O‘zbekistonning yirik shaharlarining issiqlik ta'minoti tizimlarida elektr va issiqlik energiyasini birgalikda ishlab chiqarishida iste'molchilarni energiya bilan ta'minlashning markazlashtirilgan va avtonom usullarining maqbul kombinatsiyasi

Mehriya A. Koroli [1, a)], Feruza A. Xoshimova [1, b)], Adeliya R. Ivanisova [1, c)]

[1, a)] PhD, prof., Toshkent davlat texnika universiteti, Toshkent, 100095, O‘zbekiston; mkoroly@list.ru https://orcid.org/0000-0002-4113-0923

[1, b)] Katta o‘qituvchi, Toshkent davlat texnika universiteti, Toshkent, 100095, O‘zbekiston; https://orcid.org/0009-0003-7530-229X

[1, c)] Katta o‘qituvchi, Toshkent davlat texnika universiteti, Toshkent, 100095, O‘zbekiston; ivanisovaadelia@gmail.com https://orcid.org/0009-0001-9629-4423

Dolzarbligi: energetika xavfsizligi - bu mamlakatning, fuqarolarning, jamiyatning va iqtisodiyotning normal va favqulodda vaziyatlarda maqbul sifatli iqtisodiy foydalanish mumkin bo'lgan va normativ zarur energiya resurslari bilan ta'minlashda tanqislik tahdididan kafolatlangan xavfsizligi holati. Energiya xavfsizligi, energiya ishlab chiqaruvchi ob’ektlarning ishonchli va samarali ishlashi ijtimoiy farovonlikning yuqori darajasining eng muhim mezonidir. Energetika tizimining ishonchli va samarali ishlashini ta’minlash maqsadida quyidagilar ishlab chiqildi va davlat darajasida tasdiqlandi: 2020–2030-yillarda O‘zbekiston Respublikasini elektr energiyasi bilan ta’minlash konsepsiyasi. 2020-2030-yillarda O‘zbekiston Respublikasini elektr energiyasi bilan ta’minlash konsepsiyasining asosiy maqsadi elektr energiyasiga o‘sib borayotgan ehtiyojni raqobatbardosh narxlarda qondirish va O‘zbekiston Respublikasining elektroenergetika tarmog‘ini modernizatsiya va rekonstruksiya qilish hisobiga jadal rivojlantirishdan iborat. mavjud elektr stansiyalarini, yuqori samarali energiya ishlab chiqarish texnologiyalari asosida yangi ishlab chiqarish quvvatlarini qurish, elektr energiyasini hisobga olish tizimini takomillashtirish, qayta tiklanuvchi energiya manbalaridan foydalanishni rivojlantirish hisobiga yoqilg‘i-energetika resurslarini diversifikatsiya qilish. O‘zbekiston Respublikasi Prezidentining 2019-yil 27-martdagi “O‘zbekiston Respublikasining elektroenergetika tarmog‘ini yanada rivojlantirish va isloh qilish strategiyasi to‘g‘risida”gi PQ-4249-son qarori. Issiqlik va elektr energiyasini, jumladan, gaz turbinali va gaz porshenli agregatlari hamda gaz generatorlarini birgalikda ishlab chiqarish bo‘yicha zamonaviy qurilmalarni joriy etish orqali avtonom energetikani rivojlantirish energiya xavfsizligini ta’minlashning ustuvor yo‘nalishlaridan biri hisoblanadi.

Maqsad: respublikaning yirik shaharlarining issiqlik ta'minoti tizimlarida elektr va issiqlik energiyasini birgalikda ishlab chiqarishda iste'molchilarni energiya bilan ta'minlashning samarali kombinatsiyasi, markazlashtirilgan va avtonom usullari imkoniyatlarini ko'rsatish.

Vazifalar: issiqlik elektr stantsiyalari va qozonxonalarda elektr va issiqlik energiyasini birgalikda ishlab chiqarishga o'tkazishda iste'molchilarni energiya bilan ta'minlashning markazlashtirilgan va avtonom usullarini o'rganish. Issiqlik elektr stantsiyalari va qozonxonalarni kogeneratsiyaga o'tkazish variantlarini texnik-iqtisodiy tahlil qilish.

Kalit so'zlar: kogeneratsiya, issiqlik energetikasi, Markaziy issiqlik ta’minoti, avtonom, issiqlik ta'minoti manbalarining energiya samaradorligi, gaz pistonli o'rnatish, isitish uskunalari, optimal kombinatsiya.

