KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

Development of Gazprom's Giant Fields in Eastern Siberia: Challenges and Solutions

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Main targets and factors of gas production development in Russia

Targets

- Reliable supply to the domestic market
- Maintaining and strengthening Russia's position on the global energy market

Factors influencing gas production in Russia

- Growing national economy and energy consumption
- Decreasing energy intensity of the national economy
- Growing world economy and energy consumption worldwide
- Growing international competition
- Re-estimation of sustainable development based on gas production as the best energy supplier.

There are factors favoring the growth of gas production in Russia and there are factors impeding this growth.

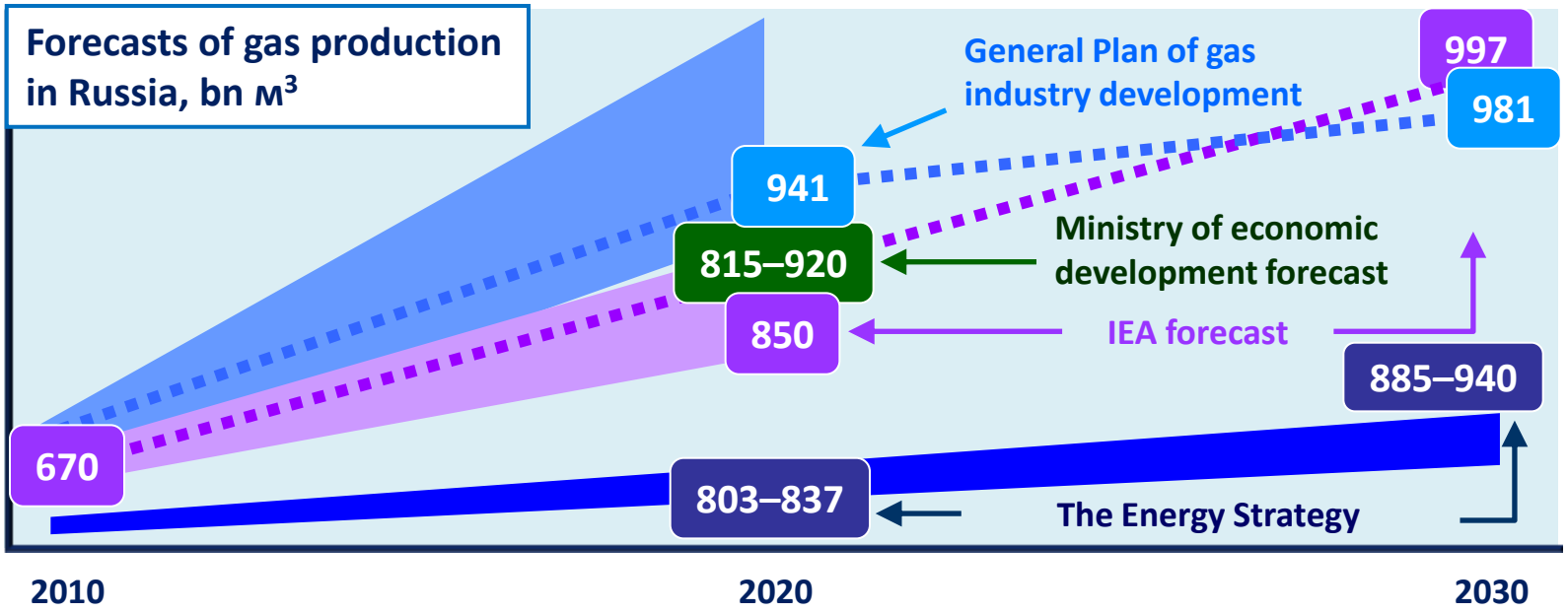
There is need to develop gas export as well as to diversify gas sales markets.

Growing international competition might weaken the Russia's position in world gas market. This represents a certain threat to the national economic interests.

Increasing of gas production & decreasing of energy intensity of the national economy can be an additional source for gas export.

Forecasts of gas production in Russia

Current long-term and mid-term forecasts of Russian gas production significantly exceed the Energy Strategy adopted in 2009.



