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# **Development of the North Sakhalin aqua territorial production complex (ATPC) program**

## **View from the past**

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The discovery of huge oil and gas fields on the shelf of Sakhalin Island has predetermined the solution for fuel and energy problem not only in Sakhalin region but also in Far East of Russia. Fuel and Energy Complex (FEC) is a basic sector for economic complex in the region, and development of a lot of other sectors depends closely on it. Therefore, as part of ATPC, oil and gas complex was given a special consideration. For its prediction, economic statement of the problem and the mathematical model of optimization of oil and gas complex structure were created. The prognostication of oil and gas complex was expected to solve following questions:

1. To identify possible variants of facilities in oil and gas complex production structure;
2. To identify territorial units of research – areas;
3. To reveal the main problems in the industry and find a quantitative solution;
4. To identify quantitative connections between objects of the complex that are subject to a quantitative solution;
5. To determine prediction period;
6. To specify the degree of detail of objects of study;
7. To find out the specifics of modeling objects and their relationships.

The basic premise of setting optimization task and developing appropriate model was a joint consideration of the following structural elements of ATPC: objects of industrial specialization and complementary industries, objects of industrial and

social infrastructure, workforce and population, local natural resources. Each element in the task reflects as a set of interrelated objects of study. For North Sakhalin oil and gas complex – it is a hydrocarbon deposits on shore and on the shelf; oil platforms factory, providing extraction of raw materials on the shelf; metal framework factory, products of which is necessary for production of ice-resistant platforms; Complex service base of offshore fields; construction organizations; aggregated objects of construction materials industry; power plants and transmission lines; pipeline and railway transport sections; hydrocarbon processing companies, manpower and population; water resources; set of other economical objects of Sakhalin.

The goal of optimizing spatial structure of North Sakhalin aqua territorial production complex (ATPC) is formulated as follows: to determine dynamics of the onshore oil, gas and condensate development, the scope and sequence of involvement in the development of offshore gas condensate fields, to make allocation schemes for recycling of hydrocarbons, the layout scheme of productions and facilities, which are service-oriented on oil and gas complex, deployment of an regional-value industrial infrastructure.

It can be solved under the following conditions:

- Execution of tasks involving oil extraction according to ATPC in general; compliance of sectoral restrictions in changes of onshore oil extraction in the context of defined periods and areas; meeting the requirements of other productions, placed in the selected areas, regional infrastructure services and territorial resources;
- Minimization of the total integral cost on the formation and development of North Sakhalin ATPC, taking into account the intended standard of living.

Peculiarity of the problem is caused by the requirement for identification of options for the dynamics of spatial structure formation of ATPC; the role of North

Sakhalin oil and gas complex in the development of economy of Far Eastern economic region.

The basic premise of the optimization problem (pic.1) is to determine the dynamics of the production of oil and gas resources according to years and fields. To solve this problem, four conditions were adopted: 1 – data of extraction volumes at the end of the reviewed period: 2 - maximum production rates for both onshore and offshore: 3 - maximum rates of decline in onshore production: 4 - restrictions on the production.

While predicting the development of oil and gas complex, there is a need to take in account a current market conditions as well as the ability of companies to develop their own facilities for oil and gas production. In the proposed model, the dynamics of oil and gas production is to be determined first, and afterwards, is the power of service and ancillary industries. The change in dynamics of oil and gas production levels affects the dynamics of the formation of complementary facilities of all branches in production infrastructure, as well as the need for labor, land and water resources. The possibility to study the structure of the complex in different conditions is available on the model level. Variability of conditions of deposits development can lead to multiple strategies of complex formation. Two of them are shown on pic.2.

If at the end of the reviewed period, the volume of extracted raw materials is considered totally both onshore and offshore, while the growth of production on the onshore and offshore remain certain, projected volume can be reached by increasing production on land and later offshore field development. This reflects the future orientation of the production volumes only on the shelf.