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Оптимальное сочетание централизованного и автономного способов энергоснабжения потребителей при комбинированной выработке электрической и тепловой энергии в системах теплоснабжения крупных городов Узбекистана

Мехрия А. Короли [1, а)], Феруза А. Хошимова [1, б)], Аделия Р. Иванисова [1, с)]

[1, а)] PhD, проф., Ташкентский государственный технический университет, Ташкент, 100095, Узбекистан; mkoroly@list.ru https://orcid.org/0000-0002-4113-0923

[1, б)] старший преподаватель, Ташкентский государственный технический университет, Ташкент, 100095, Узбекистан; https://orcid.org/0009-0003-7530-229X

[1, с)] старший преподаватель, Ташкентский государственный технический университет, Ташкент, 100095, Узбекистан; ivanisovaadelia@gmail.com https://orcid.org/0009-0001-9629-4423

Актуальность: энергетическая безопасность – состояние гарантированной защищённости страны, её граждан, общества, экономики от угрозы дефицита в обеспечении экономически доступными и нормативно необходимыми энергоресурсами приемлемого качества в нормальных и чрезвычайных обстоятельствах. Энергетическая безопасность, надёжная и эффективная работа энергогенерирующих объектов – важнейшие критерии высокого уровня благосостояния общества. Для обеспечения надёжной и эффективной работы энергосистемы разработана и утверждена на государственном уровне Концепция обеспечения Республики Узбекистан электрической энергией на 2020–2030 годы. Основной целью Концепции является удовлетворение растущей потребности в электрической энергии по конкурентоспособным ценам и динамичное развитие электроэнергетической отрасли Республики Узбекистан посредством модернизации и реконструкции существующих электрических станций, строительства новых генерирующих мощностей на базе высокоэффективных технологий производства энергии, совершенствования системы учета электроэнергии, диверсификации топливно-энергетических ресурсов использованием возобновляемых источников энергии. Постановление Президента Республики Узбекистан № ПП-4249 27 марта 2019 г. «О стратегии дальнейшего развития и реформирования электроэнергетической отрасли Республики Узбекистан». Одним из приоритетных направлений обеспечения энергетической безопасности является развитие автономной энергетики с внедрением современных установок по комбинированной выработке тепловой и электрической энергии, в том числе газотурбинных и газопоршневых агрегатов и газогенераторов.

Цель: показать возможности эффективного сочетания, централизованного и автономного способов энергоснабжения потребителей при комбинированной выработке электрической и тепловой энергии в системах теплоснабжения крупных городов республики.

Задачи: исследование централизованного и автономного способов энергоснабжения потребителей при переводе на комбинированную выработку электрической и тепловой энергии на ТЭС и котельных. Технико-экономический анализ вариантов перевода ТЭС и котельных на когенерацию.

Ключевые слова: когенерация, теплоэнергетика, центральное теплоснабжение, автономное, энергетическая эффективность источников теплоснабжения, газопоршневая установка, отопительное оборудование, оптимальное сочетание.

Optimal combination of centralized and autonomous methods of energy supply to consumers with combined production of electrical and heat energy in the heat supply systems of large cities of Uzbekistan

Mehriya A. Koroli [1, a)], Feruza A. Khoshimova[1, b)], Adeliya R. Ivanisova[1, c)]

[1, a)] PhD, prof., Tashkent State Technical University, Tashkent, 100095, Uzbekistan; mkoroly@list.ru https://orcid.org/0000-0002-4113-0923

[1, b)] Senior Lecturer, Tashkent State Technical University, Tashkent, 100095, Uzbekistan; https://orcid.org/0009-0003-7530-229X

[1, c)] Senior Lecturer, Tashkent State Technical University, Tashkent; ivanisovaadelia@gmail.com https://orcid.org/0009-0001-9629-4423