IEA forecasts through 2030 an average increase of gas production – 1.9 % in the world and 1.7 % in Russia yearly

It creates the need for further development of the mineral resource base of gas industry and field development in new regions.

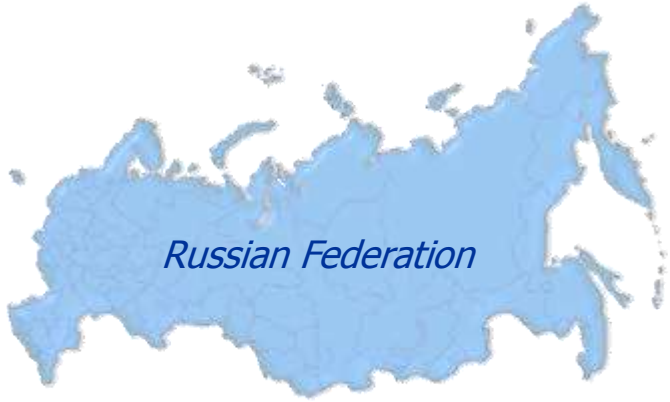
Gazprom VNIIGAZ LLC is the head research center of Gazprom

Gazprom VNIIGAZ LLC was founded in 1948

Gazprom VNIIGAZ LLC designed and implemented research and engineering projects on development of unique gas and gas condensate fields in Russia and the former USSR:

- Urengoyskoe;
- Medvezhye;
- Yamburgskoe;
- Chayandinskoe;
- Kovyktinskoe;
- Zapolyarnoe;
- Vuktylskoe;
- Orenburgskoe;
- Astrakhanskoe;
- Stavropolskoe

and many other fields



- Gazlinskoe and Shurtanskoe (Uzbekistan)
- Shebelinskoe (Ukraine);
- Karachaganakskoe (Kazakhstan);
- Shatlykskoe, Dauletabad-Donmezskoe (Turkmenistan).

Gazprom VNIIGAZ executed and implemented technology projects of all underground gas storages (UGS), operating in Russia, CIS and Eastern Europe. Underground gas storage system allowed to manage and control the seasonal irregularities of gas consumption, increasing the security of natural gas supplies.

Gazprom VNIIGAZ provided theoretical foundation and the basic principles of the Unified Gas Supply System (UGSS) establishment in the USSR.

Gazprom VNIIGAZ designed a number of gas processing plants and gas chemical facilities: Astrakhansky, Orenburgsky, Surgutsky (Russia), Mubareksky (Uzbekistan).

In 2001 Gazprom assigned Gazprom VNIIGAZ a status of the head R&D center in production technologies, transportation and processing of gas.

Organizational structure of Gazprom VNIIGAZ LLC

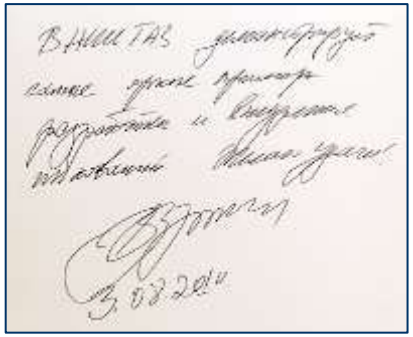
Gazprom VNIIGAZ consists of 15 research centres, a pilot testing facility and branches in regions (Ukhta, Salekhard, Lensk).

The current HR management policy created the best conditions for motivation and self-realization of research associates of the Institute and branch office,

including 50 doctors of science and 200 PhDs

which employ over 2 000 specialists

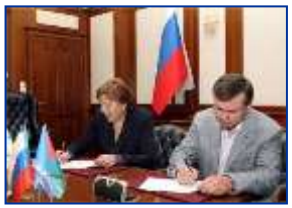
230 research associates are young experts



Scientific school of Gazprom VNIIGAZ unites many generations of scientists, who made an outstanding contribution to gas industry formation and successful development.

