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Аннотация

В статье рассматриваются принципы работы теплоэлектростанции. Проводится оценка влияния электростанции на экологию и здоровье людей. Анализируется отношение горожан к ТЭЦ в черте города на примере Санкт-Петербурга и Магадана.

Ключевые слова: ТЭЦ, проблемы экологии, влияние на здоровье, опрос населения, меры защиты.

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ABSTRACT

The article discusses the principles of operation of CHPP. The impact of the power plant on the environment and human health is being evaluated. The article analyzes the attitude of citizens to the CHPP in the city on the example of St. Petersburg and Magadan.

Keywords: CHPP, environmental problems, impact on health, population survey, protection measures.

1. Introduction. The center of people's life is the environment. Energy and natural resources are companions of our life. Now we can name several ways to get electricity. For example, hydroelectric power plants, nuclear power plants, thermal power plants. They are subdivided into condensing power plants, CHPP, as well as alternative power plants (wind power, solar power, etc.) besides electrochemical plants. However, there are certain consequences of its use, which damage not only our planet but the health of the people living on it. Consider a particular case of electricity manufacture using the model of a Combined Heat and Power Plant, and assess how much its operation affects the lives of people nowadays.

CHPP is a variation of TPP (Thermal Power Plant). It serves not only for producing electricity, besides realizes the supply of hot water to the central heating system and for domestic needs.

2. Principles of process of CHPP

The principle of operation of CHPP is not difficult. Fuel and heated air - an oxidizing agent - arrive the furnace at the same time. In Russia, pulverized coal is most often used as a fuel. The heat converts the water arriving the boiler into steam, which is then fed under pressure to the steam turbine. A solid flow of steam sets it in motion, forcing the generator rotor to work, converting mechanical energy into electrical energy. Then the steam that has missing its original parameters - temperature and pressure - enters the condenser, where, after cooling, it becomes water again. Then the condensate pump transfers it to the regenerative heaters and subsequently to the deaerator. There, the water is freed from gases - oxygen and CO₂, which can cause corrosion. After that, the water is reheated by steam and fed back to the boiler [1,2].



Figure 1. Emissions into the atmosphere from CHPP.

[Electronic resource]. <https://storage.energybase.ru/source/54/451247.jpeg>

3. The impact of CHPP on the environment.

The development of thermal power engineering has a certain impact on a lot of aspects of the environment: atmosphere, hydrosphere, lithosphere (Fig. 1). Interaction occurs at all stage from extraction to energy use.

The process of converting thermal energy into electrical energy contains three stages, each of which has a negative impact on the surroundings [3]:

1. Initial – fuel extraction and processing;
2. Main – the manufacture of heat and electricity;
3. Final – transportation and processing of waste, their disposal.

The atmosphere is important for the humans' life, flora and fauna, because it contains the largest quantity of oxygen. Meanwhile, it is the most vulnerable. Maximum air pollution occurs due to emissions of harmful substances during the operation of power plants operating on hydrocarbon fuels (gasoline, kerosene, coal). About 14% of the total air pollution comes from thermal power plants.

The minus effect of CHPPs on the environment can be associated with the consumption of big amounts of oxygen for fuel combustion and the issue of carbon dioxide into the atmosphere. Moreover, the working of a CHPP increases the ambient temperature, as a result of which it causes a greenhouse effect.

Thereto, Combined Heat and Power Plants pollute the environment with oxides of nitrogen, sulfur, carbon, as well as hydrocarbons. Precipitation in the form of acid rain can occur due to the gases produced by combustion of fuels containing sulfur dioxide and nitrogen oxides.

One of the consequences of CHPP operation is the destruction of the ozone layer.

The natural background radiation is high not far from coal-fired combined heat and power plants and their waste landfills. This is related to the radioactive isotopes in the coal that enter the environment along with other combustion products [4].

According to experts from the World Health Organization, the health of the world's population on average depends on the quality of the environment by 18-20%, which is the cause of diseases. Based on the processing of a large amount of statistical material on the loss of working time due to diseases, it was concluded that man-made air pollution contributes to the deterioration of the population's health by 45% [5].

4. The impact of Power Plant on the health of urbanite.

The CHPP belongs to the second class of danger in conformity with to the state sanitary standards and regulations.

Energy production has a negative impact not only on the environment, but also on human health.

