

**AUTONOMOUS GASIFICATION OF THE REGIONS OF THE RUSSIAN
FEDERATION**

GASIFICAÇÃO AUTÔNOMA DAS REGIÕES DA FEDERAÇÃO RUSSA

**GASIFICACIÓN AUTÓNOMA DE LAS REGIONES DE LA FEDERACIÓN DE
RUSIA**

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Abstract

This article is aimed at considering the main ways of autonomous gasification of remote regions of Russia with the subsequent use of gas fuel to provide heat supply systems and gas supply to consumers. The initial data and parameters are based on the Tomsk region that is characterized by a low gasification level. The result of the study is the calculated indicators of the economic efficiency of autonomous gasification, as well as analytical conclusions on the prospects for using this method, as fundamental for achieving the maximum level of gas supply to remote areas of the Russian Federation. The calculations and materials of Russian colleagues who have been conducting research in the field of gas energy and its efficient operation for a long time are taken as a basis. Materials and data from open sources of the Gazprom Group, PAO NOVATEK, as well as research by the Skolkovo Energy Center were considered and analyzed as an example.

Keywords: autonomous gasification, liquefied natural gas, gasification of Russian regions.

Resumo

Este artigo visa considerar as principais formas de gaseificação autônoma de regiões remotas da Rússia com o posterior uso de gás combustível para fornecer sistemas de fornecimento de calor e gás aos consumidores. Os dados e parâmetros iniciais são baseados na região de Tomsk que é caracterizada por um baixo nível de gaseificação. O resultado do estudo são os indicadores calculados da eficiência econômica da gaseificação autônoma, bem como conclusões analíticas sobre as perspectivas de utilização deste método, como fundamental para atingir o nível máximo de fornecimento de gás para áreas remotas da Federação Russa. Os cálculos e materiais de colegas russos que realizam pesquisas no campo da energia do gás e sua operação eficiente há muito tempo são tomados como base. Materiais e dados de fontes abertas do Grupo Gazprom, PAO NOVATEK, bem como pesquisas do Centro de Energia Skolkovo foram considerados e analisados como exemplo.

Palavras-chave: gaseificação autônoma, gás natural liquefeito, gaseificação de regiões russas.

Resumen

Este artículo tiene como objetivo considerar las principales formas de gasificación autónoma de regiones remotas de Rusia con el uso posterior de combustible gaseoso para proporcionar sistemas de suministro de calor y suministro de gas a los consumidores. Los datos y parámetros iniciais se basan en la región de Tomsk que se caracteriza por un bajo nivel de gasificación. El resultado del estudio son los indicadores calculados de la eficiencia económica de la gasificación autónoma, así como las conclusiones analíticas sobre las perspectivas de uso de este método, como fundamental para lograr el nivel máximo de suministro de gas a áreas remotas de la Federación Rusa. Se toman como base los cálculos y materiales de colegas rusos que han estado realizando investigaciones en el campo de la energía del gas y su operación eficiente durante mucho tiempo. Los materiales y datos de fuentes abiertas del Grupo Gazprom, PAO NOVATEK, así como la investigación del Centro de Energía Skolkovo se consideraron y analizaron como ejemplo.

Palabras clave: gasificación autónoma, gas natural licuado, gasificación de regiones rusas.

1. INTRODUCTION

Today, the problem of the gasification level of the regions of the Russian Federation is relevant for the study. In accordance with the General Scheme for the Development of the Gas Industry until 2030, the gasification rate should be increased and reach the maximum technically possible level, which, according to experts, is about 82.9%.

In 2005–2020, 36 thousand square meters of gas pipelines were built in 69 regions of the country; the volume of investments from the companies of Gazprom group amounted to more than 450 billion rubles. During this period, more than 1 million households and apartments were supplied with gas, and more than 6 thousand boiler houses and industrial enterprises were connected. According to the Program for the Development of Gas Supply and Gasification of the Regions of the Russian Federation for 2021-2025, 24.4 thousand kilometers of gas pipelines will be built, which is 2.5 times more than in the previous five-year period. Besides it is planned to gasify 3.632 settlements (an increase of 2.7 times over the previous five-year period).