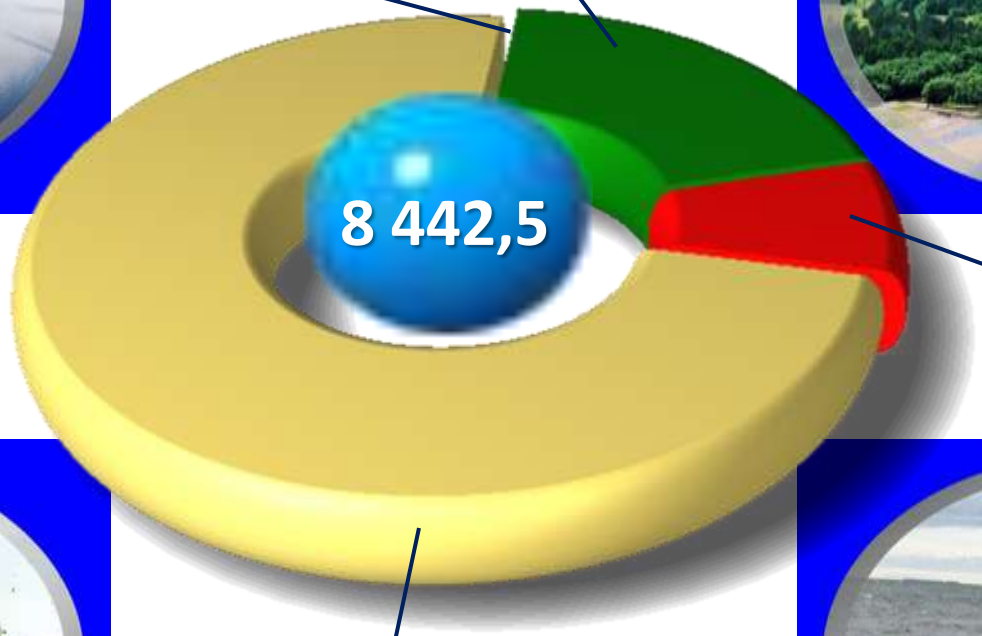
Gazprom VNIIGAZ has:

- postgraduate courses,
- 2 dissertation councils.

