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Environmental impact assessment of heat and power complexes transferred to the gas system of Nur-Sultan city

Abstract. *The article is devoted to the environmental assessment of the environmental impact of thermal energy complexes on the territory of the city of Nur-Sultan. The technology of electricity production at thermal power plants leads to large emissions of waste into the environment, which in turn worsens the living conditions of people. It is shown that the implementation of the gasification program of the Republic of Kazakhstan in practical terms can provide an effective reduction in the burden on the environment by reducing emissions of hazardous substances.*
Keywords: *environmental assessment, thermal power plants, gasification, emissions, environment.*

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Introduction

The environment is the foundation of human life, and fossil resources. The energy derived from them is the foundation of modern civilization. Without energy, humanity has no future. This is an obvious fact. However, modern energy causes significant harm to the environment, worsening people's living conditions. The basis of modern energy includes various types of power plants. At the dawn of industrial development, the main bet was placed on large thermal power plants. At that time, little thought was given to the impact of thermal power plants on the environment, since the main task was to obtain electricity and heat. The technology of electricity production at thermal power plants is associated with a large amount of waste released into the environment [1].

Today, the problem of the impact of energy on nature is becoming especially acute, as pollution of the environment, atmosphere and hydrosphere increase every year. If we take into account that the scale of energy consumption is constantly increasing, then the negative impact of energy on nature increases accordingly. According to the latest data [2], it was revealed that a large amount of electricity (63.2%) in the world occurs at thermal power plants. Therefore, hazardous substances of this type of power plant enter the environment, which can provide the highest amount of anthropogenic pollution in it. It can be said that they account for about 25% of the majority of hazardous substances that enter the environment from industrial enterprises [3].

Research methods

The following methodologies and regulation documents were used to determine the levels of different environmental contaminants in the facility's vicinity:

1) The level of pollution in the air basin: background concentrations in the location's region are calculated using data from the Republic of Kazakhstan; the impact of emissions on air basin pollution,

as well as the limits for maximum allowable emissions, are calculated using the requirements.

2) State standard 17.2.3.02-78. Conservation of the natural world. Atmosphere.

3) Methodology for determining concentrations of hazardous compounds included in industrial emissions in the atmosphere air based on the rules for establishing allowable emissions of harmful substances by industrial companies.

Instrumental measurements of nitrogen oxide and carbon monoxide levels in flue gases, as well as computation methods, are used to maintain control. Instrumental measurement employs certified and attestation-approved stationary and portable instruments, as well as procedures from the "List of methods for measuring concentrations of pollutants in the emissions of industrial enterprises approved for use"[4].

According to the results of the environmental impact assessment, it was revealed that in addition to the main components arising from the combustion of organic fuels (carbon dioxide and water), harmful substances of thermal power plants contain dust components of various compositions, sulfur oxides, nitrogen oxides, fluorine compounds, metal oxides, gaseous products of incomplete combustion of fuel. Getting into the atmosphere, they hurt all the main components of the biosphere, as well as economic objects, urban economy, transport, and the population of cities. The placement of dust particles and sulfur oxides can be caused by the addition of mineral impurities to the fuel, and the content of nitrogen oxides because of partial oxidation of nitrogen in the air in a high-temperature flame. Up to 53% of hazardous substances are sulfur dioxide, about 31% - of nitrogen oxide, and up to 28% - of fly ash [5].

Table 1

The effect of harmful substances in thermal power plants on human health

Harmful substances	Consequences of exposure to the human body
Carbon monoxide	It hampers thinking, lowers reflexes, and causes lethargy, fainting, and death by inhibiting the absorption of oxygen into the blood
Lead	It affects the cardiovascular, neurological, and urinary systems, as well as preventing the development of mental retardation in children and posing a long-term risk to bones and tissues
Nitrogen oxide	It lowers the body's resistance to infectious infections, causes bronchitis and pneumonia, and causes lung inflammation
Ozone	It induces coughing, inhibits lung function, decreases immunity, and promotes asthma, bronchitis, and heart disease by irritating the mucous membranes of the respiratory system
Toxic substances (heavy metals)	Causes cancer, interferes with genital functioning and leads to the development of numerous abnormalities in neonates.