However, the difficulties for timely and full-fledged achievement of the gasification program implementation indicators are lack of access of certain regions or consumers to the unified gas supply system, insufficient transmission capacity of the main infrastructure, and complex landscape and geological conditions when connecting consumers to the pipeline gas. Other reasons are low quality of regional gasification programs, the lack of vertical and horizontal coordination, and the lack of sources for financing gasification activities. In some cases, the regional program cannot be implemented due to lack of access to the trunk infrastructure (for example, the Murmansk region, the regions of the Far East) or the lack of its capacity (for example, the overcrowded gas-distribution stations of the Chelyabinsk or Moscow regions). Even on the territory of the Central Federal District, where the average level of gasification is about 86%, there are regions where the level of gasification is below 70%.

Gas supply to remote areas with low population density and remoteness from large settlements with existing infrastructure requires a flexible approach and individual solutions (Prasolov et al., 2020; Iskajyan et al., 2022). Autonomous gasification can become a solution of this problem, since it does not require expensive and high-tech solutions for laying a gas pipeline and connecting facilities to the pipeline gas supply. Autonomous gasification is not considered as an alternative to pipeline gas, the advantages of which are undeniable; this

method is an additional resource in regions where piping is economically inexpedient or technically impossible.

2. MATERIALS AND METHODS

To consider the efficiency of autonomous gasification in the article, the Tomsk region was selected, which is the part of the Siberian Federal District. This district has the lowest level of gasification - 16.8%, and the region itself is one of the poorest in the district and many settlements need in regular gas supplies. Data on the level of gasification of the Tomsk region in comparison with the Russian Federation and the Siberian Federal District are presented in Figure 1.

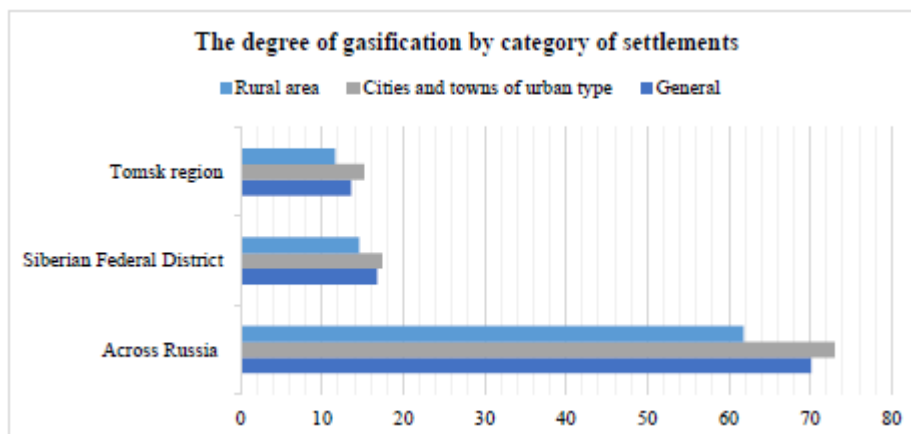


Figure 1. Comparison of the gasification level of the subjects of the Siberian Federal District, as well as the Russian Federation with the Tomsk region by categories of settlement as of 01.01.2020

In the general structure of gas demand for gasification of the population, the rate of liquefied natural gas (LNG) is 21% of the consumption volume, the rate of liquified petroleum gas (LPG) is 16%. That is, the demand of the population for gas by almost 40% should be covered by alternative resources. The efficiency of autonomous gasification projects is ensured by the following factors:

- savings on fuel when replacing traditional energy resources - diesel fuel, fuel oil, electricity (by 15-20%);
- cost savings for the construction of gas pipelines (two to three times);
- reducing the impact on the environment (three to four times).

In the coming years, the regional authorities are planning to gasify nine districts of the Tomsk region together with investors. Bakcharsky, Chainsky and Teguldetsky districts (17 thousand inhabitants, 5 thousand individual households, more than 40 heating facilities) are supposed to be supplied with raw materials, which will be produced by a low-tonnage LNG production complex with a capacity of 6-7 tons per hour. A storage system in Kozhevnikovo will be built.

Alternative gasification with LNG is planned in boiler houses and housing stock in Bakchar, Voronovka, Teguldet, Podgornoye and Kozhevnikovo of the Tomsk region.

Currently, boiler houses boiler houses in these areas use wood, coal and crude oil as an energy source, natural gas is partially used in Kozhevnikovo. In this article, it is proposed to consider the possibility of using LNG and to calculate the economic efficiency of replacing traditional energy sources with liquefied natural gas, as well as to conduct a comparative analysis with the possible connection of consumers to the main gas pipeline.