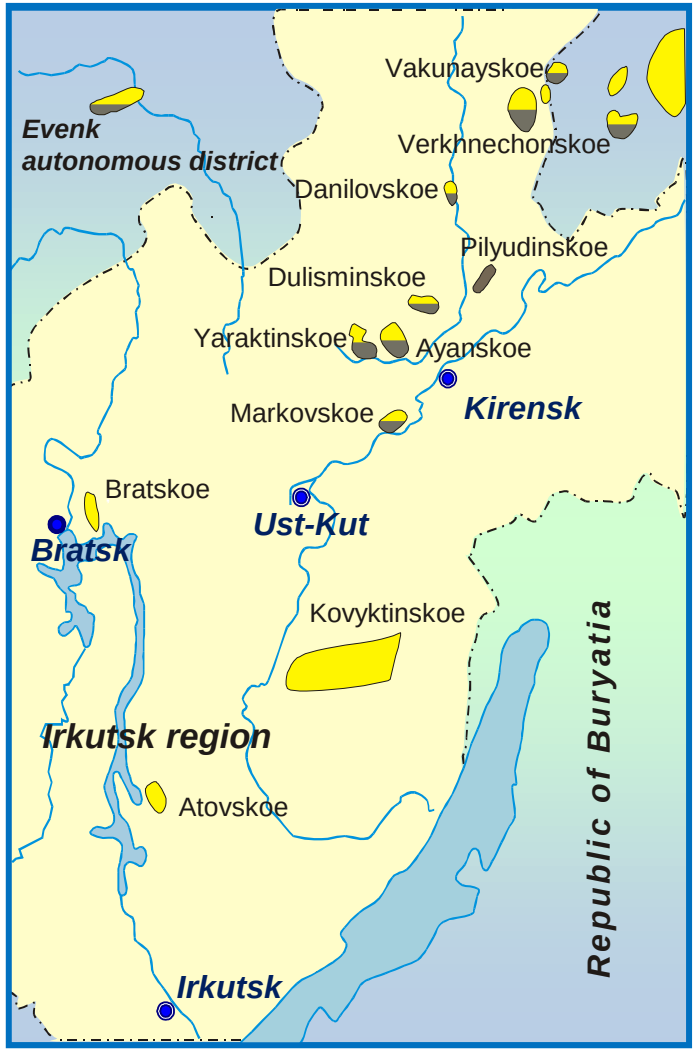


Basic plan of developing gas supply network in Eastern Russia

Gas reserves in Irkutsk region, bn м^3



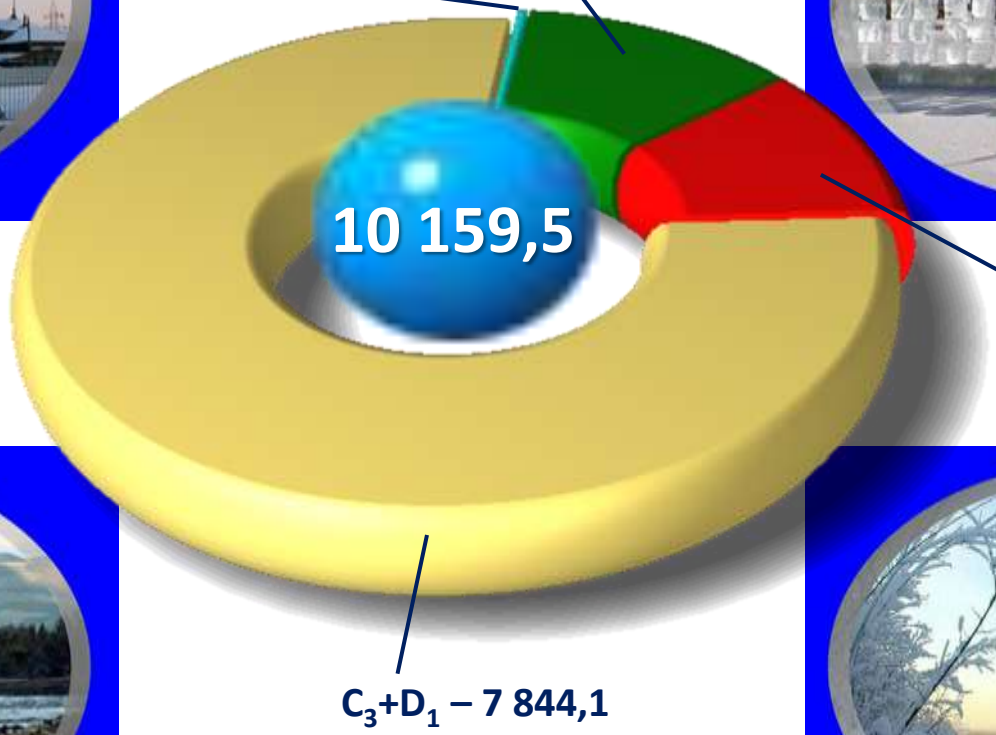
Hydrocarbon fields in Irkutsk region



