Development and substantiation of the scenarios of the development of Euro-Asia and Global energy markets in XXI century, including the dynamics of production, consumption, trade, oil and gas delivery directions and amounts, requires the analysis of their initial (with cumulative production) and current reserves, initial potential and undiscovered conventional resources (perspective and possible), with analysis of their structure, that is to say the distribution of the fields and pools by their subsidence depth, phase conditions, production possibilities etc. Reliable evaluation of the non-conventional hydrocarbon resources becomes more and more important. These are mainly the oil and gas accumulations in low permeable reservoirs and coal-bearing basins (open type), and coal-gas-bearing deposits of oil-bearing basins (closed types). In general, the spatial-genetic associations coal-gas and bitumen shale-oil have deep and wide ontogenetic sense.

On the Russian territory and in the water area of the Arctic and Far East epicontinental seas there are 35 deposit basins and mega-basins of different types and ages. The thickness of un-metamorphically altered sediments of Riphean-Vendian, Paleozoic (on ancient platforms), Mesozoic and Cenozoic age (on younger plates and in alpine regions) ranges from 1-2km to 15-18km and more. The oil-gas-bearing/gas-oil-bearing provinces and zones with defined and supposed (prognostic) interior resources are confined to the above basins. Among them the West-Siberian (onshore and Kara Sea offshore) and Lena-Tungussky mega-basins are distinguished.

Up to present the study of major deposit basins on Russian onshore including Western Siberian basin has reached a “mature” stage. There are still some undiscovered pools and fields with relatively little hydrocarbon reserves within the depth range up to 3,5 km developed by drilling. Most basic hydrocarbon deposits, which traditionally were defining the oil and gas production rate in Russia have reached the decline stage. To the full extent it refers to Western Siberian gas giants, which are still providing 90% of domestic production. This fact determines the need for extending the search in new land and sea areas, exploration activating, substantiating of new promising areas and complexes, which would make possible to maintain the high production rate in long future prospect.

Western Siberian oil-gas-bearing mega-basin (WSMB) covers the Western Siberian Lowland and adjacent Kara Sea offshore up to the Northern Siberian tectonic threshold. Its total acreage exceeds 3 million km².

The study of geological structure and oil and gas potential of WSMB search and exploration of hydrocarbon accumulations in the limits of Jura-Cretaceous sediments has had a long history of more than 60 years (1948-2008). During this period 790 hydrocarbon fields including 240 oil-bearing fields, i.e. with separate free gas pools, were discovered in promising areas. Major fields with reference to the initial reserves (with account for production and preliminary evaluated reserves) are as follows (in tcm): Bolshoye Urengouskoye (12,6), Yamburgskoye (7,4), Bovanenkovskoye (4,9), Zapolyarnoe (3,7), Medvezhye (2,3). Total initial gas reserves of WSMB are 59,6 trillion m³, 90% of which are concentrated in interior deposits of Nadym-Pur-Tazovsky region, Yamal and Gydan peninsulas, Gulf of Ob and Tazovsky gulf and external offshore.

In the limits of the sediment cover three geotectonic lithological mega-complexes are marked out below the Upper Cretaceous-Cenozoic clay-siliceous seal (400-1400m).

Low Cretaceous-Cenomanian sediments form the Cretaceous permeable mega-complex, subdivided into two lithologic stratigraphic levels: Valanginian-Aptian sand-clay and Albion-Cenomanian, mostly sandy. Mega-complex total thickness is 800-2000m. In most regions the medium part of the section (Hauterivian-Aptian) is formed by typical coal-bearing rock mass with great number of coal beds (each from 0,1 to 10m and more). From Middle Ob region to Nadym-Tazovsky interfluve the rock porosity decreases from Valanginian to Cenomanian and from the South-West to the North-East, while sand and coal content increases. The maximal coal content is observed in the Arctic part of the mega-basin (Yamal, Gydan).
**Upper Jurassic** (Callovian-Oxford) permeable complex occurs in the Eastern part of the plate, its thickness increases from 10 to 300m from the West to the East. The regional seal of the said complex is formed by clay and clay-siliceous rocks of Upper Jurassic, Berriasian, Valanginian, and on the West of the region – of the whole Neocomian of total thickness from 150 to 500m. In the seal section the permeable horizons were revealed in the Bazhenov formation and in Berriasian-Achimovskiy series.

On the most part of the WSMB onshore the **Low-Middle Jurassic** lithological-stratigraphic complex is formed by terrigen rocks interbedded with coals, coaly and bitumenol (lacustrine) shales. In the limits of the Nadym-Pur-Tazovsky region the complex is represented by poly-facial series mainly of continental, lagoon-continental and deltaic genesis with separate stratum of marine clays and clay mudrock in the North-Eastern zones. Complex thickness varies from 200 to 1500-2000m. Farther to the North almost all Jurassic formation is built with marine series.

