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PROSPECTS FOR IMPROVEMENT IN CHPP PERFORMANCE ON THE EXAMPLE OF THE CHPPS IN SAINT-PETERSBURG, RUSSIA

Lashina E.N.
Saint Petersburg State University of Industrial Technologies and Design, Saint-Petersburg, Russia

Keywords: CHPP, electric power, thermal power, indicators, consumption, prospects.
Abstract. Centralized heat supply systems of large and medium-sized cities are characterized by a significant share of combined heat and power plants (CHPPs) in the production of thermal power and electricity. CHPPs simultaneously generate heat and electricity and, as a result, participate in the wholesale electric power market (25 MW or more) and the retail thermal power market. The article discusses the prospects for the development and improvement of CHPPs on the example of Saint-Petersburg, Russia.

ПЕРСПЕКТИВЫ УЛУЧШЕНИЯ ПОКАЗАТЕЛЕЙ ТЭЦ НА ПРИМЕРЕ ТЭЦ Г. САНКТ-ПЕТЕРБУРГ, РОССИЯ

Лашина Е.Н.
Санкт-Петербургский государственный университет промышленных технологий и дизайна, Санкт-Петербург, Россия

Ключевые слова: ТЭЦ, электрическая энергия, тепловая энергия, показатели, потребление, перспективы.
Аннотация. Централизованные системы теплоснабжения крупных и средних городов характеризуются значительной долей теплоэлектроцентралей (ТЭЦ) в производстве тепловой и электрической энергии. ТЭЦ одновременно вырабатывают тепловую и электрическую энергию и, как следствие, участвуют в оптовом рынке электрической энергии и мощности (25 МВт и более) и розничном рынке тепловой энергии. В статье рассматриваются перспективы развития и улучшения ТЭЦ на примере г. Санкт-Петербург, Россия.

Demand for electricity in the North-West region has been constantly growing in recent years. The volume of electricity consumption in the United Energy System (UES) of the North-West in 2021 amounted to 97.5 billion kWh, which is 5.7% higher than the level of the previous year. By 2028, the volume of demand for electricity in the UES of the North-West is projected at the level of 104.6 billion kWh (Figure 1). The average annual growth rate of demand for electricity for the period 2022-2028 will be 1.0%.

The change in the forecast indicators of electricity consumption and power of the UES of the North-West for the period 2022-2028 is shown in Figure 1.

About 58% of the increase in demand for electricity in the UES of the North-West for the period 2022-2028 is formed in the energy system of Saint-Petersburg and the Leningrad Region. The share of the energy system in the total consumption of electricity is estimated at the end of the forecast period at the level of 50.9% with an average annual growth rate of 1.2%. The volume of consumption by 2028 is

projected at the level of 53.2 billion kWh, while the volume of electricity consumption in 2021 is 49.1 billion kWh.

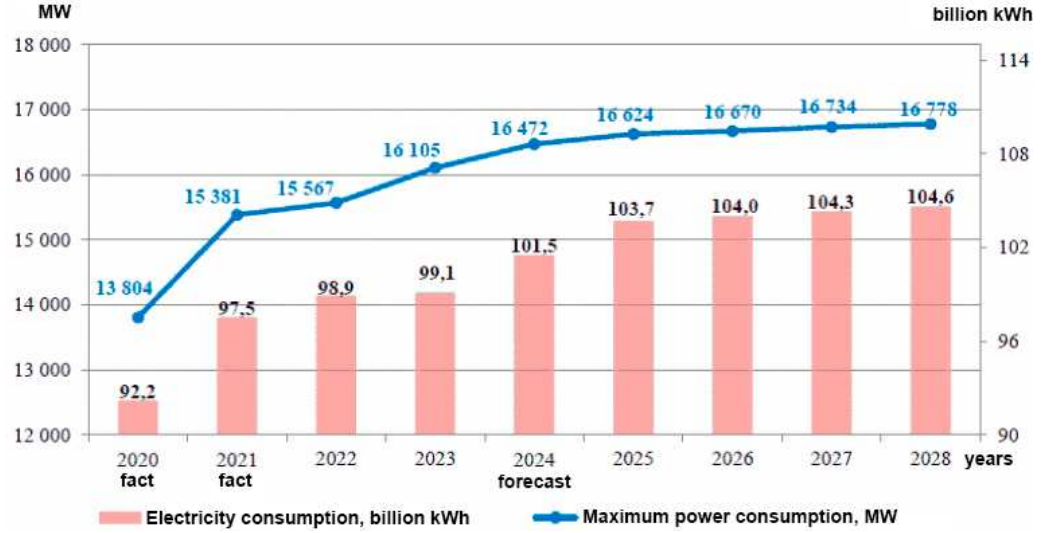

Fig. 1. Forecast values of electricity consumption and its own maximum power consumption of the UES of the North-West

The growth in demand for electric power will primarily be associated with the planned large-scale housing construction, the construction of shopping and leisure and business centers, technology parks in the field of information technology, tourist and recreational and hotel complexes. Growth in demand for electricity in the manufacturing sector will be determined by the development of existing manufacturing enterprises (TFZ LLC, Phosphorit IG LLC, Pikalevsky Cement JSC) and transport enterprises (Transneft-Baltika LLC), a Multipurpose Sea Cargo Complex (MSCC) Bronka, Phoenix LLC, and the development of the Saint-Petersburg Metro. It is planned to build a plant for the production of ammonia and urea (EKHSZ-2 LLC) and implement a project to create one of the world's largest clusters for the extraction and deep processing of hydrocarbon raw materials, BHK LLC [1].