Relevance: energy security is a state of guaranteed protection of the country, its citizens, society, and economy from the threat of shortages in the provision of economically accessible and normatively necessary energy resources of acceptable quality in normal and emergency circumstances. Energy security, reliable and efficient operation of energy generating facilities are the most important criteria for a high level of social well-being. To ensure reliable and efficient operation of the energy system, the following have been developed and approved at the state level: the Concept of providing the Republic of Uzbekistan with electrical energy for 2020–2030. The main goal of the Concept of providing the Republic of Uzbekistan with electric energy for 2020-2030 is to meet the growing demand for electric energy at competitive prices and the dynamic development of the electric power industry of the Republic of Uzbekistan through the modernization and reconstruction of existing power plants, the construction of new generating capacities based on highly efficient energy production technologies, improvement electricity metering systems, diversification of fuel and energy resources with the development of the use of renewable energy sources. Resolution of the President of the Republic of Uzbekistan No. PP-4249 March 27, 2019 “On the strategy for further development and reform of the electric power industry of the Republic of Uzbekistan.” One of the priority areas for ensuring energy security is the development of autonomous energy with the introduction of modern installations for the combined production of thermal and electrical energy, including gas turbine and gas piston units and gas generators.

Aim: to show the possibilities of an effective combination of centralized and autonomous methods of energy supply to consumers with the combined production of electrical and thermal energy in heat supply systems of large cities of the republic.

Objectives: study of centralized and autonomous methods of energy supply to consumers when switching to combined production of electrical and thermal energy at thermal power plants and boiler houses. Technical and economic analysis of options for converting thermal power plants and boiler houses to cogeneration.

Keywords: cogeneration, heat and power engineering, central heating, autonomous, energy efficiency of heat supply sources, gas piston installation, heating equipment, optimal combination.

1. Introduction

Energy security is a state of guaranteed protection of the country, its citizens, society, and economy from the threat of shortages in the provision of economically accessible and normatively necessary energy resources of acceptable quality in normal and emergency circumstances. Energy security, reliable and efficient operation of energy generating facilities are the most important criteria for a high level of social well-being. The creation of mini-CHP on the basis of industrial and heating boiler houses is justified by a number of provisions. Firstly, boiler house equipment includes a lot of auxiliary equipment that requires electrical energy: these are draft and feed devices, water treatment equipment, fuel supply equipment, as well as instrumentation and automation systems. It is obvious that for their reliable operation it is necessary to reliably supply the boiler house's own needs with electrical energy. Thus, the operation of the boiler house is directly dependent on the uninterrupted supply of electricity. Secondly, the loss of power to boiler houses will cause not only interruptions in the production of thermal energy for the civilian population or industrial consumers, but also the cooling of systems and the failure of expensive technological equipment. Therefore, ensuring a stable power supply for industrial and heating boiler houses is an important technical and economic task. In addition, the presence of a backup source is required by existing KMK 2.04.13-99 "Boiler Installations": "installation of hot water boilers with a capacity of more than 10 Gcal/h is allowed only if the boiler room is provided with two independent power sources. Thirdly, the possibility of implementing the reconstruction of boiler houses with conversion to mini-CHPs is determined by the practical interest of power engineering enterprises in orders for the development and manufacture of low-power power plants.

One of the priority areas for ensuring energy security is the development of autonomous energy with the introduction of modern installations for the combined production of thermal and electrical energy, including gas turbine and gas piston units and gas generators.

The global electric power industry has accumulated many years of experience in the development, production, and operation of autonomous and backup power supply systems based on consumer power plants (100-10,000 kW) with a primary piston engine running on natural gas or propane. These power plants have remarkable features: environmental friendliness, low cost of electricity, the ability to use the heat generated during operation, proximity to the consumer, and no need for expensive power lines and substations.

The introduction of such power plants and heating plants can provide a significant economic effect for the end consumer, and will also provide them with high-quality and uninterrupted power supply. Work in this direction is in line with the main provisions of the Resolution of the President of the Republic of Uzbekistan: dated January 20, 2023, No. 23 "On operational measures for the implementation of pilot testing projects for the purpose of ensuring population of Tashkent with additional heat and electricity", No. 4542 dated 02.12 .2019 "On additional measures to improve the heat supply system and the financial recovery of heat supply enterprises" [1,2].

The usual (traditional) way of producing electricity and heat is to generate them separately (power plant and boiler house). In this case, a significant part of the energy of the primary fuel is not used, and a large amount of generated heat is discharged into the atmosphere through steam condensers, cooling towers, etc. It is possible to significantly reduce overall fuel consumption through heat recovery, this increases the efficiency of installations from 30-50% for a power plant to 80-90% in systems through the use of cogeneration (joint production of electricity and heat). Cogeneration is the thermodynamic production of two or more forms of useful energy from a single primary energy source, i.e. combined production of electrical (or mechanical) and thermal energy.