Pre-Jurassic rock mass makes up the lower (below the cover) mega-complex, but has not been studied practically. Its geologic nature and oil and gas potential are not clear.

Initial discovered HC reserves in place (with cumulative production) are 154 billion t of petroleum equivalent, among them natural gas reserves (free and oil dissolved) are 68 tcm. Spatial segregation of oil and gas is clearly distinguished on the regional diagram of WSMB.

Among 84 large (more than 100 bcm) gas-containing deposits (with free gas pools) discovered on Russian off-shore and onshore during all exploration period 56 fields are localized within WSMB interior. Beyond question the Urengovskoye field is a leader. On the whole the following deposits were discovered in WSMB: 4 unique fields with reserves of more than 3 trillion m³ each (all onshore), 7 supergiant fields – from 1 to 3 tcm (5 fields onshore, 2 fields offshore Yamal: Leningradskoye and Rosanovskoye which have not been explored completely yet), 20 giant fields (4 of them offshore) and 26 large fields onshore. Initial discovered oil reserves are distributed rather evenly between the various deposit fields – from Samotlor field (more than 7 billion t) to small fields, containing only one pool (0.1 t and less). On the contrary the gas reserves are distributed unevenly, very high gas concentration is observed in few giant and unique fields.

Gas-bearing fields were discovered on all West Siberian territory, though in its central part and southern regions the fields are small-scale and mostly of oil-gas-condensate type. In Middle Ob region only 5 large-scale gas fields (more than 100 billion m³ each, all of them less than 300 bcm were discovered).

Gas fields are concentrated mostly in the northern regions of Siberia - Nenets Autonomous Area. Taking into account that world conventional free gas resources are estimated as 500-600 tcm, about 20% are deposited in this region. Here more than 60% of the region gas resources are concentrated in five unique deposits (more than 3 tcm each). That high concentration of gas reserves and resources enables us to assume the existence of a distinctive Western Siberian pole of gas accumulation (in terrigen and sand-clay rock mass).

There is only one gas accumulation pole known with comparable reserves and resources – the Persian gas pole, but there the gas-bearing complexes are formed by carbonate series.

The study of the WSMB stratigraphic range shows the potential of practically all permeable sediment section from the basement to Lower Cretaceous and Cenomanian. Major pools are located in Cretaceous series, which have been studied more accurately. The Jurassic series are less studied, Triassic series and carbonate-terrigen Paleozoic folded basement are not studied yet. On the grounds of the few data available we could expect relatively high gas potential.

To a certain degree we can nominally distinguish three regional gas-bearing centres in Western Siberian pole area: Urengoiisky, Yamal-Karsky and Gydansky (together with Bolshekhetskaya trough and Ust-Yeniseisky region) (figure 1).

In **Urengoiisky gas accumulation centre** the major gas giants of Western Siberia are concentrated, the gas reserves are revealed mainly in Cenomanian series. On account of these fields (Urengoiisky, Yamburgskoye, Zapolyarnoye, Medvezhye and others) we were able to maintain high production rate up to 650-665 billion m³ for the last years. Urengoiisky centre interior is studied up to 3.7-4.0 km depth, all possible gas pools are practically discovered. The commercial operation was started in 1972 and by present the major gas fields survive the declining production phase and by 2020 will not be able to maintain the production rate required.
Figure 1
Areal petroleum map of Yamal-Nenets Autonomous Okrug
Yamal-Karsky gas accumulation centre comprises the Yamal peninsula and adjacent Kara sea offshore and includes such gas giants as Bovanenkovskoye, Kharasaveiskoye, Juzhno- Tambayskoye and others. Two gas giants were discovered on Kara sea offshore in 80's of the last century – Leningradskoye and Rusanovskoye with supposed (not completely explored) reserves about 2 trillion m³. Total revealed reserves of the Yamal-Karsky gas accumulation centre are estimated as 15 tcm. Main productive horizons are found in Neocomian-Aptian (7.6 tcm) and Albian-Cenomanian (4.5 tcm) series. (Table 1). Major Yamal fields are explored and are prepared for development. Commercial operation is to be started in 2011 and by 2020 the annual production reaches its peak of 585 bcm per year.