Firstly, released carbon dioxide creates a greenhouse effect and reduces the amount of oxygen in the air.

Secondly, sulfur oxide irritates the mucous membrane of the respiratory tract.

Thirdly, benzapiren is a carcinogen that is one of the causes of cancer.

Additionally, nitric oxide, solid particles, coal dust, soot and ash compounds negatively affect the respiratory system.

Less harm to the body is caused by plants that run on natural gas. This is a relatively clean fuel, but a certain sum of nitrogen oxide and sulfur is still confined into the atmosphere. Though there is no excess of the established environmental standards in the vicinity of power plants [3, 6].

5. List of thermal power plants within the boundaries of St. Petersburg and Magadan. Comparison of them.

1. Pervomayskaya CHPP. Fixed electric capacity – 454.0 MW. Installed heat output – 1696.0 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
2. Severnaya CHPP. The installed electrical capacity – 500 MW. The main fuel is gas, the backup fuel is fuel oil.
3. Avtovskaya CHPP. Installed electric capacity – 321.0 MW. Fixed heat output – 1849.0 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
4. Vasileostrovskaya CHPP. Installed electric capacity – 135.0 MW. Installed heat output – 1213 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
5. Vyborg CHPP. Installed electric capacity – 278.0 MW. Fixed heat output – 1060.0 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
6. Pravoberezhnaya CHPP. Installed electric capacity – 180.0 MW. Installed heat output – 1120 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
7. Central Combined CHPP. Fixed electric capacity – 75.5 MW. Installed heat output – 1,340 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
8. Yuzhnaya CHPP. Installed electric capacity – 750,0 MW. Installed heat output – 2190.0 Gcal/h. The main fuel is gas, the backup fuel is fuel oil.
9. North-West CHPP. Installed electric capacity – 1800 MW. Fixed heat output – 1400 Gcal/h. The main fuel is gas, the backup fuel is gas.
10. South-West CHPP. Installed electric capacity – 500 MW. Installed heat output – 660 Gcal/h. The main fuel is gas, the backup fuel is gas [7, 8].

The population of Saint Petersburg 5,388,759 people in conformity with the statistics of 2021, they account for 10 power plants (Fig. 2). Thus, each CHPP heats approximately half a million people of St. Petersburg, using gas and fuel oil. The average installed heat capacity of the TPPP in St. Petersburg is 1,300 Gcal/h per 500 thousand population.



Figure 2. An example of Combined Heat and Power Plant.

[Electronic resource]. <http://img1.dp.ru/images/article/2018/12/27/AF8EC6F4-4F9F-4484-A351-C953657C8C9E.jpg>

In Magadan, we have only one CHPP, which has been providing heat to the city since 1962 (Fig. 3). It is situated on the outskirts of the town. This station is the only source of energy for the heat supply of Magadan. Installed electric capacity – 96 MW. Installed heat output – 295 Gcal/h. According to the latest data, the population of Magadan is 92,052 people [9].



Figure 3. CHPP in Magadan.

[Electronic resource]. <https://collectionerus.ru/media/items-large/g/ge/geqhz39hr8vcxpvj.jpg>

If the installed thermal capacity of the CHPPs of St. Petersburg and Magadan is compared, the thermal efficiency of the Magadan power plant is slightly higher, possibly due to its design fuel – coal from the Kuznetsk coal basin (Ural coal).

At one time, the Magadan CHPP tried to use coal extracted in the Magadan region, but its quality and other characteristics were unsuitable for the operation of this station.

6. Public survey on location matter of the CHPP in the city.

As part of the study, a number of questions were compiled for the population to identify the presence or absence of inconveniences and discomfort from nearby combined heat and power plants.

The survey involved 50 people. 20 of them live in St. Petersburg, 30 live in Magadan. We interviewed different categories of people of both sexes: schoolchildren, students, working middle-aged citizens, pensioners. An online survey was conducted through the social network “Instagram”. The results of the survey are shown below in the form of diagrams (Fig. 4 – 7).

