 53% per capita).
- Annual energy saving potential increased by 15%–17% from 2008 to 2022 due to an increase in electricity consumption, loss of electrical energy, and innovative development of power converting equipment.

3.1 Electric Power Industry

The electric power industry of the Republic of Sakha (Yakutia) includes centralized and decentralized power supply zones. The centralized power supply zone has three regions of the electric power system (Western, Central, and South Yakutsk) and covers 36% of the territory of the republic, where 85% of the population lives.

As of January 1, 2022, the total installed capacity of power plants in the republic is 3,308 MW, and compared with 2008, it increased by 847.75 MW (Table 1).

Table 1: Change in installed capacity by type of power plant, MW.

Power plant type	Year		
	2008 (MW/share)	2022 (MW/share)	Change, MW
Installed capacity, total including:	2,460.25/100	3,308 /100	847.75
HPP	950 /38.61	957.5 /28.9	7.5
TPP	1,022 /41.54	1,555.8 /47.0	533.8
DPP	488 /19.83	788.8 /23.8	300.8
WPP	0.25 /0.01	4.28 /0.13	4.03
SPP	-	1.617 /0.05	1.617

Note: HPP – hydroelectric power plant; TPP – thermal power plant; DPP – diesel power plant; WPP – wind power plant; SPP – solar power plant. *Source:* Compiled by the authors based on (TB FSSS for the Republic of Sakha (Yakutia), 2023).

The electric power industry is based on thermal and hydroelectric power plants. Their share in the total capacity of power plants is estimated at 47% and 28.9%, respectively. Diesel power plants (stationary and mobile) account for 23.8% of the installed capacity. Renewable energy sources (RES) account for an insignificant share in the capacity structure – 0.18%.

The total length of power transmission lines of all voltage levels is more than 32 thousand km, 23482 km of which are on the balance of Yakutskenergo PJSC, 2187.9 km – Sakhaenergo JSC, 1,771.48 km – DRSK JSC, 380.81 km – Surgutneftegaz PJSC, and 3,428.73 km – FSK EES PJSC. In the period from 2015 to 2019, the main development of the electric power network was performed through the reconstruction and commissioning of the ESPO facilities and the commissioning of the Yakutsk State Regional Power Plant (SRPP), as well as the merger of the Western region of the electric power system (WREPS), the Central region of the electric power system (CREPS), and the South Yakutsk region of the electric power system (SYREPS).

Compared to 2008, in 2019, the total length of the electrical network increased by 9,590 km, which was an increase of over 42%. In 2009, the total length of power transmission lines (PTL) was 22.5 thousand km. The main increase in the PTL length occurred due to the large-scale construction of 220 kV PTL with a length of more than 4,445 km and the construction of 35 kV and below PTL with a length of more than 2,600 km. The total length of 110 kV and above PTL in CREPS is 9,339.198 km. The total capacity of 110 kV and above transformer substations is 6,295 MVA.

The authors took the forecast data of the moderate (underestimated) scenario of economic development from the Energy Strategy of the Republic of Sakha (Yakutia) Until 2030 to analyze the implementation of key indicators of the current strategy for the production of electricity (Table 2).

Table 2 shows that the actual data are much lower than those planned for 2020 in main indicators of socio-economic development of the Republic of Sakha (Yakutia) in 2018. This testifies to the fact that the overestimated rates of development of the economy and, accordingly, of the energy infrastructure were taken in the 2009 Strategy. Many

investment projects were not implemented. For example, in the SYREPS, it was planned to open a metallurgical production, intensive development of the Elga coal deposit, and the construction and commissioning of the fourth block of the Neryugri SRPP (225 MW), the Elga combined heat and power plant (CHPP) (80 MW) in 2015, and the Elga SRPP (1200 MW) in 2020 for electricity exports to China. The expansion of the Neryungri SRPP was conditioned by the coverage of electrical loads in the Neryungri and Aldan regions. Moreover, it was envisaged to expand the Neryungri SRPP by another 330 MW and build the Kankunsky HPP by 2035 to export electricity.

Table 2: The results of monitoring indicators for electricity production.

No.	Indicator	Measurement unit	Plan 2015	Plan 2020	Actual 2022	Deviation, %
1	Electricity production	mln kWh	11,11	27,21	10,26	-7.7/-62.3
2	Electricity consumption	mln kWh	10,98	14,87	10,92	-0.6/-26.6
3	Installed capacity	thou kW	2,981	5,99	3,31	+11/-44.8
4	Loss in networks	mln kWh	1,871	2,055	1,10	-41.5/-46.7
5	Electricity supply outside the republic	mln kWh	237	12,48	237.4	+0.2/-98.1

Source: Compiled by the authors.

