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# **UNDERWATER COLLECTION OF METHANE ON EAST ARCTIC SHELF**

## **LOW-EXPENSIVE TECHNOLOGY OF GAS EXTRACTION**

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### **Abstract**

The article discusses the opportunities and prospects for the development of offshore methane hydrates in Eastern Siberia along the coast of the Republic of Sakha (Yakutia). Conducted by the authors preliminary cost estimate for the construction and operation of underwater complex collection of methane showed that the cost of production of 1,000 cubic meters of gas for the conditions of the sea shelf of the Laptev Sea is not more than U.S. \$ 20. In view of the minimal impact of underwater reservoirs on the environment, the technology of gas production will be the low-cost of all currently existing technologies of gas production in the sea.

### **Keywords**

Gas hydrates, the East Siberian shelf, territorial planning, mining methane hydrates, the development of offshore

### **INTRODUCTION**

The Republic of Sakha (Yakutia) is the largest by area subject of the Russian Federation, occupying nearly one-fifth of the entire country, with a population of about 950 thousand people. The basis of the economy of the Republic of Sakha (Yakutia) is the industry, the development of which is associated primarily with the development of abundant natural resources. Rated common stocks of all kinds of natural resources Yakutia is the first in the Russian Federation. Most of the industrial output provides non-ferrous metals (mining of diamonds, gold, tin, antimony) and the fuel and energy sector (coal, gas, oil and electricity). They make up more than 90% of the total volume of domestic production of Yakutia. One of the important features of the Republic of Sakha (Yakutia) is a historically large proportion of the rural population in the total number of residents. (36.8% and 26% on average in the Russian Federation and 8% in other northern regions of Russia). And in rural areas predominantly indigenous population - the Yakuts, Russian old-timers, the indigenous minorities of the North - with their traditional occupations. The agricultural sector as a whole has a significant share in the formation of the GRP and the number of employees in the country. In general, the integral indicators Russian Yakutia Ministry of Economic Development is on economic development to a group of the country with a rating higher than average (22 in the Russian Federation), in terms of quality of life - to the regions with a medium level of development (31st position). At the same time, GRP

and manufactured value added per-capita in 2005 the republic took 4-5 position the Russian Federation, and by the level of human development - 8th position. The country has accumulated a number of acute problems threatening the economic security and contributing to the growth of social tension. Therefore, the Government of the Republic of Sakha (Yakutia) was developed by an indicative five-year plan and fifteen targeted national programs for the period 2002-2006, aimed at solving the most important priorities. At the end of five years of work in general, these tasks are performed. In 2002-2006, ensured the growth of production in all sectors of the economy (industry - 13%, agriculture - 6%, transport - 20%, trade - 52%). As a result, the real growth of gross regional product was 116% to 215 billion rubles. Retained its leading position in the Far Eastern Federal District in terms of shipped goods of own production, construction of public facilities and housing. The share of tax revenue in fiscal revenue increased from 36% in 2002 to 45% in 2006. During this time, implemented a number of investment projects of importance not only for Yakutia, but also for the Russian Federation as a whole. Such as the construction and commissioning of one of the world's largest Nyurbinsky mining and processing plant, the first unit Svetlinskaya HES, railway Berkakit - Tommot. After 2020, due to the deterioration of the mineral resource base of the diamond industry is forecasted to decline in key macroeconomic indicators and depression in all areas of life of the republic. In this regard, there is an urgent need to develop new strategies for economic development of the Republic, which would realize the potential of Yakutia for accelerated economic growth. Comprehensive document, which is integrated, forecasting and strategic study of macro-economic, social, sectoral and territorial focus is the scheme of integrated development of the productive forces, Transport and Energy of the Republic of Sakha (Yakutia). The scheme developed by Ministry of Economic Development of the Russian Federation in cooperation with the Government of the Republic of Sakha (Yakutia), the relevant federal departments and agencies to implement the order of the President of the Russian Federation dated February 3, 2006. In developing the schemes analyzed the strengths and weaknesses of the economy of Yakutia, opportunities and threats of dynamic development.