For example, in the city of Nur-Sultan, in a winter climate at a temperature of -50°C, providing the city with heat and hot water requires large labor and energy resources. Accordingly, two thermal power plants are continuously operating in the city.

TPP-1 of «Astana Energy» JSC has been operating since 1961 and does not occupy a special place in meeting the needs of the city population for electric power, since electric power generation is aimed at its own needs.

The TPP-1 facility is located on city property and shares western borders with the wagon repair factory. Boiler units, pipes with production and heating equipment, and pipelines for generating electric energy are among the principal equipment erected at TPP-1.

TPP-1 runs mostly on a heating schedule, with the winter months being the busiest. There are a total of 22 sources of air pollution, with 5 being organized and two being organized by treatment facilities.

The average amount of ash collector operating percent, according to observations, is:

- Boiler 1 - 93.95%;
- Boiler 2 - 93.4%;
- Boiler 3 - 91.63%;
- Boiler 4 - 97.26%;
- Boiler 5 - 96.85%;
- Boiler 6 - 93.6%;
- Boiler 7 - 92.24%.

TPP-2 of «Astana-Energy» JSC has been operating since 1979 and is the main source of central heating in Nur-Sultan. The TPP-2 site is in the industrial part of the city and its northeastern part. The list of the main equipment installed at TPP-2 includes pipes with a boiler, production and heating equipment, and pipes for generating electricity. The total number of sources of air pollution is 34, of which 14 are organized, and only treatment facilities are organized 2. According to the results of the experiments, the average % of the ash recovery capacity is:

- Boiler 1 - 98.37%;
- Boiler 2 - 97.53%;
- Boiler 3 - 98.14%;
- Boiler 4 - 99.53%;
- Boiler 5 - 99.13%;
- Boiler 6 - 98.7%.

The work plan of «Astana-Energy» JSC at TPP-2 is 365 commerce days per day. Sanitary protection zone of the generation of TPP-2 1000 m, for the fiery debris capacity 500 m. The town is found at a remove of 2700 m within the southwest, 4050 m within the south, and 4950 m within the southeast [6].

Results

According to the latest registered data [7], the total amount of coal used in the city of Nur-Sultan is 3 million 500 thousand tons. And if we divide this indicator into each sector, we can determine that 3 million tons of them fall on TPP-1 TPP-2, and the rest falls in private sectors.

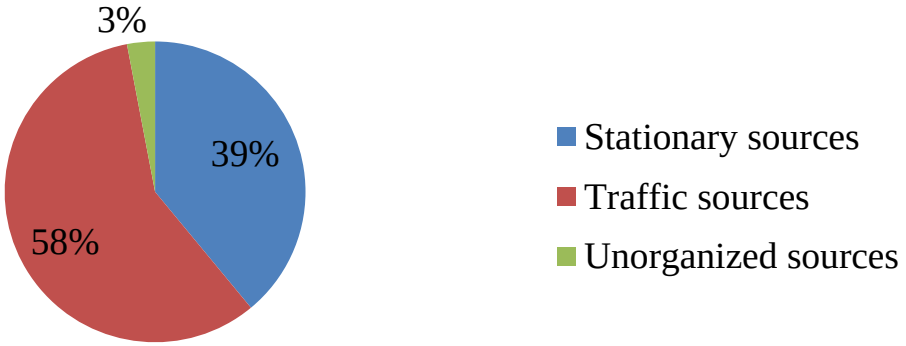

Figure 1. The share of sources of pollutants in Nur-Sultan

As part of the gasification program in the Republic of Kazakhstan and in pursuance of the Five Social Initiatives of the President dated March 5, 2018, KazTransGas JSC plans to build the Saryarka main gas pipeline along the route Kyzylorda - Zhezkazgan - Karaganda - Temirtau - Astana with a length of 1081 km. This section of the gas pipeline will provide natural gas to the population of the cities of Astana, Karaganda, Temirtau, Zhezkazgan, and nearby settlements along the route of the main gas pipeline [8].

