

Issues of Organization and Implementation of East Siberian Oil and Gas Complex Megaproject

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Abstract – The issues discussed in this paper are: organization and implementation of East Siberian oil and gas complex megaproject, state management tasks in coordination of investment operations conducted by participants of large capital investment projects of development of petroleum province and validation of a possibility and efficiency of application of network models framework of investment programs in accomplishing these tasks.

Index Terms – East Siberian oil and gas complex, network model, scenario, efficiency.

I. URGENCY OF THE ISSUE

The innovative projects aimed at the development of East Siberian and the Republic of Sakha (Yakutia) gas and oil resources play an important role among priorities of the Russian government today. The government actively participates in the reduction of technological, geological, ecological and economic risks of companies – project operators. However the problems of balance provision of companies investment activity in time remain unresolved, while this activity enables to implement a multiplier effect of gas and oil resources development.

The formation of investment megaproject of East Siberian oil and gas complex (ESOGC) is efficient for balanced development of East Siberian and The Republic of Sakha (Yakutia) oil and gas sector. ESOGC megaproject is a unique system-based pipeline of projects of interrelated industries allocated on the vast territories and encompassing several subjects of Russian Federation (Irkutsk oblast, Krasnoyarsk Krai, Sakha-Yakutia, Amursk oblast, Khabarovsk Krai, and Primorsk Krai).

Scenario analysis and preinvestment efficiency evaluation of gas and oil resources development, crude hydrocarbons refining, and flow of oil and gas exports to countries of Asia-Pacific region conducted in a number of

leading research institutes of Russian Federation at a preliminary stage of Eastern Siberia – Pacific Ocean petroleum pipeline construction, determined the industries, which should comprise ESOGC megaproject. Together with oil and gas industries, the megaproject includes oil and gas transportation, petroleum and gas refining and helium industries, petrochemistry and gas chemistry, as well as infrastructure industries, which provide ESOGC functioning and production entry on internal and external markets. ESOGC is not just a large-scale economic Megaproject, but it also has high social and geopolitical importance for Russia.

Analysis of foreign experience shows that for establishment of interaction between state authority and business in such large-scale strategic projects (megaprojects) the coordinating authority is created to form a list of project's participants and interested parties, their goals, investments intentions, involvement level and economic potentials. In the process of co-ordinating of interests the contradictions between participants are revealed and possible ways of their solution are outlined in great details, which are included in the agreements between coordinating authority and megaproject's participants. As a result megaproject's controlling mechanism is formed as the system of contracts with participating companies, in which their activity in megaproject implementation is rigidly regimented.

Russian system of implementation of large cross-industry projects preserved, to a large extent, the organizational scheme of interaction between companies and state, peculiar to the centralized system of management of cross-sectoral programs. Its main disadvantage is a lack of timely concurrence of megaproject's demands for investment resources and real investments of companies and state.

Conventional organization of investment process within a framework of projects with state involvement is characterized by frequent infringements of signed agreements between state and companies, and by instability of budgetary financing. Since investment process begins with the project's budgetary financing, then, as a result, persistent time lags occur due to companies' expectation of financing from state. Besides, instead of legally formalized contracts between companies and state, agreements of intent are being drawn, which have just permissive nature. Wide zone of uncertainty of companies' projects implementation is created as a consequence of 'soft' obligations. As a result management system is not efficient enough and it is weakly oriented at program and target-oriented results of megaproject.

At present in Russia there are precedents of adaptation of foreign experience in creation of megaprojects and their management mechanisms. Examples of such adaptation are Krasnoyarsk Regional Corporation of implementation of territorial project of the Lower Angara region development and Regional Corporation of Federal project "Ural industrial – Ural Polar" implementation. In these projects regional corporations play a role of coordinating authorities. These projects are organized on the basis of state-private partnership. Success and efficiency of the megaproject implementation depends on the quality of project preparation at its initial phase and the level of concurrence of strategic interests of the megaproject's participants. At the same time corporations do not have appropriate mechanism of coordinating interests and quantitative estimates of efficiency of possible agreements during selection of types of business participation in megaproject, as well as estimates of the state risks and formation of priorities of innovation policy. In its turn organization of interaction between business and state authority in such large-scale strategic projects assumes that federal authority has a set of tools for evaluation of multitude of alternative variants of the megaproject implementation, devising of financing schemes consistent with uncertainty

and stochastic nature of expected economic, ecologic and social effects.

