Developing Gas Fields in the Yamal Peninsula as a Factor of Economic Development of the Arctic Zone of Russia

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Abstract. Currently, one of the main gas-producing regions in Russia is the Yamalo-Nenets autonomous district. Obviously, the efficiency of hydrocarbon fields development will affect the rate of the social-economic development of the entire region. In this article, we point out that surveying the detected gas deposits in the territory of the Yamal peninsula, as well as detailed field appraisal of those fields that have been discovered already can be important stages in developing the hydrocarbon potential of this region. We also point out that, during the detailed survey of a deposit field in the Tambe suite, a unique gas deposit was discovered. As one of the most important strategic directions in developing the resource base of the Yamal peninsula, there is an integrated investment project “Yamal-LNG”, which implies production of natural gas in the South-Tambe field, with subsequent liquefying and transporting to the consumers. In this article, we characterize the production capacity of the plant for producing liquefied natural gas (LNG), as well as logistic schemes to deliver LNG to the consumers. We point out that transporting LNG via the Northern sea rout has a number of sufficient advantages. Due to presence of some unique deposits of natural gas in the territory of the Yamal peninsula, we investigate the issue of plausibility of creating high-tech manufacturing plants in this region. We characterize special features of the technological complex currently under construction in the territory of the district. We mark that the level of development of the gas-producing and gas-processing plants directly depends on the positioning of the transport network for delivering hydrocarbons and cargo to world markets. We point out that large infrastructural objects we created for transporting products and cargo in the Yamal peninsula, such as the multifunctional year-round sea port Sabetta, the international airport Sabetta; also, a new transport project “The Northern Latitudinal Railway” is now being designed; it implies constructing some railway infrastructure. We make a conclusion about the significance of the project “Yamal-LNG” for economic development of not only the Yamal peninsula but also of the entire Arctic zone of Russia.

1. Introduction
The Yamalo-Nenets autonomous district (YNAD) is currently one of the main gas-producing regions in Russia. In the territory of this district, there are about 75 % proved deposits of natural gas in Russia. According to some expert evaluations, the volume of the total gas deposits is 55.6 trillion m³ [10]. In the Yamal district, hydrocarbons are produced in four basic fields of Nadym-Pur-Tas region: Urengoi, Medvezh, Zapolarny and Yamburg. These fields account for 320 – 350 billion m³ of gas per year, which is more than 50 % of gas production in Russia; however, the maximum output period is not over, and there is natural decrease in production.
The rate of the social-economic development in this district is conditioned by further developing of hydrocarbon fields. Therefore, the perspectives of the growth of investment into development of new oil and gas fields in the territory district are obvious.

The main part of perspective deposits of hydrocarbons in the Yamalo-Nenets Autonomous District is located in its Northern part – in the Yamal peninsula, in the Arctic zone. The volume of the prepared proved gas deposits in the territory of the Yamal peninsula exceeds 17 trillion m³ [1]. Developing these deposits, as well as detailed appraisal of those fields that have been detected already can be important stages in further development of the hydrocarbon potential of the YNAD.

2. Research questions

Developing the gas resources in Yamal started with commissioning Bovanenkovo gas condensate field. Gas production started in 2012. In Bovanenkovo field, a new technology was first used – an integrated manufacturing infrastructure to produce gas from Cenomanian and Aptian-Albian stages. Using this technology significantly decreases the cost of production the operating efficiency in the field.

After commencing development of Neocomian-Jurassic stages, the predicted output capacity of the field will reach the level of 140 billion m³ of gas per year [1]. Gas is transported through the gas pipeline “Bovanenkovo – Ukhta” into the Integrated gas transportation system of Russia, and then to the European countries.

Currently, PJSC “Gazprom” have decided to start developing the deposits Harasvei field in Yamal. Besides that, the monopolist considers developing other large fields, particularly, those located in the Kara Sea.

