Accelerating the development of the hydrocarbon resource base in Eastern Siberia and the Republic of Sakha (Yakutia)

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The need to accelerate Russia’s industrial growth, strengthen its strategic position in Asia-Pacific energy markets, and improve the level of people’s wellbeing in the eastern regions of the country are the factors determining intensive prospecting and development of oil and gas resources in Eastern Siberia and the Republic of Sakha (Yakutia). Top priority exploration initiatives are now being carried out according to ‘The Programme of Geological Study and Licensing Deposits of Hydrocarbon Raw Material of Eastern Siberia and Yakutia’, approved by an order of the Ministry of Natural Resources in 2005. The main developer of the programme is the Siberian Scientific Research Institute of Geology, Geophysics and Mineral Raw Material (SNIIGGiMS).

The programme aimed at resource provision for Eastern Siberia includes planning of the optimal Pacific Ocean crude oil pipeline system and establishing a rational sequence for geological exploration and subsurface licensing on the territory of Eastern Siberia and the Republic of Sakha (Yakutia). The main tasks of the programme are:

- Substantiation and development of oil and gas production in Eastern Siberia and the Republic of Sakha (Yakutia) as defined in Russia’s energy strategy of the RF and according to the planned level of loading of the East Siberia-Pacific Ocean (ESPO) pipeline system.
- Establishment of new oil and gas production centres.
- Assessing the impact of geological exploration and subsoil licensing on the territory of Eastern Siberia and Yakutia until 2020.

Oil and gas prospects

The 2005 programme concentrated priorities on the licensing and development of the southern part of the Siberian platform, to the south of latitude 64 North (southern Krasnoyarsk region, the Irkutsk area, and the southwestern part of the Yakutia. Among the over 60 discovered oil and gas deposits in the southern part of the Siberian platform, 16 have extractable reserves that exceed 100 million tons, and three have potential hydrocarbons amounting to 1 billion tons. The main prospects are connected with the Vendian-Rifeyskii complex (geological age 0.6–1.0 billion years). Siberian platform oil is high quality and suitable for processing at operating oil refineries. The non-sulfurous natural gas contains mainly ethane (3.4–6.1%), propane (1.1–1.7%), and butane 0.4–1.1%). The gas also contains commercial concentrations of helium, a value-added raw material.

In 2008 the draft of a new version of the programme was prepared taking into account of information gathered during 2005–2007. The latest version also covers northern territories of the Siberian platform. Geological exploration during the last three years has revealed new prospective sedimentary basins and zones of oil and gas accumulation. Their accelerated study should provide an increase in oil reserves potentially able to supply the ESPO pipeline. In addition to the Siberian platform, there are also deposits in the Bolshevetsikaya zone (Vankor, Lodochnoye, Tagulsky, and Suzunsky).

According to a January 1 2008 estimate, extractable category C1 and C2 oil reserves in Eastern Siberia and Yakutia total 1.991 billion tons – including 1.2707 billion tons in the Siberian platform, 0.7203 billion tons in the Bolshevetsikaya zone. Regional estimates (Figure 1) are:

- 1.4266 billion tons in the Krasnoyarsk region, including 0.7063 billion tons from the Siberian platform.
- 237.7 million tons in the Irkutsk area.
- 326.7 million tons in Yakutia.

Cumulative extractable C1 oil reserves are estimated at 837 million tons (including 558.9 million tons in the Siberian platform), C2 at 1.154 billion tons. Estimation of oil resources is many times greater than calculated reserves – the total of extractable oil resources of C3 and D1 totals 5.3696 billion tons (including 4.9032 billion tons in the Siberian platform, 0.4664 Billion tons in the Bolshevetsikaya zone, 2.9008 billion tons in the Krasnoyarsk region, 2.0228 billion in the Irkutsk area, and 446 million in Yakutia.

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The main hydrocarbon reserves, and a significant part of oil resources, are concentrated in regions of priority development adjoining large explored deposits such as Kuyumbinskoye, Yurubcheno-Tokhomskoye, Verkhnechonsky, Talakansky, and Vankorsky. The hope is that these deposits will form the basis for development of the oil and gas potential of Eastern Siberia and the Yakutia.

The cumulative extractable C1 and C2 oil reserves in these fields are estimated at 1489.6 million tons. This and the deposits adjoining them extend via a chain that allows for the creation of a uniform transport corridor which will minimize development expenses. The location of the explored deposits, their characteristics, and degree of preparation should allow the establishment of the promising oil production at Talakan-Verkhnechonsk, Yurubchen-Kuyumba, Sobinsk-Teterinsk, Botuobinsk, and Vankor (see Chart 1).