Table 1
Gas-bearing potential for variously studied geological projects (initial discovered reserves tcm)

<table>
<thead>
<tr>
<th>Oil-gas bearing complex</th>
<th>Urengoiskoye oil-gas-condensate field</th>
<th>Yamal (onshore)</th>
<th>Gydan** (onshore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albian-Cenomanian</td>
<td>7.8</td>
<td>4.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Aptian (subsequence)</td>
<td>0.1</td>
<td>4.9</td>
<td>0.6</td>
</tr>
<tr>
<td>Neocomian (subsequence)</td>
<td>1.8</td>
<td>2.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Acimovsky series</td>
<td>2.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jurassic + contact zone</td>
<td>2.0</td>
<td>1.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>12.6*</td>
<td>13.4</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*) 13.4 tcm together with Neocomian series of En-Yakhinskoye and Pesciovoyskoye fields; **) initial stage of HC potential development

Gydan gas accumulation centre (Gydan peninsula, Tasovsky and South Ob bay offshore) is subject to active oil and gas exploration in the nearest future. Large-scale gas deposits such as Utrennyeye, Severo-Kamennomysskoye, Kamennomysskoye offshore have been already revealed. Initial discovered gas reserves exceed 3 tcm. It should be noted that 40% were discovered in Neocomian sediments, which distinguish Gydan from Urengoisky and Yamal centres. (See Table 1). Acimovsky, Jurassic series and basement contact zones have not been studied completely yet. In addition 24 objects promising for exploration are revealed in the Ob bay offshore, 9 objects in Tazovsky bay and more than 10 objects on Gydan onshore. In total the resources of Gydan gas accumulation centre are estimated at least 17-18 tcm (both onshore and offshore). Newly discovered gas fields are in close vicinity to the unique Yamburgskoye field, with developed infrastructure and gas processing plant, for this reason the Gydan gas accumulation centre seems as promising as the Yamal gas fields. According to the existing plans the gas production development with annual rate 100-150 bcm can start in 2015-2018.

One of the main problems of petroleum geology in Russia and WSMB is the evaluation of the residual HC potential of the Earth interior. Despite the fact that the resource base of Western Siberia tends to decrease there are still big amount of undiscovered and prognostic resources. According to our estimation the regional gas potential has been only half realized. Therefore today's main task is the choice and substantiation of new objects for oil and gas exploration in WSMB.

Further development of mineral resource base for gas production in WSMB, planning and performance of exploration works first of all is determined by the amount, structure and reliability of prognostic (undiscovered) resources. As we know there are two official estimations of the initial potential and undiscovered hydrocarbon resources: expert – carried out by single researchers and corporative – performed by company's scientific centres. As a rule they are different and the range intervals are rather wide.

According to the official estimation the gas potential of WSMB (onshore and offshore) is 134 tcm (conventional gas reserves only), including gas reserves of Kara sea external shelf – 29.2 tcm (here the Ob bay resources are added to the Yamal resources).

As a result of multi-variant calculations performed in 2002-2008 the total initial HC potential of WSMB is estimated by the authors as 250±5 billion t of standard fuel (conventional HC resources), here the ratio of liquid and gaseous HC is approximately 52:48%. In initial recoverable resources the free gas prevails considerably (more than 2/3). According to VNIGAZ calculations performed in 2005-2008 the initial confirmed resources of Western Siberia onshore and sea are evaluated as 100-105 tcm, including 3.0 tcm in central and southern regions. This evaluation is rather conservative which will be finally confirmed in future with probability of 75-80%. Thus according to the last calculations of 1993-2008 (both official and corporative) the gas potential of the mega-
province was evaluated by various researchers in the range from 102±3 to 130±5 tcm, in this case the minimal evaluation – official (conservative, to be proved during future exploration) is made and substantiated by the experts of VNIIGAZ.

Initial potential resources of WSMB (tcm) by series groups:

<table>
<thead>
<tr>
<th>Series Group</th>
<th>Initial Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albian-Cenomanian geological series</td>
<td>42.0 – 45.0</td>
</tr>
<tr>
<td>(with Turonian sequence)</td>
<td></td>
</tr>
<tr>
<td>Neocomian-Aptian</td>
<td>41.0 – 44.0</td>
</tr>
<tr>
<td>Achimovsky</td>
<td>7.0 – 9.0</td>
</tr>
<tr>
<td>Jurassic</td>
<td>12.5 – 14.0</td>
</tr>
<tr>
<td>Cover-basement contact zone</td>
<td>2.5 – 3.0</td>
</tr>
<tr>
<td>Total (onshore and offshore)</td>
<td>105 - 115</td>
</tr>
</tbody>
</table>

Correction of gas initial potential resources of mega-province main parts - Yamal and Gydan - is shown on figure 2.

Major undiscovered gas resources are concentrated in Aptian, Neocomian and Middle Jurassic series of WSMB arctic areas including Kara Sea. It is expected to discover 3-4 supergiant gas fields in external offshore (more than 1 tcm), 22-25 giant gas fields (0.1-1.0 tcm), 70-80 large-scale gas fields (30-100 bcm), and hundreds of medium and small fields with one or many pools.