The main goal for implementing the Energy Strategy of the Republic of Sakha (Yakutia) in the aspect of local electric power industry was the expediently possible reduction of the decentralized power supply zone and the reduction of the cost of electricity generated by the sources of this zone by means of optimization of various directions.

For the analyzed period, the following situation is observed in terms of optimization of the local electric power industry in the Republic of Sakha (Yakutia).

Changes in the installed capacity of the local electric power industry are associated with the commissioning of new capacities of various types of power plants and the installation of additional ones, as well as the replacement of 365 old diesel generators in 80 settlements.

The diversification of electricity production and the typical range of installed capacity of power plants in the Northern energy region shows the following:

- Slightly slow decrease in the installed power of the DPP with a critical deviation value;
- Active commissioning of generating RES-based plants using wind and solar potential (Dolmatov, 2018; Marinychev, 2018);
- Relatively high deviation from the goals set for the introduction of the low-capacity CHPP;
- Absolute exclusion of the nuclear low-capacity CHPP from the construction implementation, due to the commissioning of which it was planned to increase the capacity to compensate for the withdrawal of obsolete DPPs.

The lack of actual data on the volume and targeting of investment measures and the implemented connection of facilities to centralized power supply do not allow to fully present an analysis of the implementation of the set indicators for the local electric power industry.

Nevertheless, the analysis of the characteristics of sources generating electricity and the problems of the local electric power industry did not show a satisfactory situation and the achievement of the set qualitative indicators of reliability and quantitative indicators of energy efficiency in the decentralized zone of power supply.

3.2 Heat Power Industry and Heat Economy

One of the main consumers of thermal energy is the housing stock of the population (53%). Heat production volumes for 2015–2022 decreased by 7%, while the volume of consumed heat energy decreased by 3% by 2015, with a simultaneous growth in the housing stock over the same period and an increase in the provision of heating to the housing stock (Table 3).

Table 3: The results of monitoring indicators for heat production.

No.	Indicator	Measurement unit	Plan 2015	Plan 2020	Actual 2022	Deviation, %
1	Heat production	mln Gcal/year	21.1	22.6	12.26	-38/-42
2	Heat loss	mln Gcal/year/%	2.2/10.9	2.2/9.9	2.9/20	46/51
3	Heat consumption	mln Gcal/year	18.9	20.4	9.66	-48/-53

Source: Compiled by the authors.

A decrease in the effective heat supply is also associated with an increase in autonomous (including roof-top) boiler houses of associations of heat owners, management companies, and commercial and budgetary organizations deployed mainly in gasified regions of the republic (Elyakova, 2018; Darbasov, 2020). The heat and fuel consumption of these boiler houses is much lower than the costs of district heating due to the reduction of loss. Nevertheless, they are large air pollutants.

Heat energy loss for 2015–2022 increased by 15%, with the planned trend of reducing loss to the level of 9.9% by 2020. The growth of heat energy loss is primarily associated with non-compliance with the normative depreciation of heat pipelines (Solomonov, 2020). As the analysis of the renewal of heat supply sources has shown, the republic does not withstand the standard volumes of modernization of boiler equipment. Over the past four years, on average, 45 boiler houses (instead of the required 80) and 155 km of heating networks (instead of 284 km) have been renewed per year. As a result, in 2022, there were five accidents at heating networks and three accidents at heat supply sources.

The results of monitoring planned and actual indicators for the heat economy for 2022 also show that the indicators characterizing the modernization and development of the heat and power infrastructure of the republic have not been achieved (Table 4).

Table 4: The results of monitoring unreached planned indicators for the heat economy.

No.	Indicator	Measurement unit	Plan 2018	Actual 2022	Deviation, %
1	Gasification of settlements along the route of main gas pipelines and trans-river uluses, including the conversion of boiler houses to the combustion of natural gas	units converted to gas	223	105	-52.9
2	Construction of the low-capacity CHPP on coal until 2030 (a total of 11 low-capacity CHPPs)	units	8	1	-87.5
3	Construction of nuclear low-capacity CHPPs until 2030 (a total of 3 nuclear low-capacity CHPPs)	units	2	0	-100

Source: Compiled by the authors.

A significant lag behind the indicators of the previous strategy is observed: gasification of boiler houses was implemented by 46.8%, and there is a tendency to increase the consumption of firewood instead of imported coal by private boiler houses. The indicators of reduction of oil-burning are met, although the boiler houses that burned wood in the Northern and Central energy regions switched to burning oil. As regards the modernization of boiler houses and heating networks, the fulfillment of the indicators of the previous strategy does not mean that there is no problem in ensuring the reliability of the heat supply systems of the republic. More than that, the presence of worn-out and emergency boiler and heating networks do not allow ensuring the reliability of heat supply.