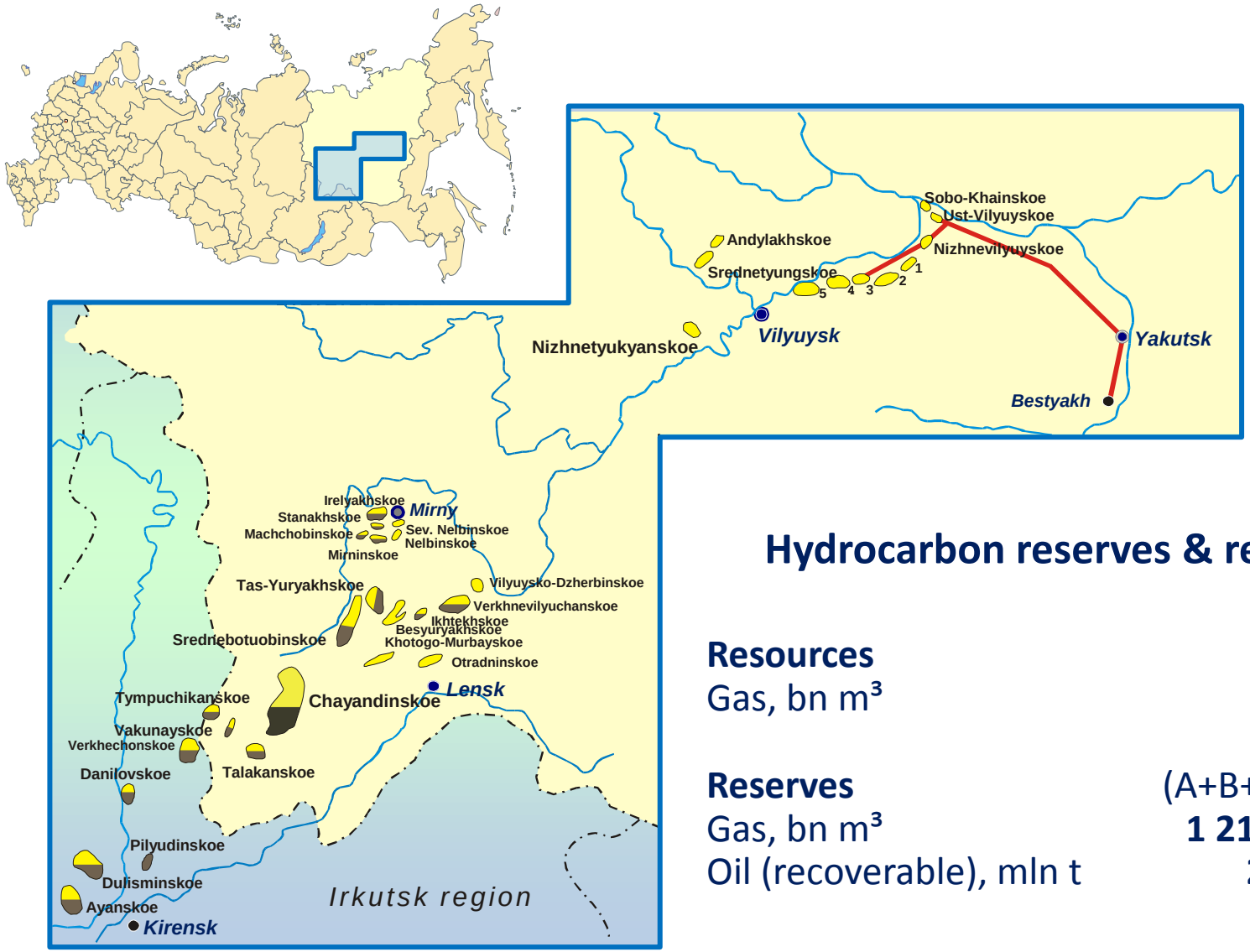
Hydrocarbon reserves & resources

Resources		(C_3+D)
Gas, bn m³		**6 161,7**
Reserves	(A+B+C_1)	(C_2)
Gas, bn m³	**1 647,7**	**632,5**
Oil (recoverable), mln t	**174,8**	**57,5**

