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Determination of the needs for energy infrastructure facilities necessary for the full functioning of the tourist industry facilities of the Central ecological zone of the Baikal natural territory (CEZ BNT) of the Republic of Buryatia

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Abstract. The article considers the priority directions of energy infrastructure development. The analysis of electricity and heat supply infrastructure in the areas of Buryatia described the problems of heat supply and proposed solutions to the problem.

1. Introduction

The program goal of the energy development of the Republic of Buryatia is a reliable and high-quality energy supply to consumers, ensuring sustainable growth of the economy of the Republic and the quality of population's life, corresponding to the average level in Russia, the development of infrastructure.

This requires:

- Balanced development of generating and network capacities, that can prevent power supply interruptions on the entire territory of Buryatia and its separate districts;
- Development of infra-system lines and substations, which will enable the connection of new consumers providing reliable and high-quality power supply;
- Solution of the issues of eliminating bottlenecks and increasing the capacity of existing overhead lines;
- Introduction of energy-saving technologies;
- In accordance with the Development scheme and program of the Unified energy system of Russia for 2017-2023 [1] and with the Investment program of Federal Grid Company of Unified Energy System [2] (Table 1).

2. Power supply

2.1. Kabansk district

The strategy of socio-economic development of the Municipal unitary enterprise "Kabansk district for the period until 2035" [3] in the sphere of tourism and recreation provides for the implementation of investment projects "Mamai Mountain" and "Podlemorye". A 10 kV power transmission line with a total length of 20.8 km should be constructed as part of the supporting infrastructure of the "Mamai Mountain" project.

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The following substations are located on the territory of the Vydrino Municipality:

- "Vydrino-traction" 220/35/10 kV;
- "Vydrino" 35/10 kV.

The actual electricity consumption by the Vydrino Municipality is 2,369 MW.

Table 1. Priority areas for the development of network of CEZ BNT at the facilities of voltage class 110 kV and above.

Name of the object	Implementation stage project	Design capacity / Network length	Year of facility commissioning	Organization responsible for project implementation	Main purpose of the object
	Under construction (UC) / Completed (C)	MW/GCal/h/ km/ MWA			
Construction of Overhead line (OL) 500kV Ust-Kut – Nijneangarsk with substation (SS) 500kV Nijneangarsk with OL branches 220kV Seberobaikalsk – Kichera and OL 220kV Seberobaikalsk – Angoya	C	290.5 km, (501+167) MVA, Shunt reactor 180 MVAr, controlled shunt reactors 2 x 63 MVAr	2019 (2021)	PJSC «Federal grid company of the Unified energy system (FGC UES)»	Minimizing the risks of entering schedules of emergency limit consumption mode. Ensuring the possibility of connecting new consumers, including objects of Public Corporation «Russian Railways (RZD)»
Reconstruction of relay protection and automation of traction substations: Baikalsk, Vydrino, Mysovaya, Posolsk, Zaigraevo, Novoilinsk, Kija, Tarbagatai, Bada, Khilok, Kharagun, Mogzon, Sokhondo, Selenginsk pulp and cardboard plant	UC		2018	Public Corporation «Russian Railways (RZD)»	Providing near and far reservation requirements
Construction of OL-110 kV from OL-110 kV Turka – Ust-Barguzin to planned SS 220 kV "Goryachinsk"	C		2017	PJSC «Interregional distribution network company (IDNC) of Siberia»	Construction OL-110 kV to planned SS 220 kV «Goryachinsk» (0.554 km)

Currently, the power supply of the Vydrino Municipality and the adjacent territory is carried out from the existing substation Vydrino of 35 / 10kV. Analysis of the current position of the power supply systems of the Vydrino Municipality shows that the built-up single-circuit feeder for a voltage of 35 kV can ensure the reliability of the power supply of consumers in category 3. The distance from the site where the rollout zone is supposed to be located to the existing 35 / 10kV substation "Vydrino" is 10.6 km.

The construction of the 10 kV power transmission line with a total length of 20.8 km as part of the supporting infrastructure infrastructure of the Mamai Mountain projects and the 35 kV and 10 / 0.4 kV overhead lines constructed as part of the tourist and recreational cluster Podlemorye will ensure the needs for tourism development in Kabansk district.