To solve the issue of cogeneration, gas piston and gas turbine units are used, consisting of an electric generator and a heat recovery system. At the moment, possible generator drives for decentralized small thermal power plants are gas piston and turbine engines [3, 4]. The operating costs of a thermal power plant with reciprocating engines are lower than those of a power plant with gas turbines.

The positive effect of the development of cogeneration is no longer in doubt, including from the standpoint of improving the environmental situation [5]. At the same time, cogeneration has become a priority in the development of thermal power engineering in developed countries. Thus, the share of combined heat production since 1991 has increased by 10% in Denmark and Finland and by 38% in Sweden. According to the European Cogeneration Association, combined generation is the main trend in energy development. Cogeneration capacity in the world will increase by 29% by 2025 compared to 2016.

Taking into account the general understanding of the advantages of cogeneration in heat supply in the republic, its share is increasing sharply. For example, preparations have begun for the installation of autonomous cogeneration plants in the makhallas of Tashkent: "Sh. Rashidov" (Mirabad district); "Oktepa" (Chilanzar); "Sultonia" (Mirzo Ulugbek); - "Shaykhontokhur" (Shaykhontokhur); "Akhilobod" (Yunusabad); "Boshlik" (Yakkasaray district); - "Uzgarish" (Sergeli); - "Beshkurgon 1" (Almazar); "Tuzel" (Yashnabad); - "Birlik" (Uchtepa); - "Charogon" (Yangihayot) [1,2,6,7].

It is known that fuel savings in combined generation, in contrast to separate generation, are up to 30%. The effect is achieved by saving fuel in cogeneration mode and reducing operating costs in the boiler room. The multiplier effect of cogeneration, in this case, also includes: the emergence of additional funds for replacing worn-out heating networks, the possibility of reducing the volume of budget subsidies for heat energy payments for the population, reducing the negative impact on the city's environment, and curbing the growth of tariffs for consumers.

2. Materials and Methods

Options for converting boiler houses to cogeneration. The best options for CCGT-CHP and GTU-CHP, created on the basis of boiler houses, provide an efficiency of supply of electrical energy in cogeneration mode at the level of 76-79%. Comparative technical and economic indicators of some options for converting boiler houses to cogeneration show that the use of steam backpressure turbines is the cheapest and most economical option for implementing cogeneration in a boiler house. In this case, the minimum specific capital costs and the lowest consumption of equivalent fuel for the production of 1 kWh of electrical energy (150...160 g/kWh). According to calculated and experimental data, gas consumption at such a mini-CHP will increase in comparison with the usual operating mode of the boiler house by approximately 7-10%. The cost of produced electricity will be no more than 35...40 kopecks/kWh, while maintaining the cost of thermal energy at the same level. Specific costs for the reconstruction of the boiler house are 400...500 USD/kW. The payback period for the reconstruction of a boiler house in a mini-CHP is 3...4 years, for the construction of a new mini-CHP - from 5 to 8 years. Gas piston units are engines running on gas fuel. It is more expedient to use them for constant operation than internal combustion engines (the cost of the generated energy is lower; when operating as a backup source, they slowly gain load). Compared to gas turbines, they have higher efficiency (for gas turbines it is 21-34%, and for gas piston installations it is 36-45%); The efficiency of a gas piston installation is practically independent of the ambient temperature. When installing a gas turbine unit, medium pressure gas is used and therefore does not require a booster compressor, as is the case with a gas turbine unit (additional costs). Gas piston installations with a power of up to several megawatts are in greatest demand, so for industrial enterprises with high electricity consumption, gas turbine or combined cycle units are appropriate.

Regarding internal combustion engines, it should be noted that their operation requires large financial costs for fuel. Since the share of the fuel component in the cost of generated energy is significant, when installing an internal combustion engine in a boiler room, the cost of generated electricity will be the highest. It is advisable to install internal combustion engines either as a backup source of electrical energy, or in conditions of remoteness from the power system.

In general, converting boiler houses to cogeneration allows not only solving the problem of independent, including from allocated limits, but also cheap energy supply. Modern reconstructions of industrial and district boiler houses in mini-CHPs make it possible to do this without significant investment of time or money for construction. In addition, in the case of combined production of electricity and heat, energy efficiency can reach up to 80%; accordingly, the possibility of obtaining a significant economic effect through the creation of power plants with cogeneration becomes obvious.