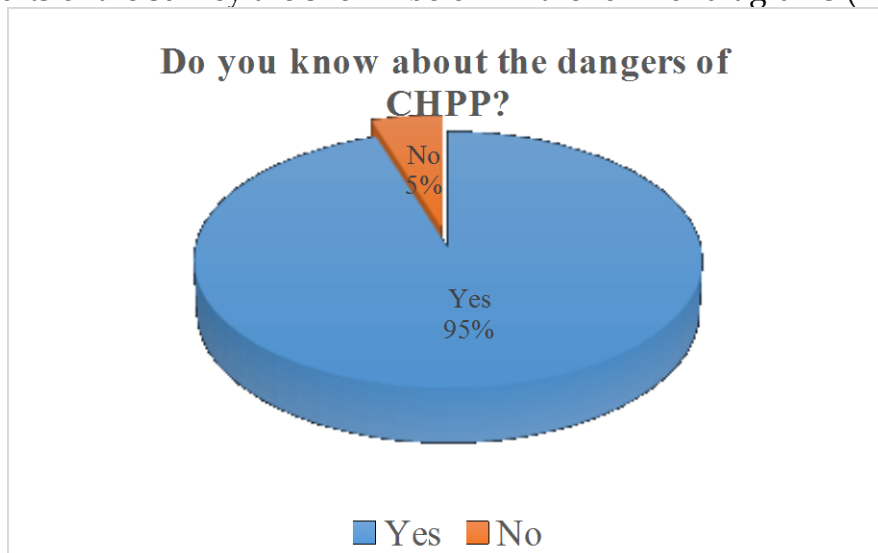


Figure 4.

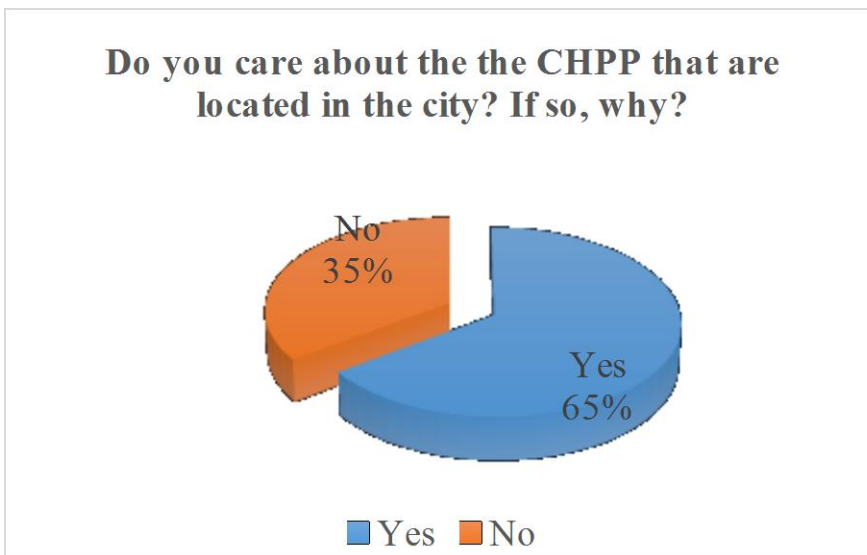


Figure 5.

These comments were more common when the response was positive: smoke and smell in close proximity, harm to health, environmental pollution, emissions into the atmosphere, use of a large area of land.

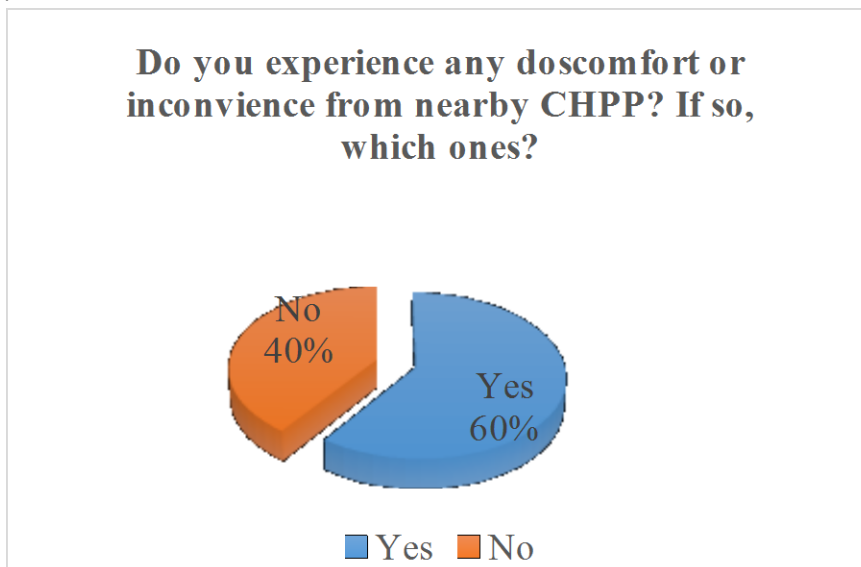


Figure 6.