In accordance with the Regional Gasification Program for the Housing and Communal Services, Industrial and Other Organizations of the Tomsk Region for 2019-2023 and the Schedule for the synchronization of the implementation of gasification programs for the regions of the Russian Federation for 2020, Tomsk region, municipal consumers and the population are proposed to be gasified (Order of the Administration of the Tomsk Region № 566-ra, 2019). The number of consumers proposed for gasification with natural gas, in accordance with the obligations of the Tomsk Region Administration, is presented in Table 1.

Table 1
Potential consumers of natural gas

Settlements planned for LNG gasification	Obligations of the Tomsk Region Administration, according to the Synchronization Schedule	
	Number of households	Number of boiler houses
Bakchar	1650	11
Voronovka	168	1
Teguldet	1000	13
Podgomoye	1200	15
Kozhevnikovo	1000	5
In total:	5018	45

According to the Program for the Development of Gas Supply and Gasification of the Tomsk Region for the period 2021–2025 and the Schedule for the synchronization of the implementation of gasification programs for the regions of the Russian Federation, the

Administration of the Tomsk Region (hereinafter - the Synchronization Schedule) sets the stage for gas supply in the amount of 5018 houses and 45 boiler houses.

Forecast volumes of natural gas consumption will be:

- 2022 - 7259.2 thousand m³ / year (6 months of work after commissioning in the III quarter of 2022);
- 2023 - 14,518.4 thousand m³ / year (55% of consumers' preparation on time, according to the Synchronization Schedule);
- 2025 - 26397 thousand m³ / year (100% according to the Synchronization Schedule). After 2025, the Project provides for an increase in gas consumption up to 37000 thousand m³ / year.

3 RESULTS

3.1 Calculation of the gas pipeline

The design of gas pipelines is carried out taking into account the results of engineering surveys in accordance with SP 47.13330.2016 (2016). The design of gas pipelines under conditions referred to special ones is carried out in accordance with SP 62.13330.2011 (2010).

The choice of the conditions for gas pipelining and the horizontal and vertical distance from the gas pipeline to the engineering and technical supply networks, as well as buildings, structures, natural and artificial barriers, are provided for by SP 62.13330.2011 (2010).

If necessary, the transition of an underground gas pipeline to the above-ground standard distance from the exit of the gas pipeline from the ground to buildings and structures is taken as the standard distance for an underground gas pipeline of the corresponding pressure in accordance with SP 62.13330.2011 (2010).

The depth of the underground gas pipeline is taken in accordance with SP 62.13330.2011 (2010). At the hydraulic calculation for the maximum required gas consumption to consumers from the conditions of Section 2.1, a steel gas pipeline with a diameter of 100 mm is assumed.

In accordance with the consolidated construction price norms of NCS 81-02-15-2017 (2017) (hereinafter referred to as NCS), the cost of laying 1 km of a steel gas pipeline with a diameter of 100 mm at a depth of 2 m is 1.929.920 rubles, Table 2.

Table 2
The cost of gas pipelining

Consumer settlements	Distance from gas distribution system	Annual LNG demand	Cost
	km	t	ruble
Bakchar	140	6 620	270 188 800
Voronovka	45	1 162	86 846 400
Teguldet	330	6 029	636 873 600
Podgornoye	210	4 754	405 283 200
Kozhevnikovo	60	7 832	115 795 200
In total:	785	26 780	1 514 788 800

The costs of the operator of such a project only for the gas pipelining to all those specified in the Program for the Development of Gas Supply and Gasification of the Tomsk Region for the period 2021-2025 and the Schedule of Consumer Synchronization will amount to about RUB 1.514 million.

However, it is worth considering the other elements of the gas pipeline construction project: the pipeline, the work of design specialists, geological exploration, etc. These costs significantly increase the total cost of construction and can increase investments in the project several times.

The tariff imposed on pipeline gas for consumers in Tomsk Region corresponds to the gas tariff AS OF July 01, 2021, on the basis of the Order of the Tariff Regulation Department of Tomsk Region.

3.2 Calculation of the autonomous gasification

Connection of consumers specified in the Program for the Development of Gas Supply and Gasification of the Tomsk Region for the period 2021-2025 and the Synchronization Schedule is possible due to the construction of the Liquefied Natural Gas Complex (hereinafter referred to as LNGC) at the “Kargala” GDS (Tomsk Region, district of the village of Kargala) and of an additional five systems for receipt, storage and regasification of LNG with the subsequent sale of fuel for the needs of users by tractors with special tank trucks for fuel transportation.