The volume of natural gas C1 and C2 reserves in Eastern Siberia and Yakutia amounts to 7963.5 billion m³, including 7608.4 billion m³ in the Siberian platform and 355.1 billion m³ in the Bolshehetskaya zone. Figure 2 illustrates the totals for the regions:

- 1839.2 billion m³ in the Krasnoyarsk region (including 1484.1 billion m³ in the Siberian platform).
- 3643.3 billion m³ in the Irkutsk area.
- 2481.0 billion m³ in the Republic of Sakha (Yakutia).

Category C3 and D1 gas resources total almost 16.5 trillion m³, including:

- 8.8 trillion m³ in the Krasnoyarsk region.
- 4.7 trillion m³ in the Irkutsk area.
- 3.0 trillion m³ in the Yakutia.

It is possible to develop three prospective centres for Eastern Siberia and Yakutia gas production – Krasnoyarsk, Irkutsk,
and Yakutia. The largest deposits are Kovyktinskoye, Chayandinskoye, and Angaro-Lenskoye, with C1 and C2 reserves totalling 1.9785, 1.2409, and 1.2216 trillion m³ respectively.

**Oil and gas production forecast**

According to the SNIIGGIMS forecast, based upon technical plans for the development of deposits, reports on estimated oil reserves, commitments by subsurface operators, and expert evaluations of large explored deposit development, the south of the Siberian platform (Kuyumbinskoye, Yurubcheno-Tokhomskoye, Verkhnechonskoye, and Talakanskoye) will by 2015 provide annual oil production of 22 million tons. That should increase to 32 million tons by 2020. Including extraction from smaller deposits, those figures would increase to 32 million and 42 million tons respectively. To maintain further expansion of annual production, development of additional territory will be necessary. Calculations have shown that, if the programme provisions are fulfilled, an increase can be expected in the annual volume of oil production from the south of the Siberian platform to 56 million tons by 2020 and up to 80 million by 2025 (Figure 3).

With regard to oil production from the Vankor centre, annual deliveries to the ESPO pipeline system could total about 30 million tons by 2011, 62 million by 2015, and 80 million by 2020. Development of Vankor oil production will reduce the economic risks associated with ESPO construction, increase the reliability of the pipeline’s resource base, and provide initial delivery capacity.

Construction of ESPO encompasses two major stages. The Taishet-Skvororodino first stage with an annual transit capacity of 30 million tons of oil should become operational in December 2009. However, oil deliveries to the pipeline already began in 2008. Commissioning of the Taishet-Talakan section started in October, initiating throughput from Talakanskoye. Until the opening of the entire first stage of the pipeline, oil will move in reverse mode westwards. Upon completion of the first stage, the transport will be eastward via both pipeline and rail. By that time, plans call for the completion of feeder pipelines from deposits in the Talakansko-Verkhnechonskoye and Yurubchens-Tokhomskoye oil and gas zones, as well as the

![Graph](image-url)  
**Figure 2** Gas reserves and resources (billion m³) in Eastern Siberia and Yakutia regions as of 1 January 2008. Bolshayaetskaya zone is included in the Krasnoyarsk region resource base.

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**Figure 3** Predicted dynamics of oil production in Eastern Siberia and the Yakutia regions.
Vankor-Purpe oil pipeline. Construction of ESPO’s second stage, Skvorodino-Kozmino, assumes transit to the Russian Pacific coast, construction of a spur line to China from Skvorodino, and increase in the overall throughput capacity to 80 million tons a year.

The interdepartmental working group at the Ministry of Energy has developed and approved a programme for the creation in Eastern Siberia and in the Far East of a uniform system of production and transportation of gas for possible export to markets in China and the Asian-Pacific Region. The Russian government appointed Gazprom as coordinator for this project. Following the Vostok-50 option recommended by the programme, annual extraction of natural gas in Eastern Siberia and the Yakutia will total 7.5 billion m³ by 2010. Further production development in the region will depend upon whether the created gas network can connect to the Uniform Gas Supply System (UGSS). If the option emerges without UGSS connection, the maximum annual extraction of gas will total 44–46 billion m³. If there is connection to UGSS, predictions put the annual level at 86–88 billion m³. The production parameters should emerge by 2020 with further support thereafter at constant levels (Figure 4).

To achieve the planned volumes of oil and gas production, the programme provides intensive measures to encourage E&P activity:

- Acceleration of subsoil licensing in Eastern Siberia and the Republic of Sakha (Yakutia),
- Steady increase of volumes of geological exploration works financed by federal budget in unlicensed blocks to increase their appeal for subsequent licensing,
- Increasing seismic exploration and appraisal drilling in blocks held by existing operators to stimulate commercial oil and gas resource development.