This approach entails a longer-term period for construction of service industries, such as ice-resistant platforms factory, comprehensive service base, ship repairing plant and others. The feature of this strategy can be its focus on onshore oil

production with a gradual decline in its volumes, and then achieving the final task due to the growth of extracted raw materials in offshore fields.

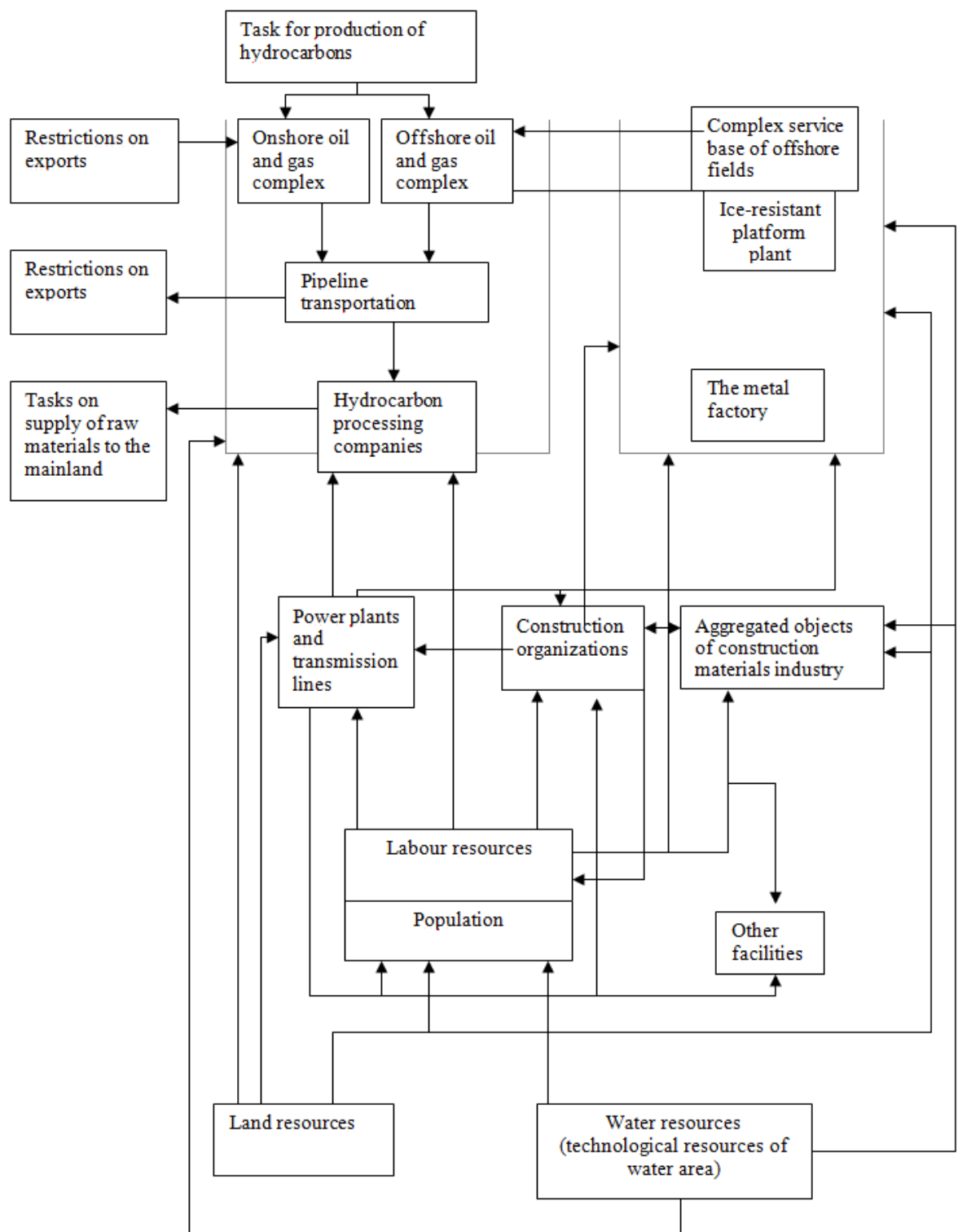
Strategy of developing offshore oil and gas resources can be different. The required amount of extracted raw materials can be reached, focusing on hydrocarbon reserves on land, with the gradual development of the shelf. In this case, its development will be formed in a different dynamics. Suggested approach involves modeling the dynamics of hydrocarbon production. Herewith, there are different approaches available to choose the ratio of hydrocarbon production on the shelf and the island itself. Development of the shelf can be interesting from the standpoint of the gradual establishment of the production structure of the complex, its auxiliary and complementary industries.