In St. Petersburg, 50% of the thermal and electric power loads of consumers are covered by 15 CHPPs with an installed thermal power of 14,786 Gcal/h; the length of heating networks connected to the CHPP is about 3.5 thousand km in one-pipe terms. CHPPs compete for a buyer in the thermal power market with boiler houses located within their effective heat supply radius. The efficiency of CHPP operation in the district heating system of St. Petersburg is determined by the duration of the heating season, which is 220 days per year, and the daily schedules of thermal and electric power consumption. The energy system of St. Petersburg, the Leningrad region and, in general, the free flow zone (FFZ) The West is characterized by an excess of generating power. The main reason for this is the overestimated consumption of electricity according to the forecast, which is reflected in the redundancy of programs for the development of electric power generation (NPP, TPP) in the region [2].

One of the central tasks for the near future is the complete replacement of obsolete heating mains using the latest technologies and materials. Due to the high level of incomplete repair in the 90s of the twentieth century, about 20% of the heating networks in the service area of the State Unitary Enterprise (SUE) "TEK SPb" need to be replaced or close to this state. When laying main heat pipelines, the company uses steel pipes in polyurethane foam insulation with a system of on-line and remote control of moisture. When updating intra-quarter networks – corrosion-resistant pipelines made of cross-linked polyethylene and stainless steel.

The goals that were set for the SUE "TEK SPb", the leading company in Saint-Petersburg in the field of generation and transportation of thermal energy in the North-West of the Russian Federation:

– improving the quality and stability of energy and heat supply to consumers;

– application of modern diagnostic methods for monitoring the state of heating networks;

– replacement of heating networks;

– reducing the number of defects;

– increase the service life of pipelines;

– reduction of energy losses during the transportation of thermal energy [3].

Work is constantly being done in this direction. In 2022, for the first time in the history of the enterprise and subordinate institutions of the energy block of Saint-Petersburg.

Within the framework of the targeted investment program, which is financed from the city budget, the SUE "TEK SPb" replaced 18.66 km of dilapidated networks in the Nevsky district of Saint-Petersburg. Another 2.14 km was renovated at the expense of the enterprise's own funds. Thus, in total, 20.8 km of new pipelines were laid in this district of thermal power engineering in 2022 [4].

In Saint-Petersburg, the reconstruction of the Simonovskaya heating network from the Parnassus boiler house has come to an end. In total, employees of the SUE "TEK SPb" renovated 1800 m of the main, replaced 106.4 m of the main pipeline and reconnected over 570 thousand consumers to a new heat source. Due to the work, the reliability of heat supply in the Vyborgsky and partially in the Kalininsky districts will be increased. In total, 1616 buildings belong to the Parnas boiler house, of which 896 residential buildings, 92 kindergartens, 65 schools, 62 medical institutions and 19 educational institutions [5].

Also, one of the prospects for improving the city's energy system is the "Introduction of technology for combined thermal and electric power generation." This program implies that a number of boiler houses of the enterprise will be equipped with gas turbine units for the production of electricity. Mini-CHPs will make it possible not only to cover the own needs of the enterprise's facilities for electricity, but also allow the SUE "TEK SPb" to supply electricity to consumers. Thus, the following prospects will be achieved:

– fuel economy;

– reducing the harmful impact on the environment;

– increasing the energy efficiency of heat and electricity production.

For these purposes, a lot has been done over the past two years. In January 2023, a system for acoustic monitoring of heat and water supply networks was presented at the Moscow Chamber of Commerce and Industry (MACC) site. An innovative project for managing defects and preventing accidents in heat and water supply networks was presented at a round table organized by the Guild of Energy Complex Organizations at the MACC. Acoustic monitoring is one of the effective preventive measures used to detect technological disturbances in networks. A pilot project for the installation of acoustic sensors has already been implemented in the SUE "TEK SPb" of Saint-Petersburg. The heating networks of the city are equipped with 1846 sets, consisting of a recorder, an acoustic correlator with a microphone and software. An alarm signal is transmitted to the server if the noise level in the heating system is exceeded. The system makes it possible to detect defects already at an early stage of their appearance, that is, even before water reaches the surface. Moreover, the "smart" system is able to filter false signals. Users of the system said that they were convinced from their own experience that the acoustic monitoring system allows: to control the dynamics of the defect that has appeared; prevent the development of this defect into an emergency; move from emergency recovery work to planned work to eliminate the defect; prevent damage to heat supply organizations. As a result, the system improves the comfort of thermal energy consumers [6].