**Oil and gas reserves outlook**

Within the framework of the Program, SNIIGGI MS carried out a forecast of the likely gain in oil and gas reserves through 2030. In 2005–2007, the actual gain of C1 oil in Eastern Siberia and Yakutia totalled 110 million tons (Figure 5).

According to the forecast, the general gain in extractable commercial category oil reserves in priority licensing areas will amount to almost 1.6265 billion tons in 2008–2020. In the territories north of the primary licensing area, the general gain of oil reserves will reach 1.0647 billion by 2030. Therefore, the overall expected gain in extractable C1 oil reserves on the southern and perspective northern territories of the Siberian platform will comprise 2.6916 billion tons by 2030.

By 2030, according to the programme, Gazprom will need an increase in natural gas reserves of nearly 4.85 trillion m³ to maintain the recommended development variant, including:

- 2550 billion m³ in the Krasnoyarsk region.
- 1500 billion m³ in the Irkutsk area.
- 800 billion m³ in Yakutia.

The SNIIGGI MS puts the gain in C1 reserves at more than 7 trillion m³ by 2030 – including almost 2.5 trillion m³ in the Krasnoyarsk region, over 2.9 trillion m³ in the Irkutsk area, and more than 1.8 trillion m³ in Yakutia.

**Licensing programme and its monitoring**

For the planned preparation of oil and gas resource base in Eastern Siberia and the Republic of Sakha (Yakutia) and realization of practical steps for distribution of exploration blocks according to the program, prospective licensing is to be based on the following principals:

- Top priority to be given to development next to prospective oil production centres and routes of oil and gas pipelines.
- Allocation of quite large blocks of up to 4000 km² for poor studied territories containing economically profitable oil and gas resources to attract serious investment by big companies.
- Determination of a licensing priority schedule in the near future.
- Forecast of volumes from geological exploration on perspective blocks to be included in licensing agreements.

**Figure 4** Forecast of gas production according to the Vostok-50 variant (including UGSS).

**Figure 5** Estimated gain of C1 extractable oil reserves, according to the programme.
Borders and optimal sizes suggested for auctions or tenders of prospective blocks have been defined and are annually corrected by regional agencies and SNIIGGiMS. The borders are decided with the aim of optimizing the effectiveness of geological exploration and expanding production of the hydrocarbon resource base in the coming years, taking into account the probable pipeline routes.

According to the programme, the licensing agencies are to allocate more than 200 prospective licensing blocks. The commercially accessible resource base comprises the initial development plans (Figure 6). On each block, the Institute has defined the following basic parameters – area; basic productive horizons; distance to operating/projected oil and gas pipelines; dimensions of the geological-geophysical investigation levels, including density based upon the current network of seismic profiles; the number of deep wells, drilled on a block; deposits and structures with C3 resources; and the volume of extractable reserves and resources of oil and gas, according to all categories.

SNIIGGiMS has estimated the resource and commercial potential of blocks for determination of licence sequencing. Also, the Institute has suggested distributing the most promising and already prepared blocks for licensing within the next two years. The blocks offered for licensing later, as a rule, have little completed seismic study or deep drilling and have no disclosed reserves or regional prospective resources estimate. The assumption is that, to increase their investment appeal, complex geological exploration finance should come from the state budget.

As of 1 January 2009, 143 blocks had been distributed (Figure 7) plus blocks distributed prior to the start of the programme and those distributed within the framework of the programme. The forecast for 2009 and subsequent years called for the licensing of 139 blocks, including those transferred from licensing lists of previous years. Three blocks are considered of federal strategic value (Tas-Yuryakhsky, Verkhnevilyuchansky, and Srednetyumskiy).

**Geological exploration and its monitoring**

A significant amount of exploration work is necessary to develop the oil and gas production base. This requires investment by exploration companies and funds from the state budget. The programme provides a geological exploration plan up to 2020.
Most of the perspective licence blocks of Eastern Siberia and Yakutia have had little study or exploratory drilling, combined with no current revealed reserves or indications of likely oil and gas resources. As such, investment appeal is low. To offset this, the suggestion is to have the state budget finance a cycle of geological exploration. The plan calls for conducting all systems of regional seismic exploration profiles with support from separate parametrical wells mainly on undistributed blocks. If necessary, provisions exist to estimate seismic and drilling results at specific locations. This should speed up the predicted production needed for ESPO by promoting hydrocarbons resources to C1 and C2 reserve categories.

The anticipated regional geological exploration will be dictated by: the presence of already explored or large accumulations of hydrocarbons, as potential centres for future extraction; prospects for new discoveries which can expanding the resource base for future centres; concentration on locations along possible pipeline routes; and favourable physical, geographical, and economic conditions for the formation of an industrial-social infrastructure at or near future centres of oil and gas production.