There are quite a lot of studies devoted to the use of low-power energy sources in power supply systems for consumers. But many issues of assessing the use of these sources still remain unexplored, the main one of which is justifying the effectiveness of such systems in comparison with centralized energy supply. Let us note that the methodological approaches to calculating their efficiency differ from calculations for large thermal power plants. When assessing economic efficiency in this case, it should be taken into account that, as a rule, some option for energy supply to a particular area or enterprise has already been fully or partially implemented. In this case, the effectiveness of additional capital investments is assessed.

In today's conditions of depletion of traditional energy resources and tense environmental conditions, it is extremely important to use renewable energy sources. An extremely effective example of this can be the use of gas piston cogenerators operating on gas, then thermal power plants built as cogeneration systems, or converted into them, can supply heat to nearby cities or city districts, industrial enterprises, greenhouses, fish farms, water desalination plants (especially on islands or in countries with insufficient water resources), etc. The distance from heat users to the cogeneration plant and the dispersion of consumers are critical to the feasibility of the project.

When a city or region is supplied with heat from a cogeneration system, it is called a district heating scheme. For district heating (DH) schemes, the most important parameters, in addition to the already mentioned distance to consumers and their dispersion, are the required thermal power and the annual number of degree days. In most cases, the maximum economically justified distance to the consumer is a distance of 10 km, but in exceptional cases this figure can reach 30 km [8].

In Uzbekistan, many perceive DH as an outdated, ineffective and ossified technology. This is true for old DH systems and worn-out houses in need of major repairs. But the latest DH systems can perform great and be cost-effective. District heating is one of the main applications of cogeneration. The main advantage of cogeneration systems compared to traditional boiler houses is the possibility of more efficient use of burned fuel (in addition to the equivalent amount of heat, "free" electricity appears). In addition, flexibility in the choice of fuel and lower emissions of harmful substances compared to traditional boilers make it possible to solve environmental problems (use of biogas from landfills, wastewater treatment plants and agricultural enterprises). The classical approach, which consists in building a centralized heating network, is losing its attractiveness due to decreased budget funding for new networks and maintenance of old ones, as well as the increased cost of performing this work associated with the abundance of underground communications in large populated areas [9].

Considering the complex set of problems that characterizes the current situation of centralized heating systems, in order to develop the combined production of electrical and thermal energy and achieve real energy efficiency of the centralized heating system, various methods can be proposed.

The consolidation of heating networks and heat supply sources into a single heat supply organization owned by one owner is, in fact, a monopolization of the heat energy market. Despite the negative (from the point of view of a market economy) attitude towards monopolies, the unification of heating networks and heat supply sources under one owner has a beneficial effect on the development of cogeneration and the energy efficiency of the centralized heating supply system. A typical example would be the heat supply scheme for the city of Tashkent [9]. The combination of thermal power plants, heating networks and boiler houses can contribute to the development of cogeneration - ensure the switching of heat consumers from intra-city boiler houses to thermal power plants and heating centers (where possible), as well as optimization of the entire system from the manufacturer to the end consumer, which made the heat supply system of Tashkent the most efficient in republic both in terms of fuel costs and in terms of reducing the negative impact on the environment (reducing harmful emissions by transferring boiler houses to reserve or mothballing). However, with such development, serious control is required from government supervision over both the owner's maintenance of the system in working order and the validity of tariffs for consumers.

In addition, there should be a Legislative ban on the construction of boiler houses, including rooftop ones, within the effective radius of a thermal power plant or a heating center that has a thermal power reserve. The direct requirement of the law to observe the priority of combined heat for heat supply to consumers is the specific responsibility of those responsible for the distribution of heat loads between heat supply sources. A ban on the construction of boiler houses with a capacity above 1 MW without cogeneration (following the example of the Danish Heat Supply Act).

This method seems to be the simplest and most effective; its implementation can also encourage boiler house owners to introduce cogeneration, however, given the chronic shortage of funds among heat supply organizations, a more in-depth analysis of the consequences of such a decision is required.

Due to the combined method of producing electrical and thermal energy, we will be able to save 30-40% of fuel. Accordingly, the costs of fuel components will decrease the tariff and level of consumer payments for the services provided will decrease.