2.2. North Baikal district and the town of Severobaikalsk

At the moment, the Severobaikalsk section of the Baikal-Amur Mainline is deficient in the power system. According to FGC UES System [1], construction of 220-500 kV power grid facilities is planned, including:

- the construction of a 500 kV high-voltage line Ust-Kut – Nizhneangarsk with a 500 kV Nizhneangarsk substation, a 500 kV Ust-Kut substation with overhangs of 500 and 220 kV high-voltage lines;
- construction of 220 kV transit at 500 kV Ust-Kut substation – 220 kV Peleduy substation – 220 kV Mamakan substation.

The power transmitted through the transit of the North-Baikal Energy District of the Electric Power Plants is limited to 205 MW across the Irkutsk – Buryatia section (the Severobaikalsk section) 220 kV Overhead Line Kirenga – Ulkan (KU-30), 220 kV Overhead Line Kirenga – Kunerma (KK-31) according to the criterion of static stability power transmission in active power in post-emergency conditions.

It requires the construction of a transformer substation (TSS) in the economic favor zone of tourist and recreational type "Severobaikalsk town" to provide electricity for tourism facilities on the route "Cape Kotelnikovsky" – Baikalskoye village – Severobaikalsk town – the urban settlement of Nizhneangarsk.

2.3. Pribaikalsky and Barguzin districts

In accordance with the Scheme and program for the development of the electric power industry of the Republic of Buryatia for 2018-2022 [4] in 2017, 110 kV overhead lines were built from 110 kV overhead lines Turka – Ust-Barguzin to 220 kV “Goryachinsk” Substation, which will provide Goryachinsk settlement with electricity.

The construction of transformer substations and distribution points of the special economic zone of the Baikal Harbor in the Turka and Peski areas will allow to provide additional electricity needs for tourism facilities in Pribaikalsky district. To meet the electricity needs of tourism and recreation facilities, construction of power lines up to the Khakusy area is required. In Barguzin district, the construction of a 10 kV overhead line from Ust-Barguzin to Maksimikha village, construction of transformer substations and distribution points in Maksimikha village.

Alongside with the projects for the development of traditional energy in the republic, the design and construction of generating facilities issue, based on renewable energy sources is being actively raised: the construction of photovoltaic solar power plants. None of all planned for the construction of power generation facilities, mainly solar power plants (SPP), on the territory of the CEZ BNT is not yet provided.

In the future, small settlements in the Central Ecological Zone of the Baikal Natural Territory should be brought to self-sufficiency by installing renewable energy sources. Generation of solar, wind and geothermal energy will reduce energy losses during transmission through power lines from areas of electricity generation. The construction of a solar substation in Kudara village, the construction of an integrated mini-power plant in the medical and recreational area "Khakusy", the construction of autonomous hybrid electrical installations in remote locations seems promising.

Alternatively, there is a proposal to construct a network of floating mini-hydropower plants that will not block the watercourses that flow into Baikal, and change their water regime. Most mini-hydropower plants will be active mainly in summer, and some power plants in winter. Local generation of electricity will provide the settlements of the CEZ BNT with partial or complete autonomy in heat and electricity supply.

3. Heat supply

It should be noted that there is no characteristic of heat sources of year-round tourist bases, as well as small boiler houses that heat the building and do not have heating networks. In the CEZ BNT of Buryatia, mainly fuel-fired boilers that operate on coal are used (Table 2).

Table 2. Summary data on boilers of CEZ BNT of Buryatia [6-9].

Municipality	Amount	Installed power, m^3/h	Connected load, m^3/h	Load percentage
Kabansk district	18	49.68	13.54	27.25
Pribaikalsky district	2	11.00	2.30	20.91
Barguzin district	3	7.56	0.99	13.09
North Baikal district	9	42.32	14.83	35.04
Severobaikalsk town	4	191.50	150.01	78.33
Total	**36**	**302.06**	**181.67**	**60.14**

From the analysis of indicators of boilers of such settlements as Nizhneangarsk, Babushkin, Ust-Barguzin, Vydrino, it follows that the heat capacity and heat loads of small local boiler houses allow connecting new consumers.

The main planned production and infrastructure facilities of the municipalities are defined by the general plans, the strategies of socio-economic development of the municipality and the measures of the Investment passport of the Republic of Buryatia. Thus, in Pribaikalsky district, it is planned to build a combined heat and power plant (CHPP) on solid household waste using the installation of equipment for processing wood waste, solid household waste and receiving solid fuel in the form of pellets sent to generate heat and electricity in settlements of the district (villages Turka, Nesterovo and Turuntaevo) [10].