3.3 Oil, Gas and Coal Production

Currently, Yakutia produces more than 40% of oil in the Far Eastern Federal District. In 2022, production volumes amounted to 19.12 million tons (Table 5). A significant increase is associated with the continued commercial operation of one of the largest assets of Rosneft in the East Siberian cluster, namely, the Srednebotuobinskoye field (Filimonova, 2019).

Table 5: The results of monitoring indicators for energy production.

No.	Indicator	Type of work	Plan 2015	Plan 2020	Actual 2022	Deviation, %
1	Oil (including gas condensate), mln tons/year	Production	8.25	11.3	19.1	131/69
		Domestic consumption	0.3	1.3	0.3	0/-77
		Export outside the republic	7.95	10.0	18.8	137/88
2	Natural gas, bln m^3/year	Production	2.6	6.9	17.3	565/150
		Domestic consumption	2.6	3.0	2.0	-23/-33
		Export outside the republic	0	3.9	15.3	-/292
3	Coal, mln tons/year	Production	17.1	30.7	32.2	88/50
		Domestic consumption	4.1	7.4	2.6	-37/-65
		Export outside the republic	11.6	19.1	25.2	117/31
		Loss in transportation	1.4	4.2	4.4	214/4

Source: Compiled by the authors.

The growth in gas production in Yakutia in 2008–2013 was closely related to the start of large-scale oil production in 2008 when the ESPO oil trunk pipeline was put into operation. The development of the oil potential has led to an increase in the extraction of associated petroleum gas by Surgutneftegas (Filimonova, 2019).

For 2014–2018, gas production increased by only 0.1 billion m3, while in 2022, there was an increase of 3.4 billion m3. This is due to the fact that large-scale gas production in Eastern Siberia and the Republic of Sakha was hampered by the construction of main gas transmission infrastructure and is conducted mainly within local gas supply centers to provide energy raw materials and electricity to production facilities and the population. Associated petroleum gas is also being extracted. At the end of 2022, gas production in the republic amounted to 17.3 billion m3 (Filimonova, 2019; Filimonova, 2019).

Coal production in the republic increased from 17.1 million tons in 2015 to 32.2 million tons in 2022, i. e., by 88%. At the same time, reaching the planned targets for 2020 is not feasible, first of all, due to the moderate growth in coal production determined by a decrease in demand for exports (Romanova, 2016). Coal is losing in inter-fuel competition in the Russian Federation. For 11 years, its share in the fuel basket of the fuel and energy system has decreased from 27% to 25% in the Russian Federation as a whole and from 75% to 56% in the Far East.

4 THREATS TO THE ENERGY SECURITY OF THE REPUBLIC

The main problems (threats) to the energy security of the republic are as follows:

- *Lack of intersystem electrical connections between the CREPS and WREPS of the republic*. The Central energy district is connected to the Western energy district through the Southern one; thus, the electric power system of the Southern energy district is a key element in the unified energy system of the Republic of Sakha (Yakutia). The existing electrical connection of 220 kV PTL along the main ESPO oil pipeline provides electrical communication between the Western and Southern energy regions but cannot provide significant transit flows of energy and power between the systems due to the significant length and targeted need provide ESPO facilities. In order to increase the energy security of the republic, it is necessary to build electrical connections between the Western and Central energy regions (thus, there will be an emergence of a ring topology of the power grid complex of the republic);
- *Presence of a significant territory (2/3 of the territory of the region) with settlements of a strategic border value located in the zone of decentralized power supply, without electrical connections to the centralized power supply sector*. Power supply for these settlements and production facilities is provided from local small power plants, mainly DPPs that are low-efficient and burning expensive diesel fuel imported;
- *Mono-resource provision of each power district, strong dependence on its type of primary energy resource* (Kryukov, 2019; Nikiforova, 2018), the lack of reliable intersystem connections within the republic, and a significant share of electricity and heat generated for the power district by a single source (Kankunsky HPP in the west, Yakutsk SRPP (Yakutsk SRPP–2) in the center, and Neryungri SRPP in the south). A certain diversification of fuel supply to power regions and deconcentration of generating electric capacities are required;
- Deficiency of investment resources of energy enterprises and *freezing* of improvement processes of energy efficiency in production due to constant underfunding of energy-saving measures, implementation of investment projects, and introduction of innovations (Gulyaev, 2017; Romanova, 2016);
- *Significant physical wear and tear of fixed assets of energy enterprises*. The farther the power generating sources are from the centralized zone, the more difficult the situation is;
- *Serious lag in development and qualitative deterioration in the resource base of the FEC extractive industries associated with a deterioration in the characteristics of reserves and insufficient prospecting work* (Romanova, 2016). Low economic availability of energy resources leads to high tariffs of heating, hot water supply, and electricity for the population and organizations (Zhirkova, 2019).
- Significant loss of heat and electric energy in networks, not decreasing since 2008 (Solomonov, 2020);
- Low energy efficiency of the economy of the republic (Elyakova, 2018);
- *High degree of wear and tear of the housing stock*. Specific heat consumption for heating residential buildings is characterized by a wide range of values from 0.15 Gcal/m2 to 0.85 Gcal/m2 per year. The republic is still among the regions of the Russian Federation with the largest share of dilapidated housing (16.5%). One of the reasons for the high share of dilapidated housing is that more than