According to the “Research of the Russian market of liquefied natural gas” by “AT Consulting” OOO and Skolkovo Energy Center, the construction of liquefied natural gas complex with a capacity of 6-7 tons per hour and five systems for receipt, storage and

regasification of LNG will cost 2.5 billion rubles. And the approximate payback is 5 years (Research of the Russian market of liquefied natural gas..., 2019; Russian small and medium-sized LNG, 2019).

Transportation of LNG from the liquefied natural gas complex to consumers in the Tomsk region (boiler house, production facility, households) is possible using specialized vehicles designed for the transportation of LNG, the amount of which will depend on the consumption degree.

According to the Decree of the Government of the Russian Federation No. 37 “On Amendments to the Basic Provisions for the Formation and State Regulation of Gas Prices and Tariffs for Gas Transportation Services in the Russian Federation” (January 27, 2012) the price of LNG at the entrance to the receival tank, technologically connected with gas distribution networks or with the networks of the end user, for the subsequent storage of liquified natural gas and its regasification, is equal to the regulated wholesale gas price. The costs for the operation of the LNG intake and regasification complexes must be taken into account in the tariff for the transportation of natural gas through distribution networks included in the area of responsibility of regional gas distribution companies.

3.3 Financial feasibility

According to the above, the tariff rate for consumers for autonomous gasification will be equal to the rate for pipeline gasification. Therefore, both gasification methods will be acceptable for settlements. However, during regasification, liquified natural gas also has better physical properties than pipeline gas. This type of fuel has significant advantages over the most common fuel types (Table 3).

Table 3
Advantages of liquified natural gas in power generation facilities

Fuel type	Fuel lower heating value, kkal/kg	Performance coefficient of heat plant, %	Present cost of production of 1 Gcal of energy, %
Liquified natural gas	11 500	91-93	100
Coal	4 200	65-67	127-174
Oil fuel	9 700	85-88	143-176
Diesel fuel oil	10 180	88-90	396-428

The next step is to compare the capital expenditures for the implementation of the two projects for the settlement gasification. Data on the costs of construction, pipelining and corresponding infrastructure solutions of the network branch of the gas pipeline up to five settlements and on the capital costs for the construction of liquefied natural gas complex and five systems for receipt, storage and regasification of LNG, as well as for LNG transport and storage costs are summarized in Figure 3.

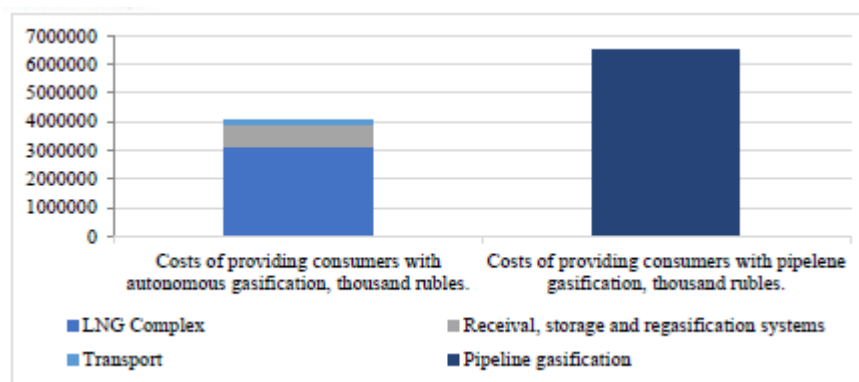


Figure 3. Comparative analysis of gasification methods

In accordance with the above calculations, there is an increase in capital costs for pipeline gasification (relative to a promising liquefied natural gas complex project) by 60%. This is evidence of the effectiveness of autonomous gasification in the territory of the region under consideration and these settlements, in particular.

3. CONCLUSION

The autonomous gas supply is technically simple and therefore reliable. The complex of equipment includes systems for receipt, storage and regasification of LNG, a gas pipeline connecting tanks and household gas equipment. Autonomous LNG gas supply ensures a life support system for remote and hard-to-reach regions.

As a result of the study, the financial and economic advantage of using this method over the classical unified gas supply system was revealed in terms of the remoteness of consumers

from the existing pipeline gas supply system of the region. This fact proves the viability of autonomous gasification technologies for the further development and gasification of remote and hard-to-reach Russian regions.

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