In accordance with the Socio-Economic Development Strategy of Severobaikalsk for the period up to 2035 [11], the main areas of investment in tourism in Severobaikalsk are the implementation of projects within the economic favored zone of tourist-recreational type of Severobaikalsk municipal unit. The list of investment projects for the development of infrastructure in Severobaikalsk includes:

- modernization of boiler rooms No 12 (development of design and estimate documentation until 2020);
- construction of a new boiler house in Zarechny with a capacity of 15 GCal/h (development of design estimates for the period up to 2025);
- construction of new trunk networks of heat and water supply of Zarechny settlement (development of design and estimate documentation till 2025);
- construction of networks: water disposal, heat and water supply, electricity (DED until 2020, the project implementation period until 2025);
- reconstruction of the central boiler house (design and estimate documentation – 2018, the project implementation period until 2020 and 2030-2035);
- construction of heat and water supply networks and water disposal to houses under construction (deadline for 2018).

There are 36 boiler houses with a total capacity of 302 m^3/h on the territory of the CEZ BNT of Buryatia. On average, the boiler houses of the CEZ BNT of Buryatia are loaded at 60 % of the installed capacity. Half of all boilers are located in Kabansk district, although they are all characterized by relatively small capacity, the total installed capacity of 18 boilers in Kabansk district is almost five times less than the capacity of 4 boiler houses in Severobaikalsk.

The most heat-supplied area is Severobaikalsk, where the total capacity of boiler houses is almost 200 m^3/h, 78.33 % of which are connected. Only the central boiler-house of Severobaikalsk has a capacity of 164 m^3/h, which is more than the total capacity of the remaining boiler-houses combined. In addition, there are three more boiler houses in the city, the capacity of which exceeds 10 m^3/h.

The least heat supply is Barguzin district with three boilers with a total capacity of 7.56 m^3/h, of which the boilers are only 13 % loaded.

Recently, many private boilers around the Baikal coast have appeared, heating guest houses and leisure complexes, whose activities are not reflected in the statistical data. It is not possible to calculate the amount of harmful emissions from these boilers and there is no data on the availability of cleaning equipment.

4. Results and Discussion

On the whole, in the areas of the CEZ BNT of the Republic of Buryatia, the volume of electricity consumption, as well as the connected load, grow on average from 4 to 9.5 % per year. About 51.5 % of consumption is accounted for legal entities and individual entrepreneurs, 40 % of electricity is consumed by the population, the rest (8.5 %) is consumed by public sector institutions (Table 3).

Table 3. Electricity sales in the areas of the CEZ BNT of Buryatia (2014-2017), mln kW/h [5].

Municipality	Total consumption	Including:			Connected load
		Population	Public sector institutions	Legal entities and individual entrepreneurs	
Kabansk district	143.150	82.270	18.110	42.780	198.822
Pribaikalsky district	40.550	18.200	4.870	17.490	56.326
Barguzin district	62.381	38.290	3.551	20.540	86.641
North Baikal district	73.224	32.427	5.366	35.431	94.472
Severobaikalsk town	269.646	64.587	17.572	187.487	359.252
Total	**588.951**	**235.774**	**49.469**	**303.728**	**795.513**

5. Conclusion

At present, energy capacities in the CEZ BNT of the Republic of Buryatia are loaded by 74%, subject to the commissioning of new capacities in accordance with the Scheme and Development Program of the Unified Energy System of Russia for 2017–2023 and with the investment program of PJSC FGC UES of the projects “Mountain Mamai” and “Podlemorye”, the completion of the construction of the special economic zone of the “Baikal Harbor” electricity requirements in the implementation of projects in the development of tourism will be provided.

In the future, it is necessary to develop an alternative heat supply infrastructure. The entire BPT Central Ecological Zone has geothermal sources coming to the surface: Khakusy, Goujekit, Kotelnikovsky springs, Goryachinsk, Zagza, etc. If the northern regions of the CEZ BNT already partially use geothermal energy, in other areas the use of groundwater heat is almost not developed. The generation of solar, wind and geothermal energy will reduce the negative burden on the environment and reduce the cost of maintaining “dirty” obsolete coal-fired boilers. It is also necessary to develop boilers that use only electricity, including those generated by renewable energy sources. To do this, first of all, the cost of electricity should be reduced.

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