half of the housing stock of the republic is wooden (56.8% of the total area), and only slightly more than one-third (41.4%) is in stone (brick, panel, block, or monolithic) construction.

5 DISCUSSION

Prospects for the FEC development of the Republic of Sakha (Yakutia) are actively discussed at various platforms. In the book Energy Strategy of the Republic of Sakha (Yakutia) Until 2030 (Alekseev, 2010) offer a very ambitious forecast for the development of the FEC sectors of the republic until 2030. The development plans were elaborated according to the Scheme for the integrated development of productive forces, transport, and energy in the Republic of Sakha (Yakutia) until 2020.

The plans for the development of FEC sectors and enterprises assumed the implementation of major projects on the territory of Yakutia, including the development of energy-intensive metallurgical and gas chemical industries. It was envisaged to build the South Yakutsk hydropower complex and new HPP to ensure the growth of industrial production. However, due to objective reasons (changes in the macroeconomic situation, sanctions, geopolitical trends, etc.), large megaprojects were not implemented, and in the future, the implementation of these projects remains in question. At the same time, the forecast for the FEC development was evaluated based on the planned economic growth rates at the level of 106%–107% per year. The actual growth rate of the gross regional product in the republic amounted to no more than 103% in the period from 2009 to 2020.

The concept of research and forecasting of the FEC development of the republic presented in this paper is based on more cautious forecasts about the rates of socio-economic development of the republic caused by the instability of the world economy, financial and raw materials markets, a decrease in economic growth in China (one of the main consumers of energy resources produced in Yakutia), and uncertainty caused by Covid-19.

Taking priority measures by the FEC is recommended to achieve the target vision and key indicators of the FEC performance, namely:

Electric power industry, including local electric power industry

- Development of power grid facilities (e. g., Suntar-Olekminsk and Suntar-Vilyuysk overhead PTL) and implementation of the option of building networks for connecting local energy facilities to centralized networks until 2032 (18 settlements);
- Construction of overhead PTL and the Nezhdaninskoe substation (110 kV) in the Tomponsky ulus, reconstruction and modernization of the Sulgachi substation (110 kV) in the Aldan ulus, and reconstruction of the Markha substation (35 kV) with transfer to 110 kV voltage class in Yakutsk;
- Joining the settlements of the Oymyakonsky ulus to the grids of the Magadan energy system;
- Implementation of pre-design work according to the scheme for developing 110–220 kV electrical networks in the direction of Maya – Khandyga – Dzhebariki-Khaya;
- Formation of the list of objects of the power grid complex of 35 kV and above, planned for commissioning by 2024;
- Development of proposals for the connection of the Talakan gas turbine power plant, the networks of the Talakan field (Surgutneftegaz PJSC), and the integrated gas treatment unit (UKPG-3) of the Chayandinskoye oil and gas condensate field (Gazprom dobycha Noyabrsk LLC) to the power grids of the unified national energy system (UNEG);
- Commissioning of compressor stations No. 1–5 of the Power of Siberia gas pipeline;
- Inventory of *ownerless* electrical and heating networks, transformer substations, heat points, and water supply and sewerage networks and putting them on economic and financial accounting in the territory of municipalities;
- Continuation of work on the consolidation of the state property of the Republic of Sakha (Yakutia) in the electric power industry based on Yakutskenergo PJSC;
- Implementation of investment projects for constructing DPPs with the RES introduction planned to be commissioned until 2025.