The main solution is to ensure energy independence through the construction of dispersed thermal power plants of low and medium power, i.e. Cogeneration systems based on gas piston and gas turbine units with a total capacity of at least 150 MW using highly efficient gas turbine and gas piston engines with a unit power of 100 kW to 30 MW and the organization of combined (joint) production of electrical and thermal energy. . Maximum proximity of mini-CHPs to centers of electricity and heat consumption, which will reduce the costs of energy transport and construction of heating networks [11]. Maximum use of the heat of gases exhausted in gas turbine and gas piston engines with a temperature of 400-500°C for heat supply to consumers with a reduction in the cost of thermal energy (due to a corresponding reduction in the combustion of natural gas in hot water boilers).

Taking into account the above, the authors propose that the optimal solution is a combination of centralized and autonomous methods of energy supply to consumers and the choice of a heat supply system should be carried out on the basis of technical and economic calculations, taking into account the quality of source water, the degree of availability of it and maintaining the required quality of hot water for consumers.

The construction of powerful heating systems made it possible to solve the problem of providing electricity and heat to rapidly growing cities and industrial complexes in the most effective way. However, district heating systems operating in Uzbekistan have a number of disadvantages. Among the most significant are the following:

- Heating networks in most cities are worn out, heat losses in them are several times higher than the normative ones, networks are highly damaged, which leads to emergency situations, and, consequently, to interruptions in heat supply.
- Significant losses occur during the distribution of thermal energy among numerous consumers due to hydraulic misadjustment of systems, as well as due to the discrepancy between the required consumption modes of individual buildings and the central regulation of heat supply.

- Electricity costs for transporting coolant through heating networks are also significant [12].

Autonomous or centralized heating and heat supply systems - problems of choice. Until the mid-eighties, large heating and centralized heating systems were predominantly developed in our country. The construction of powerful heating systems made it possible to solve the problem of providing electricity and heat to rapidly growing cities and industrial complexes in the most effective way. However, district heating systems operating in Uzbekistan have a number of disadvantages. Among the most significant are the following. Heating networks in most cities are worn out, heat losses in them are several times higher than the norm, the networks are highly damaged, which leads to emergency situations and, consequently, to interruptions in heat supply. Significant losses occur during the distribution of thermal energy among numerous consumers due to hydraulic misadjustment of systems, as well as due to the discrepancy between the required consumption modes of individual buildings and the central regulation of heat supply. Electricity costs for transporting coolant through heating networks are also significant.

In recent years, due to the appearance on the market of a wide variety of heating equipment, including small automated boilers of domestic and foreign production, as well as due to the above-mentioned disadvantages of centralized heat supply systems, the construction of autonomous systems is gaining momentum. In addition, modern autonomous automated boiler houses do not require permanent maintenance personnel during their operation (they operate “on lock”), which also significantly improves their economic performance. According to experts, the share of autonomous boiler houses in cities should be 10-15% of the thermal energy market. Autonomous systems (equipped with modern boilers, the efficiency of which is 92-95%) are more economical than centralized systems. modern autonomous automated boiler houses do not require permanent maintenance personnel during their operation (they operate “on lock”), which also significantly improves their economic performance. The high factory readiness of such boiler houses allows them to be installed and put into operation in less than a month. And finally, the placement of these boiler houses does not require the allocation of special territories. They can be installed in containers on the roof, in attics or basements, and also installed in close proximity to heated buildings. The listed advantages of autonomous systems predetermined the widespread use of the systems under consideration - mainly using automated gas modules with a unit thermal power of up to 1.5 MW [9-13].

At the same time, in many foreign countries (Denmark, Sweden, Germany, Finland, etc.) district heating systems have been intensively constructed in recent decades. The development of this process was significantly influenced not only by the global energy crisis of 1972, but also by the experience of creating powerful heating and district heating systems.

The indisputable advantage of centralized systems is the possibility of economically clean combustion of low-grade oil fuel, as well as household waste. Due to the great complexity and high cost of systems for sorting, supplying and burning this type of fuel, as well as cleaning house gases by suppressing harmful emissions, their construction is technically possible and economically justified only for large heat sources. The concentration of thermal energy production in centralized systems makes it possible to improve the condition of the air environment in cities and when burning high-quality fuels. In large installations, it is possible to implement the most efficient thermodynamic cycles for the joint production of electrical and thermal energy. Centralization of heat supply is a necessary prerequisite for heating cities and industrial complexes. Wide opportunities with centralized heat supply also open up for solving the problem of using secondary energy resources of industrial enterprises [14-15]. Improving the reliability, efficiency and quality of existing heat supply systems is achieved through the systematic implementation of a set of technical and organizational measures. These include: replacement of heat pipelines using effective heat-insulating materials, reconstruction of heating points with the installation of automated heat exchangers in them, implementation of joint work of thermal power plants and boiler houses on common heating networks, construction of highly efficient combined heat and power plants with a steam-gas cycle, transformation of district boiler houses into mini-CHPs, use of computer technologies for systems management, etc.