An important stage in development of the hydrocarbon potential of the Yamal peninsula is detailed appraisal of fields in the Tambey group, which led to discovering a huge gas condensate field. Discovering this group of fields took place in the 1980-ies. The main volume of geologic survey works including 2D seismic survey works and drilling 69 survey wells has been competed before 2000. During this period, 35 productive gas suites were discovered in the surveyed territory; the estimated retrievable gas deposits were 1555 billion m³, the retrievable condensates – 75 million tons, the retrievable oil – 33 million tons; 76% of all the deposits have been surveyed in detail [10].

The license for the right to carry out survey and production of hydrocarbon resources in the Tambey fields (West-Tambey, North-Tambey and Tas sites) was obtained by PJSC “Gazprom” in 2008. In 2009 – 2012, the company carried out works to update the geologic structure models for the fields, the 3D seismic survey works were carried out, the detailed field appraisal program was prepared. In 2013, survey drilling was resumed in the Tambey field – 14 survey wells were drilled, which made it possible to obtain more than 70 gas kicks.

Intensifying the drilling works in the Arctic conditions, in under-developed remote territories, demanded quick development of a logistic scheme to deliver equipment and materials, as well as creating a large-scale production complex including transport infrastructure and a full-fledged support system.

It should be noted that geologic survey works in the Tambey field are carried out by PJSC “Gazprom” with observance of strict ecologic requirements applied to companies operating in the vulnerable natural conditions of the Arctic zone. Starting from the initial phases of the geologic survey in all the sites of the field, industrial ecologic monitoring of the environment is being carried out as well as revegetation works.

As a result of the geologic survey works carried out by the service company “Gazprom Geologic Survey”, unique data was obtained. It was found out that the West -Tambey, North-Tambey and Tas sites are a combined huge gas condensate field. It was estimated that the main part of the deposit is located in deep Jurassic and Lower Cretaceous horizons. Therefore, the current estimate of the gas deposits in the Tambey field is 5.5 trillion m³ [7].

As a result of drilling survey wells in the Tambey field, the gas content of the Achim suite in the North of the Yamal peninsula. It should be noted that the Achim complex is widely spread in the
territory of the West-Siberia oil and gas province, it has a significant resource potential; however, no industrial yield of gas has been obtained in the Northern part of the Yamal peninsula before.

For further surveying of the deposits in the Tambey field, PJSC “Gazprom” is planning a more detailed examination of the Lower Cretaceous and Middle Jurassic series. For this purpose, a new program of geologic survey works has been developed including detailed 3D seismic survey, drilling 21 survey wells of a complex design, particularly, slanting holes. Besides that, it is planned to use modern methods to intensify kicks of hydrocarbons, such as multi-stage hydraulic fracturing, as well as physical-chemical methods of influencing the geologic horizons. Fulfilling this program should make it possible to change the category of the main part of hydrocarbons deposits from \( C_2 \) to \( C_1 \) and complete preparation of the Tambey field for industrial production, which will increase the mineral resource base of PJSC “Gazprom” in the Yamal peninsula.

The second strategic direction for developing the resource base in the Yamal peninsula is implementing a large-scale integrated investment project “Yamal-LNG” that implies production of natural gas in the South-Tambey field, as well as its liquefaction and transportation to the consumers. The volume of probable and proved gas deposits in the South-Tambey field have reached 926 billion m\(^3\) according to the PRMS standards. The projected yearly production level is 27 billion m\(^3\) of gas, the production period is at least 20 years [8].

The project operator is the company “Yamal LNG” - a joint-venture company of the company “NOVATECH” (50.1 %), the French group of companies Total (20 %), the Chinese company CNPC (20 %) and the Silk Way fund (9.9 %) [11].

As the project “Yamal-LNG” is unprecedented in the level of complexity, and is to be implemented in the extreme climatic conditions, all the equipment required for the works in the field is adapted for the local environment conditions. Particularly, the “Arktika” type of the drilling rigs was specially designed for this project, with complete wind-resistance. This will make continuous work possible, with convenient conditions for the staff.