II. ORGANIZATION OF EAST SIBERIAN OIL AND GAS COMPLEX MEGAPROJECT FORMATION

In modern conditions large companies-participants of development of East Siberia and The Republic of Sakha (Yakutia) have gas and oil resources has strategic programs of petroleum complex development which include the whole processing chain: from geologic exploration and recovery to hydrocarbon refining and petrochemistry, including transport/export of production to internal and external markets. The obvious example of this is "The program of organization of consistent system of recovery, gas transmission and gas distribution with consideration of possible exporting of gas to the markets of China and other APR countries in East Siberia and Far East (Eastern Gas Program)", which is a strategic document of Russian Energy Strategy for the period up to 2030. OJSC Rosneft also has strategy of ESOGC development as part of general strategy of company development.

The following is required for balanced development of ESOGC:

- coordinated development of oil and gas recovery and transportation systems;
- development of transportation, energy and social infrastructure;
- development of gas refining and helium industry with future creation of the world center of helium refining;
- construction of repositories of helium concentrate, product pipelines, etc.;
- development of petrochemical and gas chemical plants, which would provide a large-scale output with high added value.

Unique features of East Siberian gas and oil enable to develop a heavy-tonnage, hi-tech production of polymer materials in the south of East Siberia. Now Russia stays behind

developed countries in polymer materials usage. This production can be organized in the first place in Irkutsk oblast and Krasnoyarsk Krai where a well-developed infrastructure of petrochemical and gas chemical factories provision exists. At the same time OJSC “Gazprom” considers the alternative variant of allocating these plants in The Republic of Sakha (Yakutia), Amursk oblast and Khabarovsk Krai. OJSC Rosneft, the owner of oil-gas field mining licenses, in its investment strategy prefers creation of petrochemistry in Far East. So the Russian Federation subjects compete with each other for attracting investment projects of petrochemistry and gas chemistry with large multiplier effect for social and economic development of the regions. To make an agreed decision on petrochemical plants allocation with due account for state and regional interests the proper mechanism is required to evaluate the efficiency and complexity of usage of raw materials base at various scenarios of ESOGC development strategy.

The megaproject framework forms on the base of the investment projects of oil and gas companies strategic documents. Formation of investment projects of other industries is influenced by the oil and gas complex companies demand for their services.

We determined the following list of participants of the megaproject implementation:

- federal and regional level state authorities, as well as local authorities;
- large oil and gas companies (OJSC Surgutneftegaz, OJSC NK Rosneft, OJSC Gazprom, TNK-BP, Gazpromneft and others), Transneft, construction, power, transportation and other companies of the current megaproject;
- investment banks and funds, and foreign investors.

The following scenarios of ESOGC development [1, 2] present various strategies of prospecting and preparation of deposits by companies-subsurface users and discovery ratios of exploration and appraisal with variation in volume of extraction, refining and

allocation of petrochemical and gas chemical plants (Table I).

TABLE I SCENARIO OF OIL AND GAS COMPLEX DEVELOPMENT IN EAST SIBERIA AND REPUBLIC OF SAKHA (YAKUTIA)