From the above it follows that for large cities, autonomous boiler houses are not competitors of large thermal power plants and district boiler houses, but serve as their reasonable addition. According to experts, the appropriate share of autonomous boiler houses in cities should be 10-15% of the potential heat energy market. The scope of application of autonomous boiler houses includes individual newly constructed or modernized buildings in densely built areas covered by centralized heat supply, where, due to the limited capacity of the heating network, it is impossible to connect additional consumers to it, and the relocation or laying of new heating networks is difficult; buildings remote from district heating areas; low-rise estate houses; buildings with a temporary connection to a mobile autonomous source; objects with increased requirements for heat consumption, which cannot be guaranteed to be provided by heat supply from the heating network; newly constructed facilities in areas where there is a shortage of heat from the main source.

In conclusion, as a result of the analysis, the combination of centralized and autonomous methods of energy supply to consumers with the combined production of electrical and thermal energy in heat supply systems, I would like to emphasize that in order to justify a gas piston or gas generating installation at an enterprise or residential complex, it is necessary to conduct a thorough analysis based on a feasibility study.

3. Results

As a result of the analysis, the combination of centralized and autonomous methods of energy supply to consumers with the combined production of electrical and thermal energy in heat supply systems, I would like to emphasize that in order to justify a gas piston or gas generating installation at an enterprise or residential complex, it is necessary to conduct a thorough analysis based on a feasibility study.

4. Conclusions

- Uzbekistan has a large market for thermal energy consumers. Improving the reliability, efficiency and quality of existing heat supply systems is achieved through the systematic implementation of a set of technical and organizational measures. The main principles in the development of generating capacities for the period up to 2030 include: covering heat loads primarily with sources operating in cogeneration mode, as well as re-equipping gas boiler houses that have sufficient heat loads during a feasibility study in mini-CHPs.
- When constructing autonomous energy sources, schemes for combined generation of thermal and electrical energy can be used based on the use of gas turbine units (GTU), combined cycle gas turbine technologies (CCGT), internal combustion engines (ICE), and back-pressure steam turbines of the “R” type.
- Advantages of autonomous installations: high efficiency of their operation, determined by energy production from thermal consumption without losses in a cold source; low specific capital costs for construction; short periods of reconstruction without stopping the main equipment of the boiler room during the heating season.
- Advantages of autonomous installations compared to conventional boiler houses: the ability to provide reliable power supply for one’s own needs; saving noble fuels burned in boiler houses; higher (3-5%) efficiency boiler plant; reduction of excessive fuel consumption due to low efficiency of fuel use in existing boiler plants; uninterrupted power supply to boiler houses in case of emergencies in the energy system, as a guarantee of reliable heat supply to residential areas and industrial enterprises; when installing turbogenerators, the connection between the boiler room and the power system is maintained, which will ensure that one’s own needs are covered in the event of a power outage from autonomous turbine units; It is possible to produce electricity both for one’s own needs and, if there is a surplus, for sale to a third-party consumer.
- In conclusion, it should be noted that the spontaneous development of autonomous systems can significantly deteriorate the city’s infrastructure that has developed over decades and even lead to its destruction. Therefore, it is necessary to ensure fairly strict urban planning regulation of this process with simultaneous intensive reconstruction of centralized heat supply systems, allowing to reduce heat losses, reduce tariffs for supplied heat energy, thereby making the spontaneous construction of autonomous sources uncompetitive in many cases.
- Options for the development of city heat supply systems that contribute to increasing the combined production of heat and electricity are shown. In any case, when determining the optimal development option, an individual approach to each source and each system is necessary, since they are all very different both in technical parameters and in form of ownership.
- It is also important to develop in detail the operation scheme for simultaneous consumption of electricity from the power system and from the new installation. This logically implies the need to solve issues of complex automation and optimization of operating modes of the system as a whole. If it is difficult to meet the requirements of the power system, the question of allocating electrical capacity for autonomous power supply remains.

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