The main competitive advantage of Yakutia is its mineral potential, which is estimated at 78.4 trillion. rub. The share of reserves of the Republic of Sakha (Yakutia) in the mineral resource potential of Russia is: Diamond 82%, 17% for gold, 61% of the uranium, 82% antimony, 5% iron ores, 5% coal, 28% tin, 8 % mercury. There are significant reserves rare earths elements, silver, lead, zinc, tungsten. Currently, oil reserves are 330 million tons of natural gas - 2.4 trillion cubic meters, though geologically examined no more than 10% of the territory of Yakutia four oil and gas provinces. The Republic of Sakha (Yakutia) has the fifth overall

potential hydropower resources of the Russian Federation. The current and expected long-term state of the world and Russian markets suggests a high degree of demand for existing and potential mineral resources in Yakutia. In this regard, the Scheme provides that the sub-sector of mining and the energy industry will continue to serve as a basis for a system-economic complex of Yakutia. On this basis, formulate strategic priorities in economic development, which is a creation of the conditions for the stable operation of the existing basic industries, the creation of new sub-sectors of the mining industry and the energy sector on the basis of a number of large-scale investment projects, accelerated development of transport and energy infrastructure. Given the multiplier approach to the development of related industries, including in the area of small business, it will increase the regional product of the Republic of Sakha (Yakutia) in 2020 was 2.8 times. Economic growth, in turn, will increase the incomes of the population in 2020 to 3.6 times, to solve the major issues in the social sphere, and the Republic of Sakha (Yakutia) by 2012 to become without subsidy fellow of Russian Federation.

The first task of the strategic priorities - the stabilization of existing basic sectors of the economy Yakutia - Scheme provided by the modernization process: the transition to underground mining of diamonds; development of ore deposits of alluvial gold in exchange, the use of new methods of ore in order to integrate poorer content of valuable components Mineral Deposits (biological and heap leaching, enrichment aboard quarries, etc.) of raw materials processing in gold-antimony industry, the development of diamond cutting and jewelry industry, wood processing and agricultural products. About 20 billion rubles will be allocated for the modernization of existing facilities in the coal industry. Require significant investments and other non-ferrous metals industry.

***The second strategic priority under the Scheme*** - the creation of new revenue generating sector of the economy of Yakutia. These branches should provide most of the growth of the gross regional product of the country. Their creation is due to the implementation of a number of major investment projects. One of the areas is the technical development of gas hydrate deposits on the continental shelf of the Laptev Sea and East Siberian Sea.

About 80% of underwater permafrost containing thousands of gigatons of methane hydrate is located on the eastern Siberian shelf. Available evolved from marine methane hydrates methane - a new alternative source of natural energy source, with recoverable reserves in the tens of trillions of cubic meters of gas, which is currently not used. Due to global warming in the Arctic region (both onshore and offshore) began the processes of permafrost degradation, followed by the release of carbon dioxide and methane. Huge deposits of methane hydrates at the

bottom of the Laptev, East Siberian and Chukchi seas, the Beaufort Sea (depths less than 50 m) began to distinguish methane in increasing numbers.

International expedition on the research vessel "Jacob Smirnitsky" and "Academician Lavrentiev," conducted in 2011, found in the waters of the Laptev and East Siberian Sea areas in which methane is released freely in the form of huge underwater plumes with diameters up to 1 km [7,8]. Logged thousands of underwater "Fountains" larger than 100 m in the shallow marine shelf. Overall picture of the distribution of emitted methane is presented in Figure 1.

The situation is similar in the shallow shelf of the Beaufort Sea (USA, Alaska) and on the shelf around Svalbard. The main results of the expeditions in 2011 were presented in Novosibirsk (May 2012) on the Russian-German seminar on the evolution of the environment in the Arctic region of Siberia. In expeditions using submersibles recorded coming from the bottom of a flood of methane, found many kilometers of subsea fields, "fountains", which poses a serious threat to the climate. Because about 80% of underwater permafrost containing thousands of gigatons of methane hydrate is located on the eastern Siberian shelf. In case of contact, even 5% of these reserves of methane in the atmosphere (about 40 gigatons of methane, that is eight times more than today in the earth's atmosphere) is not excluded climate disaster, and observed in the current rate of global warming makes it highly probable forecast .