The project includes construction of a plant to produce liquefied natural gas (LNG). The plant shall include three technological lines with the production capacity 5.5 million tons of liquefied gas per year. Currently, two of them have been commissioned. LNG deliveries on the long-term contracts basis were started in April, 2018, and the third technological line is planned to be commissioned in 2019. The planned yearly production of LNG and gas condensate is about 16.5 million tons and 1.2 million tons, respectively. The main consumers of the plant will be the countries of the Asian-Pacific region and Europe.

Transportation of LNG to the countries of the Asian-Pacific region shall be carried out along two logistic schemes in the Easterly direction – on the Northern sea route in ice-class tankers, and via the Suez canal – in the Westerly direction. In the latter case, LNG will be transported in ice-class tankers to European ports, where gas will be trans-shipped to standard LNG tankers and transported further on to the Asian region. The Northern sea route has a number of essential advantages, the main one being a significantly quicker transportation. For example, transporting cargo from Norway to Japan is 21 days quicker than via the Suez canal [7]. An additional advantage of the Northern sea route is the fact that bunkerage of ships with natural gas from on-shore and shelf fields is possible practically along the entire route.

It should be noted that the first transportation of LNG from Yamal to the Asian-Pacific region was carried out in December, 2017 in the unique gas tanker “Christophe de Margerie”, one of the 15 tankers specially built for the project “Yamal-LNG”. This ship can perform year-round navigation without ice-breaker assistance along the Northern sea route in the Westerly direction and, during the summer, – in the Easterly direction.

The gas tanker “Christophe de Margerie” was built in the South-Korean shipyard Daewoo Shipbuilding Marine Engineering and put afloat in October, 2016. It is 300 m long, displaces 172 thousand m\(^3\) and has the engine power of 45 MW. It can turn in place and break ice up to 2.1 m thick. The tanker was designed with consideration of very strict ecologic requirements [6]. Besides conventional types of fuel, the tanker’s power plant can use boil-off LNG. Compared to the
conventional heavy fuel oil, LNG ensures less pollution of the atmosphere. The most decrease is in the
Sax and hard particles. NOx emission is decreased by 80 % [4]. Besides that, there is decrease of
greenhouse gases emission. The gas tanker “Christophe de Margerie” is the first in a new series of
ships – Yamalmax – and is now the largest ice-class ship in the world. Obviously, the beginning of
deliveries of LNG via the Northern sea route in an Arc7 ice-class ship will become an incentive for
developing cargo transportation and further development of shipping in the Arctic Ocean.

Further development of liquefied natural gas production in the Yamalo-Nenets Autonomous
District will obviously look more intensive after commissioning the second LNG plant – “Arctic
LNG-2”. This plant is now in the pre-design stage: the basic variant of the project is now under
development, with consideration of international requirements; various technical solutions are now
being considered so as to select the optimal and safest one. The resource base of the projected plant
will be the Salman field in the Yamal peninsula Gydan. Besides that, construction of the third LNG-
producing plant in Yamal is now being considered, as well as evaluation of its resource base.

Presence of unique deposits of natural gas in the territory the Yamal peninsula makes it possible to
raise the issue of creating high-technology plants in this region. Particularly, the currently constructed
New-Urengoi technological complex was designed for processing ethane-containing gas that is a by-
product obtained as a result of deethanization of gas condensate [3]. The projected capacity of the
processing complex shall be at the level of 1.4 million tons per year; also, the plant will produce
polyethylene of various grades, in the total volume up to 400 thousand tons per year. On the basis of
this technologic complex, it is planned to form a technologic cluster and manufacture materials from
polyethylene, stretch film etc.

It is necessary to take into consideration that the scale and the level of development of gas-
producing and processing plants directly depends on the presence and correct positioning of the
transport network for hydrocarbons to be delivered to the consumers markets. Therefore, one of
the primary tasks is creating of a thorough transport corridor to enable delivery of Russian hydrocarbon
resources to world markets.