| Industries | Optimistic | | | | Pessimistic | | | |
|--|------------|------|------|------|-------------|------|------|------|
| | 2010 | 2015 | 2020 | 2025 | 2010 | 2015 | 2020 | 2025 |
| Oil sector | | | | | | | | |
| Oil production, including: | | | | | | | | |
| Irkutsk oblast | 9 | 50 | 70 | 80 | 9 | 23 | 35 | 50 |
| Krasnoyarsk Krai | 3 | 22 | 30 | 35 | 3 | 6 | 10 | 17 |
| Republic of Sakha (Yakutia) | 5 | 18 | 25 | 25 | 5 | 10 | 15 | 20 |
| Oil export | 1 | 10 | 15 | 20 | 1 | 7 | 10 | 13 |
| Gas sector | | | | | | | | |
| Natural gas extraction, billion m ³ | 5 | 40 | 50 | 50 | 5 | 15 | 10 | 30 |
| Gas export, billion m ³ | | | | | | | | |
| Helium extraction, million m ³ | | | | | | | | |
| Helium injection in underground gas storage (UGSF), million m ³ | 9 | 60 | 70 | 70 | 9 | 35 | 40 | 40 |
| Helium export, million m ³ | | 35 | 35 | 35 | 0 | 30 | 25 | 25 |
| Processing | | 180 | 212 | 212 | | 108 | 150 | 150 |
| Volume of crude oil refining, million tons | | | | | | | | |
| Volume of gas refining, billion m ³ | | 170 | 198 | 198 | | 90 | 138 | 138 |
| Ethelene production, million tons | 9 | 12 | 12 | | 9 | 10 | 10 | |
| Production of propane/butane mix, million tons | 10 | 30 | 30 | 2 | 5 | 13 | 13 | |
| | 25 | 35 | 35 | | 5 | 15 | 15 | |
| | 1.1 | 2 | 3.4 | | 1.25 | 2.5 | 2.5 | |
| | 1.0 | 1.6 | 2.3 | | 1.25 | 2.5 | 2.5 | |

The tasks of the state coordination of ESOGC megaproject investment projects implementation are:

- to determine the dimension of agreement of projects life-times, commission of facilities of production and refining complexes and analysis of time reserves for development of consensual companies' decision on changes in their investment intentions in the megaproject implementation;

➤ to identify the issues requiring state involvement for provision of balanced companies' investment plans and to estimate required additional resources for increase of intensity and acceleration of projects launch time;

➤ to develop the economic and institutional conditions – offers for business to reduce their economic risks.

III. MODEL COMPLEX OF DEVELOPMENT AND COORDINATION OF THE MEGAPROJECT PARTICIPANTS

The model complex consists of investment program's network model and simulation model of estimation of the program variants efficiency in different modes of state regulation. [3].

The network model is formed as a tool for state authorities coordination of investment operations conducted by various program participants. The network model of investment program for hydrocarbon resources development of East Siberian petroleum province is an array of net graphs of projects implementation which are executed in conditions when resources are limited for a specific time period, including companies' investments. Acceptable schedule of projects implementation with minimal duration of the mega-project's program implementation is determined. Besides, additional criteria, such as minimization of resources demand deviation from dynamics of limited resources per individual companies, can be used in search for acceptable schedules.

Simulation model of the program efficiency estimation is intended for defining the priority directions of state-private partnership, the selection of state regulation tools, which provide the conditions for investment appeal of innovative technologies. The model is based on the system of efficiency calculation of array of investment projects at different variants of tax and price regulation. Estimation of money flows occurring during the program implementation and comparison of different variants is conducted according to net present value (NPV), internal rate of return (IRR), and return on investments time (T).

The following are the accepted criteria of the program efficiency evaluation:

1. Maximization of integral profit of all project's participants;
2. Minimization of investment risks of pipeline industry projects;
3. Maximization of integral state profit from infrastructure projects implementation per unit of invested capital;
4. Maximization of state profit from program implementation when NPV norm of particular projects is acceptable for companies.

Program's network model reflects the following features of petroleum province development, as well as institutional conditions of oil and gas complex formation:

1. Stochastic nature of geological prospecting work efficiency is shown as stochastic graph (module) of geological prospecting work. Innovative technologies are presented as alternative technologies with a certain probability of their implementation.
2. Multiple use of hydrocarbons assumes synchronism of implementation in time and equilibrium of investment projects in recovery, refining and transportation.
3. To show the influence of oil and gas complex on social and economic development of Siberia and Far East regions, geography of investment program is presented. It includes three regions, subjects of Russian Federation: Irkutsk oblast, Krasnoyarsk Krai and Sakha - Yakutia, where besides production plants, refining plants are located, as well as aggregated region – “Far East” (Amur oblast, Khabarovsk Krai and Primorsk Krai) – the zone of allocation of large petro- and gas chemical complexis and “East Siberia – Pacific Ocean” mainland pipelines.
4. It is assumed for simplicity at this stage that within boundaries of one subject of Russian Federation there is one company-subsurface user with a license to explore and to develop a deposit

The network model of investment program of hydrocarbon resource development in East-

Siberian petroleum province has block-modular structure. Five investment blocks are marked in each regional province. In its turn investment block is represented by unified modules of technological sequence of operations in implementation of the following projects:

- 1) region-wide geologic exploration (GE);
- 2) geologic exploration in companies – subsurface users;
- 3) infrastructure development and development of a group of oil and gas fields;
- 4) construction of oil and gas pipeline;
- 5) creation of facilities for oil refining, gas refining and helium complexes.