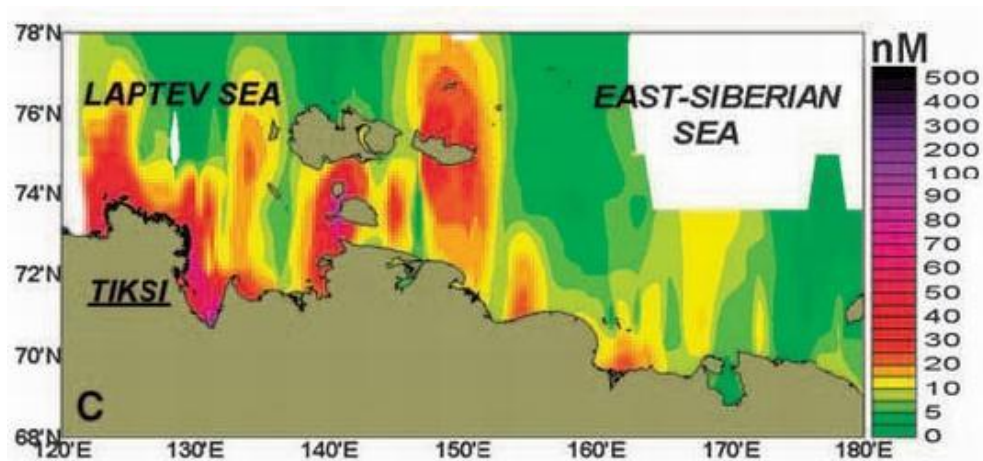


Fig.1. Distribution of freely methane streams on the Eastern Siberian shelf

Freely evolved from marine methane hydrates - a new alternative source of natural energy source, with recoverable reserves in the tens of trillions of cubic meters of gas, which is currently not used. To produce such a methane does not require any seismic surveys or exploratory drilling or extracting huge offshore platforms. The main costs with this method of production of gas will cost to manufacture underwater, fully automated reservoirs of methane, install them in the shallow water (at depths less than 50 m), laying on the seabed pipeline to pump the gas to shore station, the construction and maintenance of the gas station and the coast electric power station

on the produced gas. The power plant is needed to provide electricity to all processes of this method of gas production.

Given the simplicity of the technological processes of underwater methane capture and transport it to shore, all operations on subsea production system can be fully automated and performed with little or no human intervention throughout the year. The layout of the complex under water (water depth should be at least 10 m) to avoid the negative impact of the ice cover and rough seas on the complex. Conducted by the authors preliminary cost estimate for the construction and operation of underwater complex collection of methane showed that the cost of production of 1,000 cubic meters of gas for the conditions of the sea shelf of the Laptev Sea is not more than U.S. \$ 20. In view of the minimal impact of underwater reservoirs on the environment, the technology of gas production will be the low-cost of all currently existing technologies of gas production in the sea.

Unfortunately, at present, the development of this technology is not yet done by anyone, even releasing a huge amount of gas in the East Arctic shelf has already been confirmed by both Russian and foreign scientists. In May 2012, U.S. Department of Energy announced the success of the first phase of a joint U.S. and Japanese companies, a pilot project for the extraction of methane hydrates in the Arctic shelf (coast of Alaska) [8]. Investment in the project to explore the potential of methane hydrates as a source of natural gas in 2012 amounted to 6.5 million dollars. For 2013 the budget of the project should reach five million, said U.S. Energy Secretary Steven Chu. According to him, "this is just the beginning, and it will be several years before production of methane can buy industrial scale, however, this technology could eventually become an important source of natural gas." The project scientists working in the Arctic Shelf off the north coast of Alaska (Beaufort Sea shelf), where for the first time in the field have used a method in which a mixture of carbon dioxide and nitrogen. The mixture was injected into ice arrays methane hydrates at the bottom, while natural gas is released, which is then captured and sent to the collector pipeline. It is clear that the developed U.S. and Japanese technology specialists methane production more costly than collecting natural gas by subsea manifolds large area. Furthermore, adverse effects inevitably artificial gas mixtures environment including benthic biota.



Fig.2. Deposits of methane hydrates on Eastern Siberian shelf

Natural conditions in the Laptev and East Siberian Sea authors favor the proposed mining technology methane (small depth, small fluctuations in sea level, the absence of strong currents, etc.), so the development and implementation of this technology can be implemented in just 3-5 years. With high probability we can assume that during this time the intensity of methane emissions will increase even more under the influence of global warming and the proposed technology will get a great development for the purpose of gasification of settlements on the eastern Arctic coast of Russia. For development in Russia this promising field of energy to develop new technologies for extracting methane in 2013 to the state and national levels to plan and carry out the initial research on issues related to the feasibility of technology and technical issues with the conceptual design of the underwater complex, including:

- Development of means of bottom profiling to assess the extent of gas hydrate deposits and productivity;
- Collection and processing of data for the feasibility study of the new technology of gas production;
- Development of the conceptual design of the underwater automated complex for collection and transport of methane;
- Development of the investment project of the 2014 International Maritime proving grounds for testing for methane capture in the waters of the Bay of Tiksi;
- Justification of the spatial structure of the socio-economic development of the regions with the capabilities of the new energy.