In order to solve this task, large infrastructural objects were created in the Yamal peninsula; their
significance for economic development of the entire Yamal peninsula is obvious:
- within the framework of the project “Yamal-LNG”, on the principles of the state-private
   partnership, the multifunctional year-round sea port Sabetta has been constructed. Construction of the
   port was ordered by the Federal State unitary enterprise “Rosmorport”. According to the agreement,
   some of the objects are in the State ownership, others belong to the project “Yamal-LNG”. According
to the data from the source [11], the Federal ownership covers the ice-protection facilities, the
operational water body, the approach channels, the shipping control and navigation support system,
shipping services buildings. “Yamal-LNG” owns technologic moorings for LNG and gas condensate
trans-shiping, roll-on and construction cargo moorings, storage facilities, the administrative and
support zone, engineering networks and lines [2]. The port Sabetta operates all the year round. At the
moment, logistic schemes have been developed for large ships in the Northern sea route, with
consideration of ecologic safety requirements;
- also, within the framework of the project “Yamal-LNG”, the airport Sabetta was constructed, with
   the international status. The airport can accommodate large airships with cargo for constructing the
   natural gas liquefying plant. Besides that, presence of an airport in the region enabled shortening the
   travel time for the work-shift personnel from the central Russia to Yamal down to three hours;
- in order to connect the Northern railway and the Sverdlovsk railway in the territory the Yamalo-
   Nenets Autonomous District, a concession agreement was signed in August, 2018 between the
government of the Russian federation and OJSC “NLR”, which started a new project – “The Northern
Latitudinal Railway”. This agreement implies financing, construction and operation of railway
transport infrastructure in the direction “Obskaya – Salekhard – Nadym”. The activities for financing,
projecting and commissioning separate parts of the railway will be carried out by OJSC “Russian
Railways” and PJSC “Gazprom”. The required project documentation and financing the construction of
the motor-way and railway bridge across the river Ob will be provided by the government of the
district. The next stage of forming the transport infrastructure is continuing the railway line from the station Obskaya to the port Sabetta. In order to solve this task, the project “The Northern Latitudinal Railway 2” was initiated, which is necessary to develop the central part of the Russian Arctic [5].

In the experts’ opinion, efficient implementation of investment projects for LNG production in the Yamal peninsula will make it possible to produce more than 70 million tons of LNG per year [11]. Using this potential will enable Russia to become one of the world leaders in exporting liquefied natural gas.

3. Conclusion
On the basis of the above-said, the following conclusions can be made:

1. The unique project “Yamal LNG” is one of the most significant projects for the Russian economy. It should be noted that this project is being implemented with strict observance of the time schedule and budget requirements. The project became a model from the viewpoint of organization of works for developing the Arctic territory: the work-shift principle of works organization in Yamal has proved its efficiency.

2. The project “Yamal LNG” is a successful replacement of the delayed equally large project for developing Stockman gas condensate field and it enables Russia to compete with the world-largest LNG manufacturers.

3. The strategic and geopolitical significance of LNG production in Yamal are obvious. Due to the logistic opportunities of the Northern sea route, Russia, as one of the main suppliers of natural gas, can obtain competitive advantages in the conditions of the heated competition for the consumers.

4. Implementation of the project “Yamal LNG”, with yearly commissioning of new capacities, plays an important part in developing the entire region. Constructing of the Northern-most LNG-producing plant, a new international airport, as well as the full-fledged multifunctional year-round sea port Sabetta can become incentives for development of the Northern sea route.

5. In general, implementation of the project fully corresponds with the most reasonable strategy for the Russian fuel-energetic complex that greatly depends on the state of the hydrocarbon resource base [9]. The project “Yamal LNG” promotes economic development not only for the Yamal peninsula, but also for the entire Arctic zone of Russia. Besides that, in the process of implementing this project, a number of new technologies were developed and tested in the Arctic conditions, and it was proved that it is necessary to have an alternative to the pipeline method of gas transportation.

6. A steady growth of gas production as a basic sector of economy, the Yamalo-Nenets Autonomous District will promote development of such branches of economy in this region as oil and gas service and petro-chemistry, which will become a step to diversifying the single-industry character of the economy in this district.

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