"The project of gasification of the capital provides, among other things: reconstruction of TPP-1 and TPP-2 with the transfer of hot water boilers of the TPP to natural gas combustion while maintaining the possibility of working on coal; phased gasification of private sector houses and the transfer of residential boiler plants to gas; transfer of existing consumers of LPG (liquefied petroleum gas) to natural gas," the message says.

The dynamic development of the city with the development of new construction of both housing and public buildings causes an increase in the need for thermal and electrical energy, which in turn is reflected in the level of atmospheric air. For the sustainable development of the capital, it is important to observe the principle of an optimal combination of economic, social, and environmental factors.

The construction of gas distribution networks is divided into three stages.

The construction of the 1st stage of the project with 9 launch complexes was started by the Akimat in the fall of 2019.

According to the report of the Akimat of the city of Nur-Sultan, 13 boilers are currently connected to gas at the TPP-1. And only one boiler is connected to the TPP-2. Five more will be transferred later. At the same time, both hot water and power boilers are connected to gas at TPP -1. But at the TPP -2 – only hot water.

Now, large-scale works on the gasification of the city are continuing in Nursultan. In two years, more than 645 kilometers of intra-block gas supply networks have been built in the capital. Residents of residential areas Koktal-1, Koktal-2, Zheleznodorozhny, part of the Agro-town, ZHM South-East, and Industrial have already received access to gas.

KazTransGas Aimak JSC is also building gas supply networks in the Kuygenzhar, Michurino, and International railway stations - it is planned to provide gas through them by the end of the year. Design and estimate documentation is being developed for the Kazakhaul microdistrict (Karaotkel) [9].

To date, more than 5,000 technical specifications have been issued in the city, and more than 20 thousand people have been consulted. 2700 subscribers are connected to natural gas. Work in this direction continues.

Design and survey work is underway on the remaining part of the 2.3 th stage. The term of their implementation is planned in the period from 2022 to 2024 at the expense of the republican and local budgets, as well as with the involvement of private investment.

In arrange to appraise the volume of outflows into the air from warm control complexes within the city of Nur-Sultan, we calculated discussed contamination utilizing uncommon analyzers.

Outflows were calculated for the taking after destructive substances that enter the air from warm control complexes:

- CO;
- NO_x (in term;
- SO_2;
- ash.

The parameters (initial data) used in the calculation of emissions were determined based on field studies conducted on the simplest model, which requires instrumental support.

Within the course of deciding the volume of poisons discharged into the environment sometime recently the move to the gas framework of warm control complexes of the city of Nur-Sultan and comparing these markers with the markers after gasification work, the fundamental materials were gotten from the Esil Department of Ecology of the Committee for Environmental Regulation and Control of the Ministry of Environmental Protection environment of the Republic of Kazakhstan.