The most frequent comments with a positive response were: difficulty breathing, noise, unpleasant smell and smoke, coal settling near the thermal power plant, creating traffic jams during its transportation.

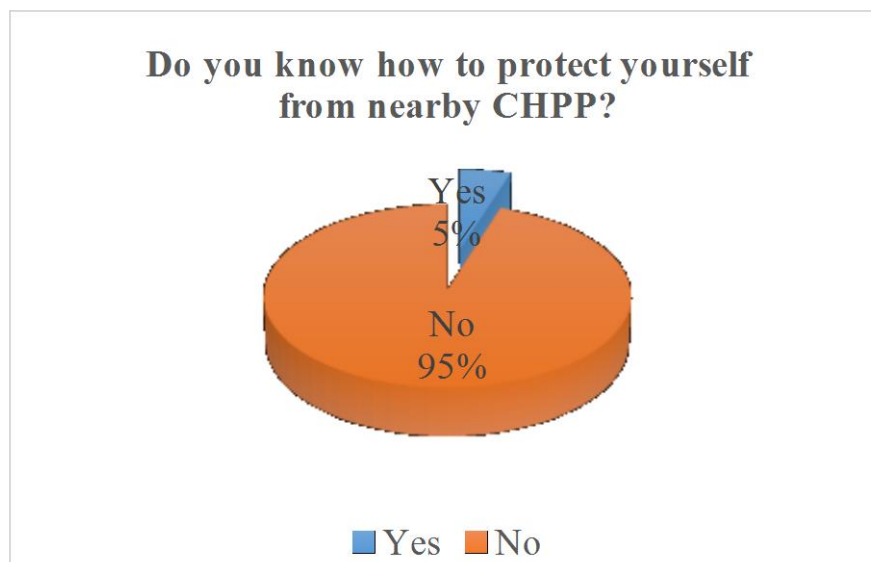


Figure 7.

Thus, the public survey showed that there were no ardent opponents of the working of CHPP in the city. Meanwhile, Combined Heat and Power Plants that use coal as fuel cause bigger discomfort in the life of citizens, unlike gas-fired power plants, due to the supply of coal by numerous trucks on city roads and carrying out unloading and loading operations.

7. Recommendations to citizens living near the CHPP

The recommended distance that can be careful safe for life near a CHPP is from 300-500 m. If the plant works on coal or fuel oil, the distance does not have to be less than 500 m, and if the work is carried out at the expense of gas and gas-oil fuel – more than 300 m. Moreover, to fuel, the location can be influenced by climate, terrain, wind strength, direction, and a range of other factors [6].

If you live near a thermal power plant, here are several recommendations to protect yourself [10]:

1. If there is excessive air pollution, you are able to complain to the opportune regulatory authorities in order to measure the sum of emissions and carry out other measures: Rostekhnadzor, Rospotrebnadzor, Rosprirodnadzor. In case of a poor-quality inspection of the regulatory authorities, you have the right to contact the Environmental Prosecutor's Office.

2. You can install modern ventilation with the installation of additional air filters in the apartment/house.

3. Only modern windows and doors equipped with an additional sound insulation system can help with noise.

4. Do not open the windows in case of wind direction from the CHPP.

5. Do not spend time in the close proximity of the CHPPs (hiking, sports, picking berries and mushrooms, etc.).

6. Try to systematically relax in environmentally friendly areas.

7. Take an annual medical check-up.

8. Conclusion. So, the study confirmed that the damage from the CHPP really has a place to be both on the environment and on the health of citizens. However, most people do not worry, as no one lives in the proximate vicinity, in accordance with sanitary norms and instructions. The key discomfort is associated rather with external stimuli such as noise and smoke, as well as with the aesthetic side. People emphasize that the greatest concern can be caused by the lack of heat in residential buildings, caused by the breakdown of combined heat

and power plans, untimely delivery of fuel, especially in cities located in remote areas of the Russian Federation.

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