Prospects for projects of the liquefied natural gas production

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Abstract. This research paper examines the current state of the liquefied natural gas industry in Russia, the goals set in the Energy Strategy, as well as the prospects for the development of LNG projects within the framework of market instability, the use of new technologies in the production of liquefied gas. Also the authors assess the competitiveness of these projects. Based on the results of the analytical study, conclusions were formulated. The work can be of value to practitioners and researchers in the industry.

1. Introduction

The gas industry plays a significant role in the modern world economy. Energy transition, modern requirements in terms of ecology and impact on the climate, green energy - all these are factors that reduce the use of petroleum products, as well as any fossil hydrocarbons. Nevertheless, due to its energy qualities and environmental friendliness, natural gas is an exception that meets modern, constantly increasing requirements for industry, energy, and also for use as a motor fuel.

The world market for liquefied natural gas (hereinafter LNG) continues to grow at a significant pace. According to forecasts of leading expert agencies and market participants, this trend may continue until 2040 according to the most pessimistic forecasts. The expansion is planned due to the growth of consumption in the countries of the Asia-Pacific region.

At the moment the estimate of the potential LNG production in the Russian Federation, according to the Ministry of Energy, is more than 80 million tons per year, and taking into account the potentially announced projects, production may amount to about 163 million tons per year. The ongoing large, medium and low-tonnage projects can have a strong impact on the formation of a resource base for the production and export of gas.

Russia is currently in the top of the leading countries in terms of LNG production and transportation capacities. According to analysts' forecasts, by 2035, Russia's share in the world liquefied natural gas market may reach 20% and the country will be able to compete with such market participants as Qatar, the USA, and Australia. Until 2024, the government plans to invest over 2.5 trillion rubles for LNG projects [1].

On April 2, 2020, the government of the Russian Federation approved the draft Energy Strategy of Russia for the period up to 2035. One of the main emphasis of this document is made on the further development of liquefied natural gas production, as well as motivation for the formation of LNG clusters and priority development points in such territories as the Yamal and Gydan peninsulas. To achieve all the ambitious goals of this strategy, it is important to analyze LNG projects and identify their competitiveness in the world market.


2. Materials and methods
The purpose of this study is to analyze the prospects of projects currently being developed in the Russian Federation and other countries for the production and sale of liquefied natural gas. To do this, it is necessary to solve a number of tasks:

- Conduct an analysis of world experience in the implementation of LNG projects;
- Assess the competitiveness of Russian LNG projects.

As an example of industry development and comparative analysis, the study uses a sample assessment and consideration of medium-tonnage LNG projects, including the use of composite analysis based on world experience.

The information base of the study was information from government, corporate and analytical organizations. The study used descriptive, comparative, economic-statistical and logical methods.

3. Results
For Russia, a completely new direction in the development of the gas industry has become the production of liquefied natural gas, starting in 2009, when the first plant for its production was put into operation.

Today, the Russian Federation is actively expanding the geography of both production and consumption of natural gas, including in the form of liquefied gas. One of the priority areas, according to ES-2035, is to use a gas as an engine fuel. By the beginning of 2019, the number of stationary NGV facilities amounted to more than 400 points, while the volume of sales at gas-filling compressor stations for cars reached more than 650 million cubic meters. Such an increase in indicators, among other things, is due to the existing program for subsidizing certain cost items from the federal budget aimed at acquiring technologies used in the gas engine sector. To date, more than 45 constituent entities of the Russian Federation have and are implementing programs to develop this market.

This energy sector is facing its own specific problems, such as, firstly, an increase in costs for the production and transportation of gas, both to the domestic and global markets. Secondly, it is an oligopoly on the domestic market, which is, among other things, provoked by the creation of the UES gas market as a common one to maintain external competition. An equally significant limiting factor is the still unfinished process of creating a regulatory framework for the functioning of the LNG market within the country.

During 2020, the global LNG market entered a phase where production exceeded consumption. This state, taking into account the commissioning of new liquefaction capacities, may persist for several years. The COVID-19 epidemic has led to a decline in economic activity and demand for energy. As a result, LNG demand is likely to decline in 2020-2021, further increasing pressure on prices.

In a situation of overproduction, the level of costs is of great importance, which determines the long-term competitiveness of the project. Below are the main and considered in the work models for the implementation of LNG projects (table 1).

The Russian Arctic is becoming the world's leading center for LNG production. Several projects are being implemented in different parts of this macro-region. They are located in different segments: from global production to low-tonnage. In the face of increasing competition in the global LNG market (as well as LNG with pipeline gas), there is an oversupply. In such conditions, non-price factors of competition, such as environmental, climatic, geological and political, acquire a special role.

The location of production in the Arctic zone is fraught with significant difficulties in the implementation of the project. This is reflected in increased capital costs throughout the entire production chain and increases the risks of not implementing the project within the agreed time frame within the provided budget. However, external cold accompanies the production of additional products. Large-scale Russian LNG projects are actively using this, increasing their productivity up to 17% in the framework of individual projects, such as Sakhalin-2 [2-4].
Table 1. Models for the implementation of LNG projects [5].

| Functions                | Models                      | Ownership / Cost Model                  | Trading / Market Model |
|--------------------------|-----------------------------|----------------------------------------|------------------------|
| LNG buyer                | End-user                     | Various                                | Various                |
| LNG seller               | National or international vertically integrated companies | Various, according to the distribution of shares | Various |
| Financing                | Whole production chain or LNG plant | Various, supported by larger owners or long-term commitments | Market based, no risk of LNG sales |
| Ownership structure      | Closed, often as an SPV     | Closed to maximize sales margin        | Depends on the owner, rather with maximizing sales margins |
| Project scope            | Onshore large-scale projects | Expansion of existing production facilities and construction at new sites | Expansion of existing production facilities and construction at new sites |
| Gas supply               | Included in the project outline | LNG plant only | Combined     |
| Gas operator             | National or international vertically integrated companies | An independent company without ownership of production assets | An independent company without ownership of production assets |
| Gas source               | Fields with proven gas reserves | Gas is purchased on the market | Gas is purchased on the market |

In other countries, manufacturers seek to improve their efficiency in other ways. Thus, the Japanese company Chiyoda Corporation is starting a project using artificial intelligence or AI to increase the productivity of the RT Donggi-Senoro LNG plant located in Indonesia. Such technologies can also be actively applied in the Arctic, which will further significantly increase productivity (table 2).