Node events are determined in unified modules. Interrelations between network model blocks are shown by relations of precedence or synchronism of node events of individual modules. This provides technological and time coordination of commissioning of hydrocarbon production facilities, refining and transportation.

Each work of network graph reflects an array of technologies of its implementation. Technology is characterized by vector whose components are: work duration, volume of work done per time unit, resource costs, and production rate, which are represented by functions depended on work completion time.

Main pipeline creation and operation graph with scheduled dates of putting facilities into operation is a core of network model. The network graph enables to coordinate preparation time of raw material base of hydrocarbon development with commencement of oil and gas fields and pipeline capacities.

There are 370 works, describing investment processes in companies and regions, and 90 fictitious works, describing cross-sectoral linkages between them, included in deterministic network model of ESOGC megaproject's investment program of oil and gas resources development.

Investments of companies–subsurface users are resource limitations of projects' implementation in the program's network model.

Critical path analysis of the program implementation reveals an array of projects, restraining its implementation in a specified time period (so-called bottle necks); time reserves of industry projects' implementation, influence of innovative technologies on terms and demands in investments, labor supplies, and other material resources of East Siberian oil and gas complex. This enables to formulate a direction for coordination of investment operations of companies participating in the program, to determine how imbalance of economic interests of the project's participants influences the efficiency and project's life time and to determine nodal points of development of contracts and agreements with companies and regions within a framework of state-private partnership.

IV. ESTIMATION OF FEASIBILITY OF ESOGC MEGAPROJECT'S SCENARIOS

We conducted series of model calculations for various scenarios of ESOGC development and export deliveries of oil and gas using the network model of the Program for a period up to 2025 (Table I).

The optimistic scenario of oil and gas complex development considers high levels of development and refinement of hydrocarbon resources and corresponding volumes of export to APR countries. This scenario is based on the hypothesis of implementation of the most favorable factors of ESOGC formation: high sustainability of expected oil and gas reserves, time consistency of investment strategies of producer, refining companies and OJSC Transneft, state participation in a decrease of companies-project operators investment risks by creating preferential tax regime for activation of investment activities. By 2025 the growth of crude oil production is expected to reach 80 million tons, gas production – up to 70 billion m³. In order to decrease the Program's payback period about 70% of crude oil and half the volume of produced gas are exported to APR countries. The rest of hydrocarbon

materials will be refined in ESOGC itself at large oil and gas complexes such as Boguchnaski, Sayanski, South Yakutski, and in Primorsk Krai. This will enable to satisfy the domestic demand for petroleum products in East Siberia and Far East. Capacity gain of oil refining is anticipated to reach 12 million tones. Also it is anticipated that operating capacities of Angarsk petrochemical complex and Achinsk oil refining plant will be fully loaded. Gas chemical complexes production entry to internal and external markets is anticipated as well.

Investment program of ESOGC oil resources development will require \$101.7 billion. 13% of this sum will be invested in oil and gas refining, 18% in pipeline construction, 68% in oil and gas development and geologic exploration (38% in Irkutsk oblast, 29% in Krasnoyarsk Krai, 21% in Republic of Sakha (Yakutia)). As a result of ESOGC program's implementation, anew added value equaling \$478 billion will be created during anticipated period. More than 80% of this added value will be comprised of gross regional products of Russian Federation subjects in Siberia and Far East: 34% in Republic of Sakha (Yakutia), 28% Irkutsk oblast and 19% in Krasnoyarsk Krai. The life time of the megaproject's investment program for development of forecast resources of ESOGC equals to 15 years.

The influence of different variants of geologic exploration results on the income of program participants and regions has been researched as well as the efficiency and ESOGC program's life time. The research revealed that region-wide geologic exploration works in Irkutsk oblast, financed from federal budget, and resource preparations conducted by oil companies – subsurface users of Republic of Sakha (Yakutia) are on a critical path. The projects of region-wide geologic exploration limit rate and scale of oil resource development. They should be managed by the state.