Doing this will allow a range of works in 2014 to begin sketchily-engineering design of a prototype underwater mining complex for testing at the site and for the development of gasification and electrification Tiksi. Conceptual proposals for R & D to develop a set of

program documents the development of urban settlements Tiksi Bulunskiy Ulus of the Sakha Republic (Yakutia), developed by Arctic Public Academy of Sciences and the Russian Scientific Research Institute of Urbanistiks includes four basic section.

### **1. The necessity of execution of works**

Current conditions of development and tasks of improving municipal management orient urban settlement for an integrated approach to economic and social development, which allows you to balance the various areas of planning, placing their common strategic goal of long-term policy documents. The settlement, which has long term (concept) with marked development priorities and mechanisms of their achievement, has a considerable openness and transparency in decision-making, predictability and attractiveness for investors.

### **2. The aims and objectives of the works**

*The main objective* is to create on the territory of the municipality of urban settlement of Tiksi growth pole of federal importance, addressing both the geopolitical and strategic objectives (restoring lost positions of Russia in the Arctic region, giving a fresh impetus to the research activities in the Arctic, the development of the Russian continental shelf, the revival of the Northern sea route), and to increase the level and quality of life of the urban settlement of Tiksi, on the basis of an integrated socio-economic development and the creation of sustainable livelihoods.

*The main directions of development (functions of the urban settlement of Tiksi in the resettlement of the Arctic North).*

- One of the underlying key settlements in the central part of the Arctic along the North Sea route (availability of commercial sea port, airport)
- Economic-organizational development centre of the Russian Arctic continental shelf (estimated reserves of hydrocarbons on the shelf of the Laptev sea) and mining of alluvial diamonds ("Molodo", etc.) in the Bulunskiy ulus.

#### **International Center of environmental monitoring consist of:**

- The centre for the study of climate-based hydrometeorological observatory, the leading regular observations from September 2009, equipped with modern means of observation, laboratory, which collects data on the composition of the atmosphere, atmospheric processes and parameters, ocean and land. This information is used to study the weather and climate, identify the causes and effects of the changes.
- Scientific Center studying the flora and fauna of the Protected Area (Ust-Lensky State natural reserve of federal importance).



**Creation Education Center Arctic Arctic maritime shipping** on base of the Tiksi Shipping Company.

**Tourism development** (cognitive, ecological research - establish tourist routes on the Ust-Lena's reserve, cruise).

**Energy project** in the far north with a low capacity floating nuclear power plants (placing of FNPP in Tiksi)

### **3. In frame of the objectives achievement should be developed**

1. Socio-economic development strategy of the urban settlement of Tiksi in the period up to the year 2030, including:

- analysis of the current socio-economic situation of the urban settlement of Tiksi in the resettlement of Russian North;
- definition of strategic goals, objectives and directions of social and economic development in the long term the growth poles in the Russian North;
- optimization of the system of municipal social-economic planning based on coordination of different types of planning at the local level;
- development of a list of targeted programmes and key projects development of urban settlements.

2. Medium-term socio-economic development programme for the period up to 2020 year.

3. Preparation of proposals for amending the programme of integrated development of housing, transport, social infrastructure, the municipality of 2010-2030 years.

4. On base of developed strategies different levels development general plan of Tiksi and rools of planning.

5. Creation of Information system of city-building activity of settlement.

6. Forming of monitoring system and estimation of programme documents realization and effectiveness.

7. Raising of municipal specialists qualification in sphere of city-building planning.

### **4. General requirements**

The key requirements for the implementation of the integrated research and design work in accordance with the terms of reference are:

- systematic approach to software development documents, their consistency, coherence and direction to the overall implementation of the set objectives;
- correspondence provided by the present terms of reference of research and development best practices training of municipal programs and strategies in the cities of the Russian Federation;

continuity with respect to federal and regional policy documents, as well as international agreements on sustainable development in the Arctic region;

- Integration of the system of monitoring of program documents with a monitoring indicators to assess the effectiveness of local government in accordance with the Decree of the President of the Russian Federation of 28.04.2008 № 607 and the Order of the Government of the Russian Federation of 11.09.2008 № 1313-p;
- performance of work under the present terms of reference, in conjunction with the functional (sectoral) and territorial bodies of the administration of the settlement, organizations and public utilities;
- consultation for functional (sectoral) and territorial administration of the settlement, and communal organizations in various areas of work performed.

#### **Developers:**

- Development and justification of key strategic areas of development - scientific organization St. Petersburg Academy of Sciences;
- Development of software and documents of territorial planning documents - RosNIPI Urbanistics.

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