Gas reserves in the Sakha (Yakutia) Republic, bn m^3



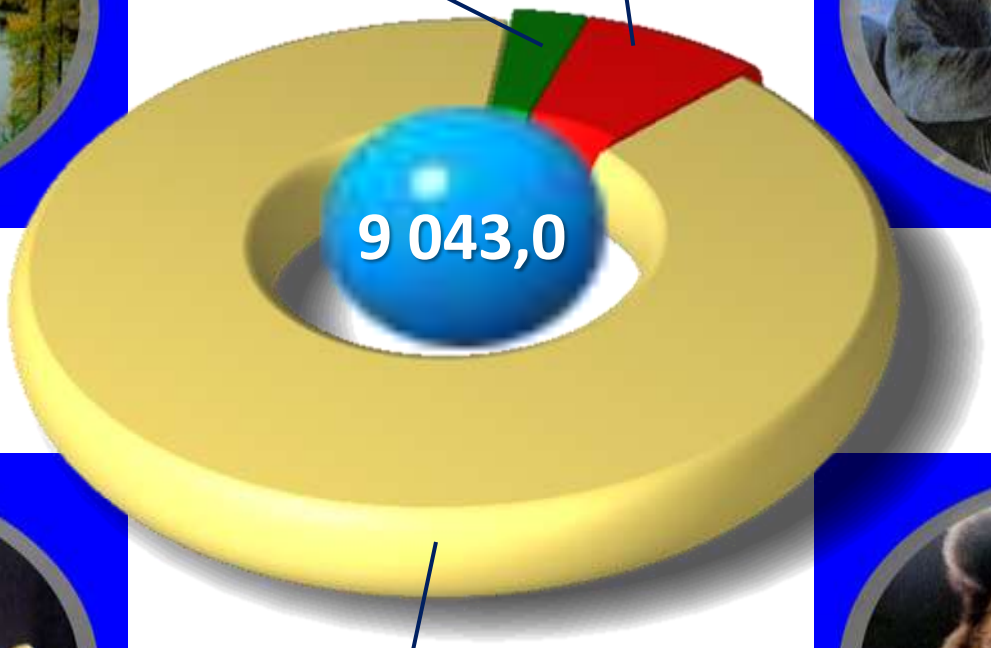
Hydrocarbon fields in the Sakha (Yakutia) Republic



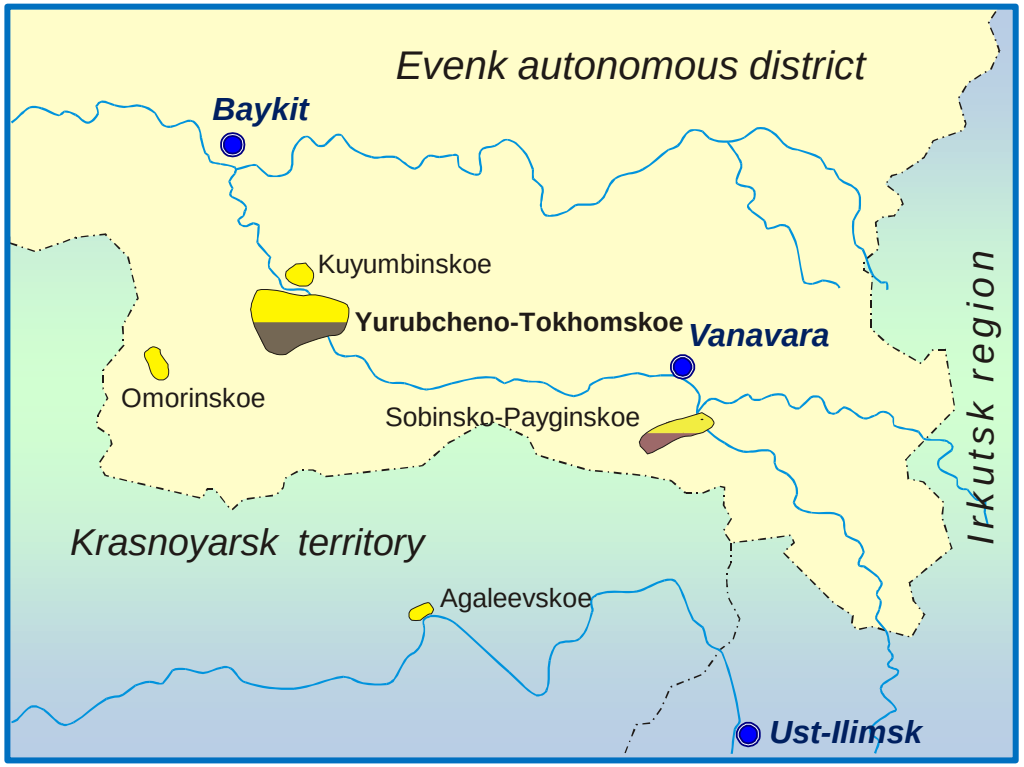
Hydrocarbon reserves & resources

Resources		(C_3+D)
Gas, bn m³		**7 844,1**
Reserves	(A+B+C_1)	(C_2)
Gas, bn m³	**1 215,3**	**1 063,7**
Oil (recoverable), mln t	**218**	**91**