It is then appears the possibility of varying the powers of production of hydrocarbons on offshore fields depending on market conditions.

Thus, the selected strategy for the development of the shelf will determine the dynamics of complex creation.

Prediction of the formation of ATPC is based largely on the choice of the industry development strategy, which is determined by a complex of factors and relations. Solving the task according to suggested model outlines the areas of development and placement of ATPC.

Territorial units of study, by analogy with the objectives of optimizing the spatial structure of a production complex are areas. Existing or potential new industrial units of territories, associated with the formation of Sakhalin oil and gas complex act in their capacity.

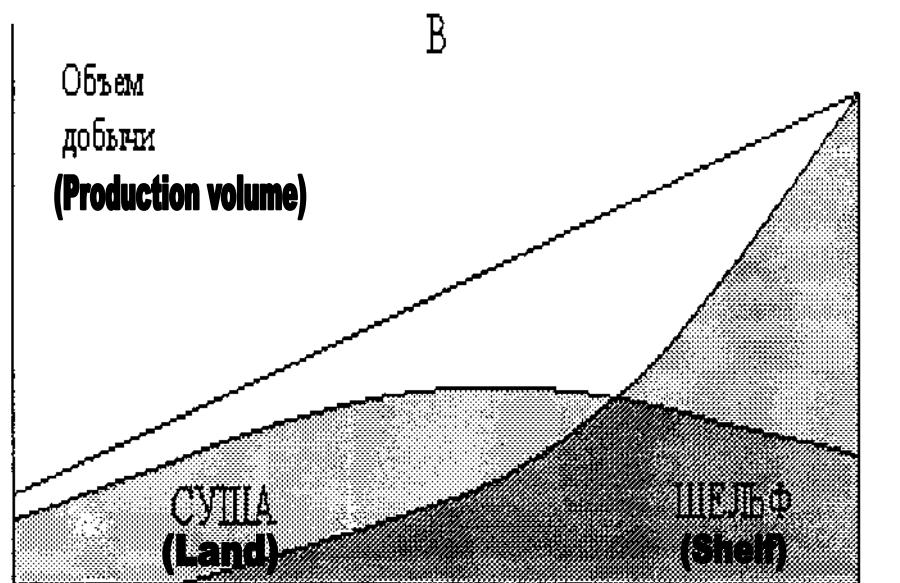
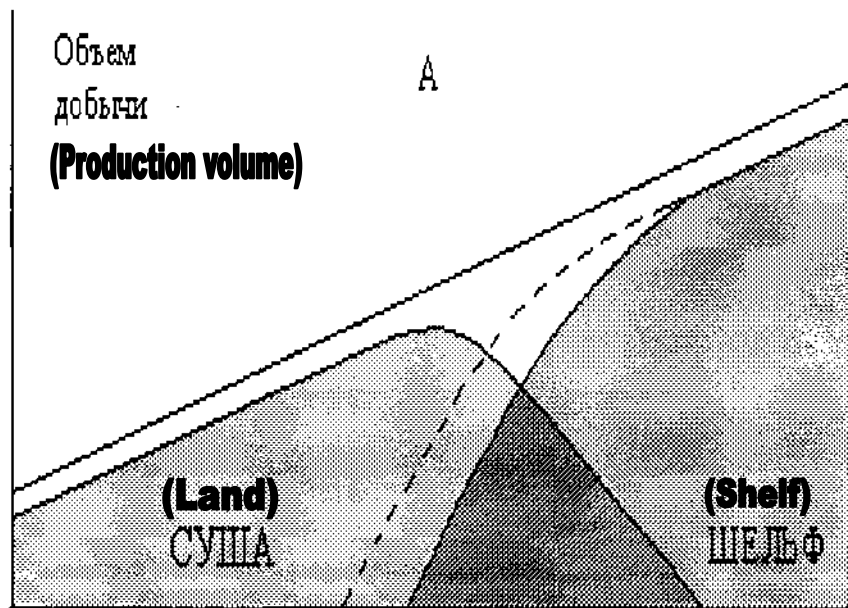