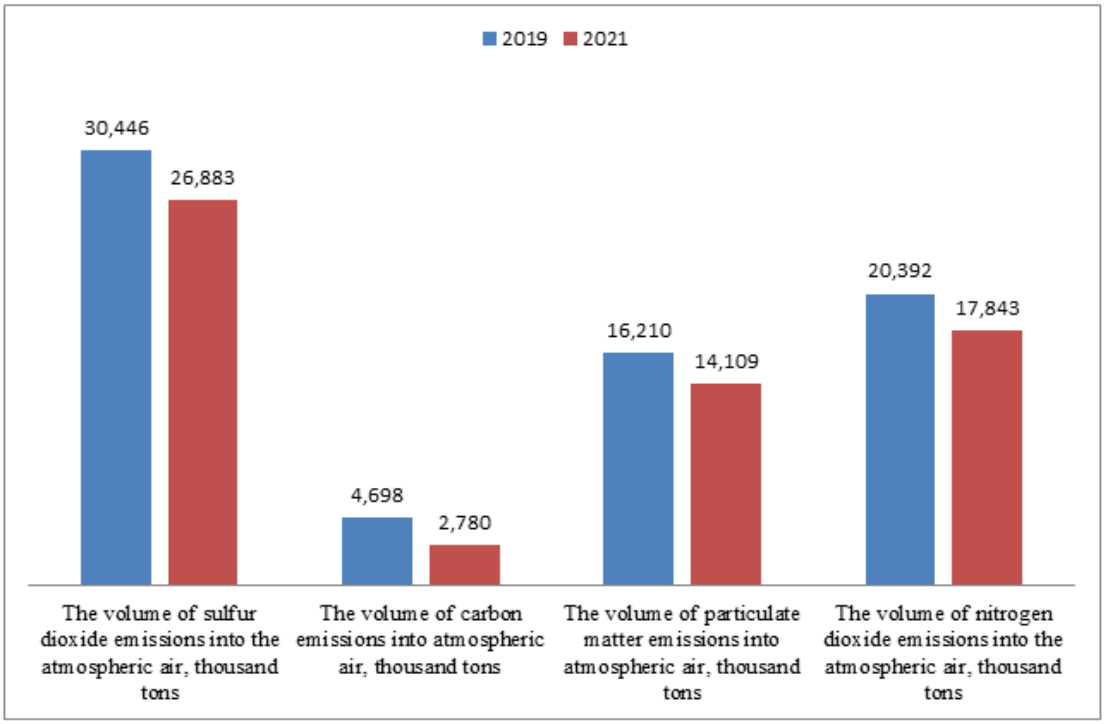

Figure 2. Astana-Energy JSC's atmospheric air pollution forecast for 2019-2021y

Concurring to the come about of the consider for 2019-2021, changes within the escalated of the stack of mechanical emanations on-air discuss were uncovered.

- the volume of sulfur dioxide emanations into the barometrical discuss, thousand tons: 2019y. – 30,446; 2021y. - 26,883;
- the volume of nitrogen dioxide emanations into the barometrical discuss, thousand tons: 2019y. – 20,392; 2021y. - 17,843;
- the volume of particulate matter emanations into air discuss thousand tons: 2019y. - 16,210; 2021y. - 14,109;
- the volume of carbon emanations into barometrical discuss, thousand tons: 2019y. - 4,698; 2021y. - 2,780.

The number of poisonous outflows into the air was assessed at 61,615 thousand tons in 2021, and 71,746 thousand tons in 2019 (according to insights), which is 12,7% less than in 2019.

Discussion

Rustic residents were encountered after large-scale gasification activities were completed. According to the way the survey was handled, 114 people responded, with 73,33 percent of women and 26,67 percent of males. Almost all of the advantages of switching to gas were mentioned throughout the overview. Table 2 and the diagram in Figure 2 reflect the characteristics of respondents by place of residence.

Table 2

Characteristics of respondents by place of residence

Place of residence	Number	
	people	%
Residents of the South-East	68	60
Residents of Koktal	46	40
Total	114	100