With favorable success ratio of geologic exploration in ESOGC the producer companies could increase their capacities in oil extraction up to 80 million tons per year. And by 2020 they should be able to provide maximum

pipeline throughput in accordance with the scheduled dates of raw materials export supply. The pessimistic scenario of production and export of hydrocarbons (Table I) was created as a result of expansion in time of investment program of oil and gas complex development in the network model at:

- ✓ extrapolation of actual rates, volumes and efficiency of geologic exploration in the first five-year period¹;

- ✓ preservation of low level coordination in time of investment decisions of state authorities and producer companies responsible for mineral raw material base organization, implementation of projects aimed at creation of regional and field production and transport infrastructure (modern business risks of ESOGC formation).

According to our calculations this temporal and resource limitations prolong the ESOGC investment program to 5 years (the length of the program's critical path increased by 5 years due to the increase of pioneer stage of Irkutsk oblast and Republic of Sakha (Yakutia) fields development). The terms of the beginning and the end of investment projects aimed at oilfield construction were moved to later ones. In Ewenkiya the field production can start only in 2025. As a result the stage of intensive development of oil industry is moved from 2010 to 2015 in ESOGC, and expected volume of oil production in ESOGC during a period up to 2025 will be three times lower than anticipated in the Energy Strategy of Russia. In such conditions oil production will reach 32 million tons in 2025.

ESOGC oil export capabilities will drop 4 times comparing with optimistic scenario under the conditions of priority assignment to raw material provision of refining industry of Eastern regions of Russian Federation. In such situation, in order to fully load ESOGC oil pipeline capacity it is planned to keep the level of transit oil flows from Western Siberia at 30 million tons, and maximum possible load of ESOGC pipeline at 55 million tons.

In pessimistic scenario integral investments will decrease in 1.8 times, to \$62 billion,

¹ About 30% of forecasted resources pass into the reserves category at present.

correspondingly the integral economic effect of the Program will decrease, according to our calculations, to \$106.4 billion. The main effect (\$75 billion) is formed as GRP, mainly in Republic of Sakha (Yakutia) and Irkutsk oblast, \$31.4 billion – integral export taxes.

Suggested approach enabled to estimate influence of companies' investment strategies and geological risks on the megaprojects efficiency and scale of petro chemistry and gas chemistry development.

Formation of East Siberian oil and gas complex will give an impulse to the development of East Siberian economy, its integration with Far East and developing Asian-Pacific region. If the favorable factors of ESOGC development take place the increase of East Siberia and Republic of Sakha (Yakutia) GRP is estimated to be \$227 billion in 2010-2025. An array of investment oil and gas projects, suggested by companies is not supported by ESOGC raw material base. As a result higher-priority regions for allocation of petrochemical and gas chemical production are raw material oil and gas regions (Republic of Sakha (Yakutia)) and East Siberian regions with well-developed petrochemical and gas chemical infrastructure (south of Irkutsk oblast, central part of Krasnoyarsk Krai, and Lower Angara region), enabling to provide domestic demand for motor fuel and polymer products of Siberia and Far East. Far Eastern investment projects require supplementary assessment with due consideration of APR markets demand. The network models mechanism enables to determine time reserves for coordination of companies investment intentions and estimate required federal and regional additional resources to increase the intensity and efficiency of geologic exploration for resource base provision of the megaproject's refinement complex. To increase the ESOGC investment Program's efficiency the government of Russian Federation have to focus its attention on the creation of economic stimulus, tax holidays and investment risks neutralization for companies, which attract innovative technologies in prospecting works and geologic exploration.

The suggested methodology can be used as a basis for development of long-term investment Program of large-scale megaprojects of hydrocarbon resources development and used by the state joint committees of the Russian Federation government, the Ministry of Industry and Energy, the Ministry of Regional Development of Russian Federation and Federal Districts as business mechanism for coordination of investment projects-participants of the Program.

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VI. BIOGRAPHIES



Nina I. Plyaskina, DSc, has been awarded her doctoral degree by the Higher Attestation Board of the Ministry of Education and Science, Russian Federation. She also holds a PhD in Economics and Management from the

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