Pic.1. Flowchart of connections in optimization

Table 1

## Options for possible location of ATPC

Nameoftheobject	Moskalvo	Okha	Piltun	Chayvo	Lunskoe	Nogliki	Dolinsk	Kholmsk	Korsakov	Slavianka	De-Kastri
Onshore, offshorefiels		X	X	X	X	X					
Ice-resistant platform plant	X								X	X	
Oil refinery plant							x				
Liquefied natural gas plant									X		X
Complex service base								X	X		
Shiprepairplant								X	X		
Capacitorrefinery plant			X	X							
Thermal power station		X			X						
Ports, shipment	X							X	X		



Pic.2. Strategies for the development of oil and gas resources

A. 1st option    B. 2nd option



The specific composition of areas for the North Sakhalin ATPC, possible options of their production structure (or its complement) are shown in table 1. There are three groups of areas:

I - Areas of the northern part of Sakhalin, with centers: Moskalvo, Okha, Val, Nogliki; II - Areas of the southern part of Sakhalin, with centers: Dolinsk, Korsakov, Kholmsk; III - Far East coastal areas with centers: De-Kastri, Komsomolsk-on-Amur, Vanino, Slavianka.

Areas of first two groups do not imply entire coverage of Sakhalin territories. Statement of the problem is caused by research objectives - identification and analysis of options for the spatial and production structure of North Sakhalin ATPC.

Statement of the problem involves determining the form of accounting while optimizing the time factor. For specific calculations entire estimated period is divided into separate periods of 5 years. These periods serve as temporary control points of the formation of dynamics of development of oil and gas industry and related ATPC facilities.

In order to solve this task, modified version of the optimization model of the spatial structure of the TPC economic region is used. Modification is caused by the requirement of certain embodiments of the dynamics of formation of the spatial structure of the economy of ATPC; role of North Sakhalin oil and gas complex in the development of economy of the Far Eastern Economic Region; specifics of intracomplex relations of North Sakhalin ATPC; ATPC features as a form of spatial organization of the productive forces.

In structure of the model stands out the following groups of equations and inequalities, formalizing:

- Conditions of formation of the dynamics of the optimized parameters of objects of study;
- Balancing conditions of production (availability) and distribution of products and resources (including infrastructure services);
- Conditions of formation of relationships between objects of research in general, their shared use of resources of the area.
- Limitations on functional parameters of objects of study, including on the scale of used resources;
- Requirements for the implementation of tasks on output of products of specialization sectors
- Criteria for choosing the optimal solution under model calculations.

A series of calculations are conducted based on posed model, results are obtained, predicting the development of oil and gas complex of Sakhalin Island. For five-year periods the following indicators are calculated:

- 1 - Dynamics of oil and gas volume increase on land and offshore on separate fields;
- 2 - Development indicators of ice-resistant platform plant and complex service base;
- 3 - Indicators of development of the building complex as a part of specialized construction organizations and building materials industry;
- 4 - Need for labor resources from the production facilities and infrastructure;
- 5 -Resettlement options based on fly-in fly-out (FIFO) method of development of offshore oil and gas fields;
- 6 - Main indicators of economic development of territorial units of study.

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