Table 2. Artificial intelligence vs cold climat [5-6].

| Project            | Installed capacity, million tons | Actual capacity, million tons | Production start year | Year of fixing the result | Cause                        |
|--------------------|---------------------------------|------------------------------|-----------------------|---------------------------|------------------------------|
| Sakhalin-2         | 2x4,8                           | 11,5                         | 2009                  | 2018                      | Climatic features, technological improvements |
| Yamal LNG          | 3x5,5                           | 16,5+7-10%                   | 2017                  | 2018                      | Climatic features            |
| PT Donggi-Senore LNG | 2                               | No data                      | 2015                  | 2019 (project start)      | Artificial Intelligence      |

High quality and a large resource base allow companies to increase production by building additional LNG production lines in industrial parks. The use of the existing infrastructure and its
modernization at the existing sites greatly affects the efficiency of the entire LNG production complex. For example, thus, the placement of the T4 production line ensured a cumulative synergistic effect and a significant increase in the efficiency of the Yamal LNG project from Gazprom by 3-4%.

4. Discussion

For the development of the LNG industry in Russia, a set of basic measures is envisaged, including legislative, infrastructural, regulatory, and technological ones. First, it provides for the development and improvement of a mechanism to ensure legislative, as well as regulatory and legal conditions, such as measures of tax and customs tariff incentives and regulation, focus on cost-effective improvement at all stages of the LNG industry: production, transportation, storage, sale and use of LNG.

Secondly, a set of measures for the liberalization of LNG exports, the creation of a mechanism to control balanced competition in external markets for natural pipeline gas and LNG.

It also provides for the modernization and construction of auxiliary and additional infrastructure, such as port, transport, electricity and others on the principles of public-private partnership, including within the framework of the creation of an LNG cluster on the Yamal Peninsula and the Gydan Peninsula. In the Arctic zone of the Russian Federation, it is planned to create specialized hubs for transshipment, storage and trade of LNG, the implementation of projects for the construction of terminals in Kamchatka and Murmansk, as well as the development of the production of low-tonnage LNG and the formation on its basis of the internal LNG market as a tool to ensure the energy security of territories remote from unified gas supply system.

Today in Russia there are several companies engaged in the distribution of LNG abroad: Gazprom, Gazprom export, Rosneft, Yamal LNG, Arctic LNG-1, Arctic LNG-2, Arctic LNG-3 - which, in turn, are subsidiaries of PJSC Novatek" (figure 1).

![Figure 1. Map of Russian LNG projects [5].](image_url)

According to the 2020 market reviews by IGU and GIIGNL, Russia ranks 4th in terms of LNG exports for 2019, exporting 29.3 million tons of LNG (8% of the global market). 51% of LNG exported by Russia comes from Europe and 46% to the Asian market (figure 2).
The quantitative benchmark for the LNG industry is production of 80-140 million tons by 2035. In a number of publications in previous years, a target level for the Russian industry of 140 million tons was determined, which is confirmed by the statements of the Minister of Energy of the Russian Federation Alexander Novak and the Chairman of the Management Board of PAO NOVATEK. The role of the LNG industry in the Russian gas industry should grow significantly: from 4.2% in 2018 to 22.4% in 2035.

LNG is an essential element of Russian energy exports. This applies to both low-tonnage (up to 80 thousand tons per year) and medium-tonnage (up to 2 million tons per year) segments, as well as large-scale projects in the Arctic, the Baltic and Asia [7-9].

Taking into account the projects implemented under the Production Sharing Agreement, in the period up to 2035 more than 75% of the planned LNG production in Russia will be exported under exceptions from the Federal Law "On Gas Export", which means without the participation of Gazprom. Thus, this law has actually lost its significance and role for " maximizing gas rent" in Russia [10-11].

It is no coincidence that the liberalization of LNG exports is one of the elements of Russia's energy strategy until 2035, which makes it possible to fully unleash the potential of LNG production in Russia.

5. Conclusion
For research on this topic, a huge array of various information from authoritative sources was taken, comparing and analyzing which, the authors analyzed and identified potential prospects for the development of Russian LNG projects, in accordance with world experience and based on statistically confirmed materials and knowledge bases on the effectiveness of LNG enterprises, both in Russia and in other countries. The scientific value of this work lies in the presence of a value judgment of the above information and the formation of certain conclusions made by the author of this research work.

Based on the research carried out within the framework of the designated topic, conclusions were made on the current state of the LNG component of the fuel and energy complex in the Russian Federation, the main aspects and directions of increasing stability were considered, on the basis and within the framework of the Energy Strategy 2035, studies were carried out and conclusions were drawn based on qualitative and quantitative indicators provided by the largest companies representing LNG production in the Russian Federation. The main models used in LNG projects were considered, their advantages, disadvantages and characteristic features. The main priorities for the development of
the Russian direction of the LNG industry were also identified; The prospects and advantages of introducing AI into production in the Arctic are considered.

Development of production and consumption of LNG, the desire to enter the Russian Federation in the medium term among the world leaders in its production and export.

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