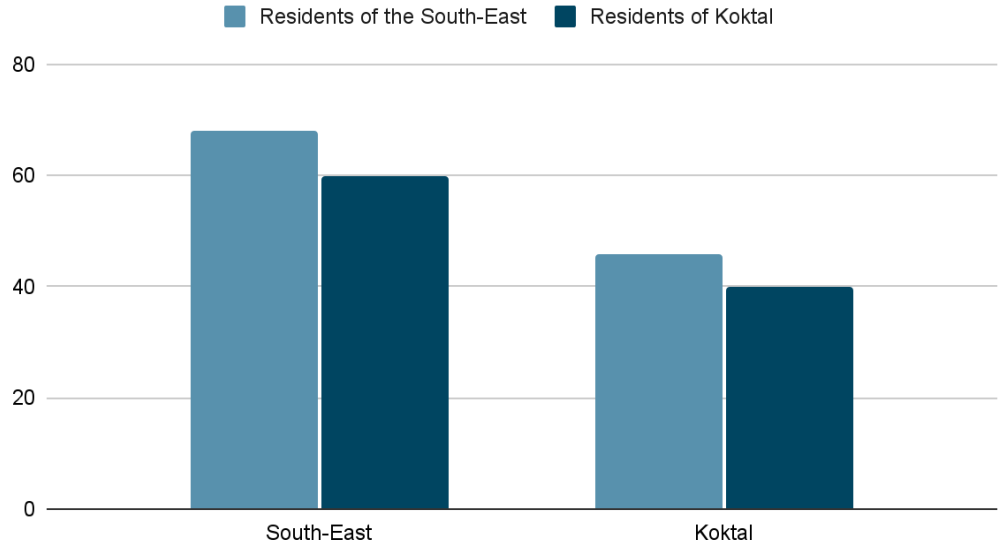

Figure 3. Characteristics of respondents by place of residence

The analysis of respondents' answers to the next question of the survey of residents about the advantages of gasification, also to the question of whether the difference is felt before and after the gasification of the village were 100% similar since everyone was for gasification.

A few of them have included their comments in this way. For illustration, Zamanbek Alkeuly moved to the private range of Koktal-2 final year and promptly chose to switch the house from stove warming to gas. He moreover shared his contemplations after the gasification works: "We moved final year, in December. Since that time we have been utilizing gas. Usually exceptionally helpful, particularly for us - people of the more seasoned era. It is additionally clean, and eco-friendly for our family, and children. It's great for your well-being. I encourage everybody to switch to gas. The discussion will end up cleaner,".

Moreover, the moment respondent Aisulu Askarova said that she works as a kindergarten educator and herself lives within the same zone, in a private house. Since the final year (since December 2021), they have associated the home house with the gas framework. And presently she said that she does not lament these choices. Since after interfacing with the gas framework, she was cheerful to say that time was saved, the warmth within the house is at the same temperature all the time, other than, the fuel issue does not bother. In conclusion, he said that it is presently arranged to switch to gas and kindergarten, in which he works. And they shared that for them it is once more a reason for bliss [10].

Conclusion

The implementation of this project will significantly improve the fuel and energy balance and the ecological state of the city's environment. At the same time, both hidden effects related to the quality of products and comfort for household needs when using natural gas will be achieved as well as a direct economic effect from the energy carriers used.

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Нұр-Сұлтан қаласының газ жүйесіне көшірілген жылу энергетикалық кешендерінің қоршаған ортаға әсерін экологиялық бағалау

Аңдатпа. Мақала Нұр-Сұлтан қаласы аумағындағы жылу энергетикалық кешендерінің қоршаған ортаға тигізетін әсерін экологиялық бағалауға арналған. Жылу электр станцияларында электр энергиясын өндіру технологиясы қоршаған ортаға қалдықтардың үлкен шығарындыларын алып келеді. Бұл өз кезегінде адамдардың өмір сүру жағдайын нашарлатады. Ал Қазақстан Республикасы аумағына газдандыру бағдарламасын іс жүзінде енгізу - қауіпті заттар шығарындыларының азаюына, қоршаған ортаға түсетін жүктемені төмендетуді қамтамасыз етуге ықпал етеді.

Кілт сөздер: экологиялық бағалау, жылу электр станциялары, газдандыру, шығарындылар, қоршаған орта.

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Экологическая оценка воздействия на окружающую среду теплоэнергетических комплексов, переведенных на газовую систему города Нур-Султан

Аннотация. Статья посвящена экологической оценке влияния на окружающую среду тепловых энергетических комплексов на территории города Нур-Султан. Технология производства электроэнергии на тепловых электростанциях приводит к большим выбросам отходов в окружающую среду, что ухудшает условия жизни людей. Показано, что внедрение программы газификации Республики Казахстан в практическом значении может обеспечить эффективное снижение нагрузки на окружающую среду за счет уменьшения выбросов опасных веществ.

Ключевые слова: экологическая оценка, тепловые электростанции, газификация, выбросы, окружающая среда.

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