An important direction is the development of Saint-Petersburg's electric power facilities in the long term. For example, the development and implementation of intelligent electrical grids, which combine electrical networks, consumers and electricity producers at the technological level into a single automated system, is now being actively carried out. Such a system allows real-time monitoring and control of the operating modes of all participants in the process of generation, transmission and consumption of electricity.

Table 1 shows a fragment of an increase in the power of 2 CHPPs [7].

Tab. 1. Volumes of modernization of generating electric power of CHPPs in Saint-Petersburg

No	CHPP name	Equipment (number, turbine type)		Change in installed electric power, MW		
		No	Type	Before	After	Year
1	2	3	4	5	6	7
1	Avtovskaya CHPP (CHPP-15) TGC-1 PJSC (Nevsky branch)	7	T-97/117	97	116,4	2022
2	Avtovskaya CHPP (CHPP-15) TGC-1 PJSC (Nevsky branch)	6	T-100/ 120-130	100	120	2024

Today, Saint-Petersburg's CHPPs play a key role in supplying the city's consumers with heat and electricity, while there is a significant reserve of installed

thermal power. At the moment, the construction of new CHPPs in the territory of Saint-Petersburg is not feasible, since there are a sufficient number of CHPPs in the region with sufficient power to serve consumers. But there is a need for structural and technological modernization aimed at improving their efficiency, reliability and economy.

Список литературы

1. Приказ Минэнерго России от 28.02.2022 N 146 "Об утверждении схемы и программы развития Единой энергетической системы России на 2022-2028 годы" [Электронный ресурс]. – Режим доступа: http://www.consultant.ru/document/cons_doc_LAW_416587/f4c82f338006b92563e19c3e6f97c8c7db7fa728/
2. Перспективы развития ТЭЦ Санкт-Петербурга в современных условиях [Электронный ресурс]. – Режим доступа: https://www.rosteplo.ru/Tech_stat/stat_shablon.php?id=3804.
3. ГУП “ТЭК СПб” [Электронный ресурс]. – Режим доступа: https://www.gptek.spb.ru/product/perspectives/
4. ГУП «ТЭК СПб» в 2022 году обновило почти 21 км ветхих трубопроводов в Невском районе Санкт-Петербурга [Электронный ресурс]. – Режим доступа: http://energyland.info/news-show--teplo-238807.
5. Реконструкция Симоновской теплосети полностью завершена [Электронный ресурс]. – Режим доступа: https://piter.tv/event/Simonovskaya_teploset_rekonstrukciya_/
6. На площадке МТПП представлена система акустического мониторинга сетей тепло- и водоснабжения [Электронный ресурс]. – Режим доступа: https://mostpp.ru/news/deyatelnost-mtpp/na-ploshchadke-mtpp-predstavlena-sistema-akusticheskogo-monitoringa-setey-teplo-i-vodosnabzheniya/
7. Схема и программа перспективного развития электроэнергетики Санкт-Петербурга на 2020-2024 годы [Электронный ресурс]. – Режим доступа: https://www.gov.spb.ru/static/writable/documents/2020/03/19/% D0%A1%D0%B8%D0%9F%D0%A0%D0%AD_%D0%A1%D0%9F%D0%B1_2020-2024.pdf.

References

1. Order of the Ministry of Energy of Russia dated February 28, 2022 N 146 "On approval of the scheme and program for the development of the Unified Energy System of Russia for 2022-2028" [Electronic resource]. – Access mode: http://www.consultant.ru/document/cons_doc_LAW_416587/f4c82f338006b92563e19c3e6f97c8c7db7fa728/
2. Prospects for the development of St. Petersburg's thermal power plant in modern conditions [Electronic resource]. – Access mode: https://www.rosteplo.ru/Tech_stat/stat_shablon.php?id=3804.
3. State Unitary Enterprise “TEK SPb” [Electronic resource]. – Access mode: https://www.gptek.spb.ru/product/perspectives/
4. State Unitary Enterprise "TEK SPb" in 2022 updated almost 21 km of dilapidated pipelines in the Nevsky district of St. Petersburg [Electronic resource]. – Access mode: http://energyland.info/news-show-teplo-238807
5. Reconstruction of the Simonovskaya heating network is fully completed [Electronic resource]. – Access mode: https://piter.tv/event/Simonovskaya_teploset_rekonstrukciya_/

6. A system of acoustic monitoring of heat and water supply networks is presented at the MACC site [Electronic resource]. – Access mode: https://mostpp.ru/news/deyatelnost-mtpp/na-ploshchadke-mtpp-predstavlena-sistema-akusticheskogo-monitoringa-setey-teplo-i-vodosnabzheniya/
7. Scheme and program for the prospective development of the electric power industry of St. Petersburg for 2020-2024 [Electronic resource]. – Access mode: https://www.gov.spb.ru/static/writable/documents/2020/03/19/%D0%A1%D0%B8%D0%9F%D0%A0%D0%AD_%D0%A1%D0%9F%D0%B1_2020-2024.pdf

Лашина Екатерина Николаевна – старший преподаватель кафедры иностранных языков	**Lashina Ekaterina Nikolaevna** – senior lecturer of the Department of foreign languages
lashinapiter@gmail.com	

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