In 2005-2007, exploration projects to realize the programme objectives received R30.2 billion in investment. Funds from the federal budget totaled R7.7 billion, while operators provided R22.5 billion. In January-September 2008 investments in exploration received R16.1 billion (federal budget – R3.3 billion, operators – R12.8 billion). These projects identified localized hypothetical oil and gas D1L category resources, opened new hydrocarbon deposits, and increased commercial reserves.

A required action in the geological studying of the Eastern Siberia and Yakutia subsurface is parametrical drilling. The current plan is for the three years 2007-2009. Expectations are that similar three-year programmes will continue until reaching an annual production rate of up to 60-80 million tons.
The aim of the parametrical drilling programme is to establish an increased rate of oil resources to sustain ESPO. Current drilling includes seven parametrical wells two of which, Argishskaya and Chaikinskaya, have revealed direct indications of oil and gas.

The estimate of total geological exploration expenditure from all sources of financing in 2008–2020 is R547.4 billion (Figure 8). From these funds, the state budget on exploration including regional geophysical work, parametrical drilling, prospecting and estimation of new projects, as well as research and development, will contribute a total of nearly R110.1 billion. Block holders will bear the main exploration costs (80% of all expenses).

Results of the programme
Programme results in 2005–2007 indicate a considerable increase in geological exploration for oil and gas in Eastern Siberia and Yakutia and an increase in the licensing process essential to sustain the ESPO pipeline system.

For the last two years, intensive geological study of the Siberian platform, financed by the state budget, has revealed new promising areas located near the zone covered by the ESPO route. Expanding geological exploration at these locations, including parametrical drilling for exploration and estimation, as well as the subsequent development of resource potential, will allow the state to sustain planned targets for oil reserves increase and volumes for ESPO transport. Given that ESPO has a planned capacity of 80 million tons a year, combined with the distribution over the next several years of all exploration blocks covered by the programme, will result in prioritizing geological studying and exploration licensing.

So far the economic benefits have been favourable to the state. Regional projects have promoted more effective subsequent exploration, a decrease in geological risks, an increase in the investment appeal of blocks, and an improvement in realizing licensing fees from competitive bidding. Having committed funds for exploration, the budget can return them during licensing, while in the future receiving significant income from the gain in tax revenues. During 2005–2008, the state budget provided R11 billion for exploration financing and received in return R30.8 billion in licensing payments, a more than 280% return to the budget. In the future, the profit to the state should increase even further, because of tax receipts and licence holder payments from the preparation of reserves and extraction of oil and gas in the region.

Permanently functioning of the monitoring programme
The programme’s success depends upon non-stop monitoring and control by the Ministry of Natural Resources and Ecology (MNRE), the Federal Agency on Subsoil Use (Rosnedra), and the supervising institution SNIIGGIMS.

At present SNIIGGIMS fulfils the scientific supervision of the program. For this purpose, a permanently functioning computer system to monitor the programme has been created using a GIS database for spatial geological, economic, and technical data.

The next steps to developing the resources of Eastern Siberia and Yakutia will require a new document coordinating all the stages of complex development of hydrocarbon resources for the territory, including geological exploration, oil and gas production, its transportation and selling, and also efforts of all the interested participants of the process (the state, licence holders, research institutions, financial structures, etc.).

Correction: December 2008

In First Break Volume 26, December 2008, in an article entitled ‘Making the case for ocean bottom seismic data’ by Chris Walker (RXT), we regret that the source of Figure 16 was not acknowledged as Figure 8 of an article published in The Leading Edge (November 2000) by Kenneth Duffaut, Trine Alsos, Martin Landro, Hege Rognø and Nazih F Al-Najjar of Statoil, now StatoilHydro, entitled ‘Shear-wave elastic impedance’. Mr Walker writes: ‘Figure 16 should indeed have been captioned to indicate the origin of the figure and I can only apologize for this error. By way of explanation the image was provided to me by a consultant several years ago, who did not indicate that it had been extracted from the November 2000 Leading Edge article by Duffaut et al. (the publication of which, it should be noted, pre-dates the existence of RXT by several years). As it is such a striking example of the benefits of combining pressure and shear information I simply used the image to demonstrate a further benefit of acquiring marine 4C data’.

As a point of clarification we also note that the introduction to the article, not written by Mr Walker, may have inadvertently implied that all the figures were an illustration of operations carried out by RXT. In fact Figures 13, 14, 16 and 18 do not derive from RXT acquisition and we apologise for any misleading impression that may have arisen.

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