Heat power industry and heat economy

Optimization of producing and consuming heat energy necessitates a set of priority measures:

- Implementation of metering of heat energy generation by separating heating network organizations from the operator's workstation;
- Price regulation of heat energy generation with mandatory performance testing of boilers and subsidies for consumer facilities after an energy audit;
- Expansion of the market for energy service contracts by small and medium-sized businesses in apartment buildings and organizations by improving mechanisms for financing subsidies from the republican budget for heat energy saved by the concessionaire;

- According to the standard, the modernization of 50 boiler houses and 168 km of the heating network is required annually. With consideration of the emergency ones for the next five years, the modernization of 70 boiler houses and 271 km of the heating network is required annually;
- Promotion of using local coals for energy generation;
- Automation of the processes of fuel preparation, generation and distribution of energy and its automated state price regulation.

In the formation of an action plan for implementing the Strategy, it is also advisable to consider the following important circumstances that will significantly affect the energy sector of the republic:

- Within the target vision of the development of the electric power industry of the Republic of Sakha (Yakutia), it is advisable to consider the electric power complex of the republic (through the nodes of the Yakutsk power system) as a promising key element of the Russian UNEG in the Far East according to the following scheme: Eastern Siberia (Irkutsk power system) – Yakutia – Far East (Magadan power system). The implementation of this scheme will ensure the effective participation of the republican energy system in the UNEG (including through pricing). Ensuring an economically effective flow of energy and power through the nodes of the Yakutsk energy system needs trunk 330–500 kV overhead PTL, including 220 kV overhead PTL in the direction of Khandyga – Nezhdaninskoe – Ust-Nera;
- One of the mechanisms for solving this problem is the inclusion of the above objects in the investment program of FSK EES PJSC;
- The UNEG development calls into question the efficient functioning of enterprises producing and selling electricity in technologically and territorially isolated power systems, including in the Arctic zone of the republic (Sakhaenergo JSC). In this regard, it is necessary to develop a new concept for the development of power generation in the changing market conditions and with changes in the schemes of cross-subsidization of *Arctic* costs. The need to change the organizational structure of the existing management systems (including an enterprise or a set of enterprises) of the electric power industry of the republic is not excluded;
- One of the alternative mechanisms for developing energy systems in the Arctic zone may be the state policy aimed at combining electricity and heat energy using a single infrastructure, logistics, technologies, and common management systems, including financing and subsidies. The state policy for the development of isolated energy systems should include measures to reduce administrative and market barriers for new economic entities participating in the regional energy market, including the heat power industry. It is advisable to determine the conditions and factors that allow demonopolizing the regional energy market;
- It is necessary to continue work to improve energy efficiency and energy saving, including through the use of RES technologies. World practice shows that the development of the RES market requires government incentives, motivation, and support, including government investments in the development of the technological base and fixed capital in this energy segment. Of particular importance is the state regulation of project activities aimed at introducing new cost-effective technologies for the production and sale of energy in harsh geo-climatic conditions. An integral part of the state regulation of the RES market should be the personnel policy aimed at providing the industry with highly qualified specialists;
- In current conditions, one of the challenges affecting the regional energy system may be an uncontrolled process of development of *split* energy. Modern technologies allow economic entities of various levels and sizes to generate electricity *for their needs* at costs that ensure a sufficient efficiency level of such production. In the long term, this process can lead to a significant change in the market situation in the regional energy market and *erosion* of the regulated tariff. It is advisable to develop preventive mechanisms and instruments for state regulation of the process of development of *split* energy.

6 CONCLUSIONS

An accelerated transition (modernization breakthrough) to a more efficient, flexible, and sustainable energy will be required in the context of the projected changes in the global and Russian economies.

The priorities of the state energy policy are as follows: (1) guaranteed provision of energy security for the whole country and the constituent entities of the Russian Federation, especially those located in geostrategic territories; (2) priority satisfaction of domestic demand for products and services in the energy sector; (3) transition to environmentally friendly and resource-saving energy; (4) development of competition in the competitive types of FEC activities in the domestic market; (5) rational use of

natural resources and energy efficiency; (6) maximum possible use of equipment with a confirmation of production in the Russian Federation; (7) improvement of the efficiency and effectiveness of all levels of FEC management; and (8) maximum use of the benefits of centralized energy systems.

These priorities determine the content of the energy policy and goals and tasks of the Energy Strategy of the Republic of Sakha (Yakutia). During the implementation of the Energy Strategy of the Republic of Sakha (Yakutia) Until 2032 (with a target vision until 2050), the following tasks should be solved: (1) provision of technological renewal of the FEC sectors; (2) improvement of the efficiency of geological exploration and ensuring rational use of mineral resources; (3) satisfaction of the prospective domestic demand for energy resources and formation of a rational fuel and energy balance of the republic in conjunction with the constituent entities of the Russian Federation; and (4) development and rational use of the export FEC potential of the republic.

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