Figure 3 shows the following Russian regions to be explored in future:

- In central part of WSMB – Ural region, Ob area;
- In the North – north part of Yamal peninsula, south-east part of Pur-Tazovsky region, Ob-Nadym interfluve, Bolshekhtskaya trough (active exploration is planned on 2011-2020);
Apparently the most active exploration works will be carried out during 2031-2040 on Kara Sea external offshore, considering that after 2009 the existing and newly discovered reserves should be exhausted on Yamal and Gydan onshore.

In case of active exploration works the discovered (proved) reserves in medium perspective (2030) can be actually increased up to 8.4 tcm on WSMB onshore (including 350-400 bcm in central and south-western regions). Gazprom share is expected to be about 5.2 tcm, approximately the same amount of gas (8.5-9.0 tcm) is possible to be discovered offshore (Ob and Tazovskaya bays, East Yamal offshore). The study of hydrocarbon potential of Western Siberia will be continued after 2030, many gas-bearing fields will be discovered both onshore and offshore in depth 4.0-6.0 km, though small ones in general (30-20 million t standard fuel and less).

Until 2030-2040 the Russian gas industry will develop due to expanding of the gas productive regions of Yamal and Gydan peninsulas (Yamal-Karsky and Gydansky gas accumulation centres) in Western Siberia, Eastern Siberia, Kara Sea, Barents Sea and Okhotsk sea offshore, including gulfs and bays, at the same time we expect the permanent development of nonconventional (in present day meaning) gas resources. The resources of Eastern Arctic seas, deep pools (5-8km) as well as nonconventional resources will play more and more significant role in the natural gas production.

Conventional gas resources of Western Siberia onshore (80-82 tcm according to the author’s minimal realistic evaluation) will provide gas production 500-650 bcm during the first decades of XXI century. Diagram of gas production by Gazprom companies in the north of WSMB is shown on the figure 4. Gradual decrease of production of the conventional (by present day criteria) gas on onshore will be compensated by the development of Kara Sea gas potential (“guaranteed” resources 22-23 tcm) and by putting into operation of gas-bearing offshore fields (beginning from 2015-2016 and more actively during 2026-2050).

Perspective for the gas production material base expanding in WSMB in XXI as well as in all Russia to much extent depends on the development of the tight low-permeable gas-bearing reservoirs (epigenetically modified sandstones and siltstones). Major gas resources are confined to deep horizons of already revealed deposits (Urengoiskoye, Yamburgskoye, Bovanenkovskoye, Kharasaveiskoye and others).
Geological gas resources in low-permeable thickness and in tight reservoirs of various age from Aptian (Yamal, Gydan) to Pre-Jurassic roof (everywhere on the North of WSMB) is estimated at least 75-80 tcm, and it should be noted that in Jurassic series the nonconventional resources predominate over the conventional resources.

Study and expanded development of residual HC potential of Western Siberia will be continued till 2060-2070 approximately. Great discoveries are expected on Gydan onshore, Ob and Tazovskaya bays, but mainly on Kara Sea external offshore. During many decades some discoveries will be made on the rest of WSMB: among them we expect to reveal few large-scale (about 40-70 million t of petroleum equivalent), medium (less than 30) and predominantly small HC deposits in Achymovsky, Jurassic series, contact zone and Pre-Jurassic series. At the same time gas-bearing capacity of Triassic and Paleozoic series which are deeply subsided (5-8km) remains rather questionable.

At present free gas production from low-permeable gas-bearing rocks in Western Siberia is unprofitable. Nevertheless by 2020 the total gas production from tight reservoirs can reach 40-50 bcm, and will make up 7-8% of the total gas production of the region. Development of such resources is a problem mainly from technical and economical aspects but not geological. As far as gas potential of Cretaceous series has been exhausted, the significant role will be played by the deposits in deep subsided low permeable Jurassic and Triassic horizons, located chiefly in Nadym-Pursky and Pur-Tasovsky regions.

In summary with account for geologic resources of many thousands of small gas pools (3-5 tcm in sum) the total initial gas potential of Western Siberia mega-basin is estimated as 180-190 tcm (excluding coal gas and hydrate). The development of this great potential, which is the exploration works, production and transportation development of gas and associated hydrocarbon fluid (condensate and oil from the gas plugs) in arduous arctic regions require big investments of Russian and international capital, so the task will be transnational. At the same time the West Siberian gas (from Kara Sea onshore and offshore) will be the basis for Russian national gas production and for gas supply for many countries and regions of European-Asian territory during all XXI century.

Western Siberian mega-province “started” with Jurassic gas in little depth (methane, condensate free gas from Beresovsky region, 1953) and will “finish” with Jurassic gas from more deep horizons (4.0-6.5km) by the
end of XXI century, when the reserves and resources of free gas in pools of conventional and nonconventional types will be exhausted.

The development of undiscovered gas resources including gas and their conversion into the commercial resources during exploration as well as the development of newly prepared resources will prolong the life of Western Siberian oil-gas producing region till the last decades of the current century.