Gas reserves in Evenk autonomous district, bn m^3



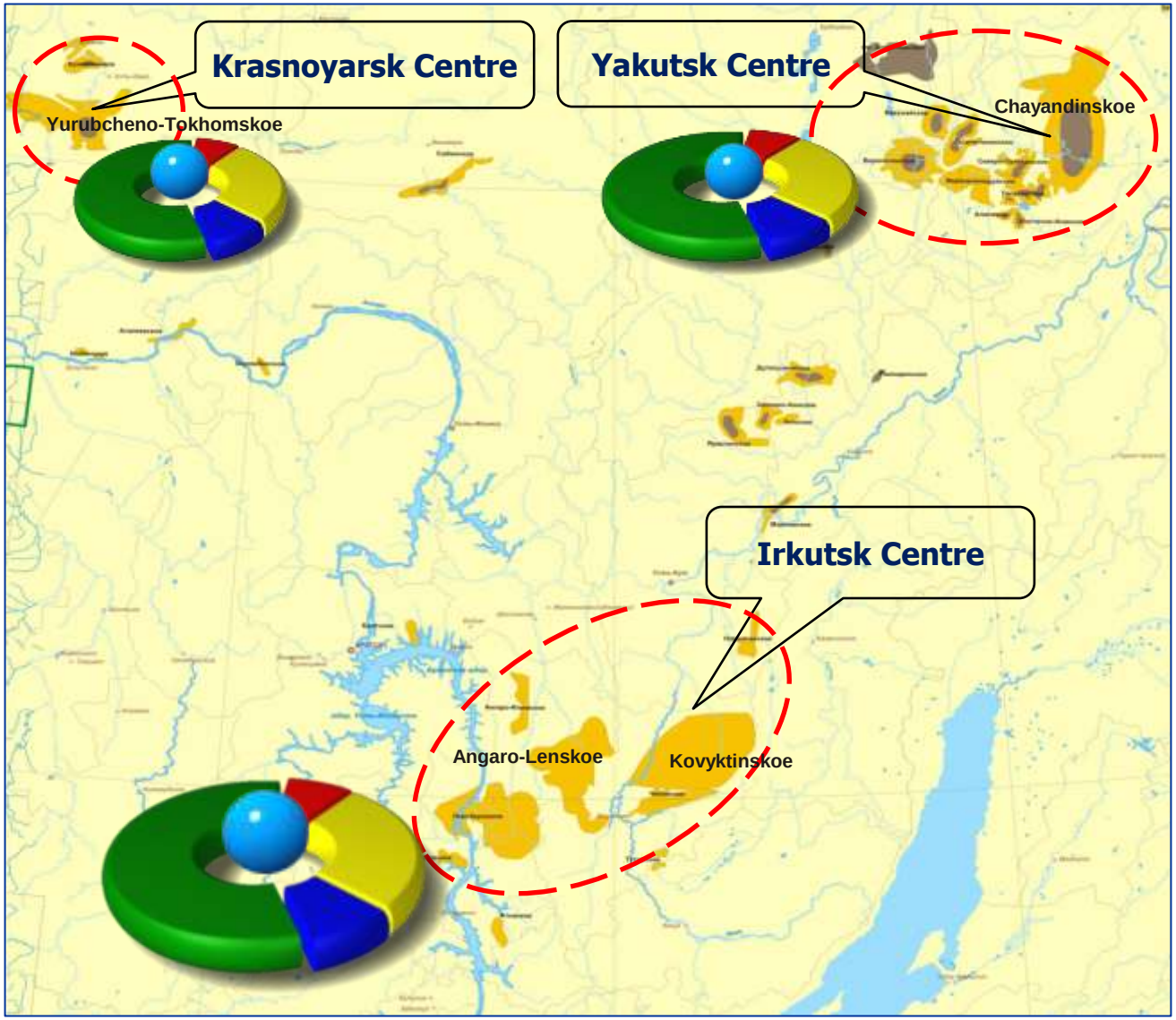
Hydrocarbon fields in the southern part of Evenk autonomous district



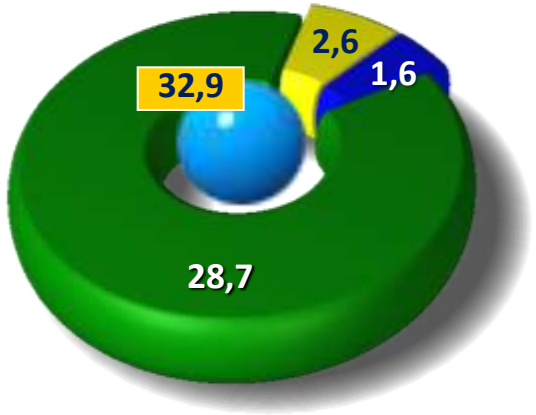
Hydrocarbon reserves & resources

Resources		(C_3+D)
Gas, bn m³		**8 033,3**
Reserves	(A+B+C_1)	(C_2)
Gas, bn m³	**290,3**	**719,4**
Oil (recoverable), mln t	**117,7**	**376,9**

Developing new gas production Centres in Eastern Siberia by Gazprom



Gas reserves in Eastern Siberia, bn m³



32,9 Total initial reserves

- $A+B+C_1$
- C_2
- C_3+D

Main trends of HC exploration and main features of HC fields development in Eastern Russia

Main trends of HC exploration in Eastern Siberia

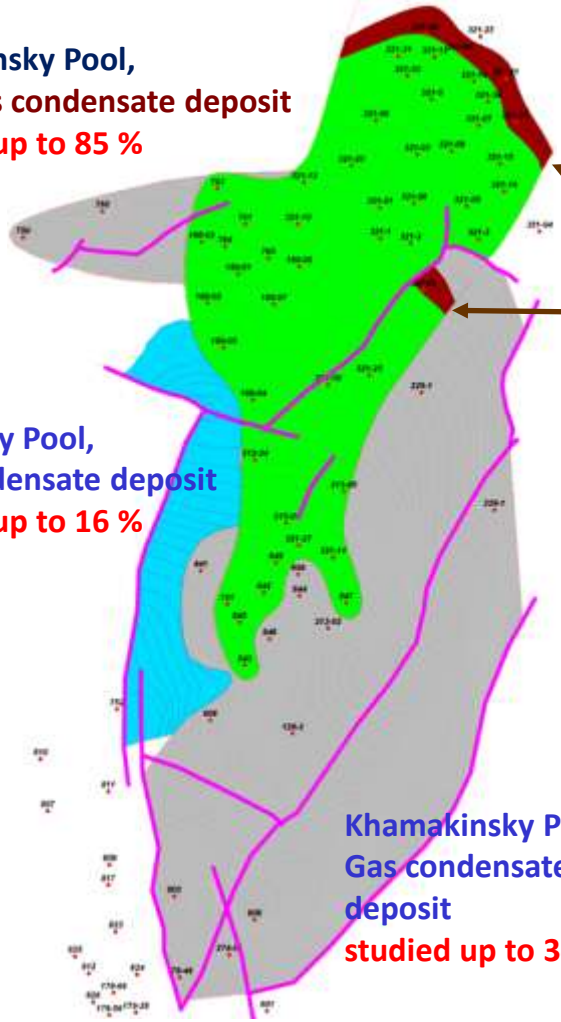
Satellite fields near main fields	Satellite fields along the lines of the ESPO oil pipeline and GTN pipelines	Isolated fields for regional gas supply
Resource base management in the gas production centres: ▪ Krasnoyarsk (Yurubcheno-Tokhomskoye) ▪ Irkutsk (Kovyktinskoye) ▪ Yakutsk (Chayandinskoye)	Reliable gas supply to the Eastern Siberia & Far East regions and resource supply to GTN	Gas supply to the isolated and remote areas

Main features of HC fields development in Eastern Siberia

HC reserves located in several large and dozens of small fields are scattered over the region	Industrial development of the fields is not started as GTN is not yet set up	Comprehensive HC utilization is an issue of complexity for the subsurface users
Small fields development tied to the main fields and the pipelines of GTN	Reliable gas supply to the region Fulfillment of export commitments	Gas chemical industry Helium industry

Brief geological description of Chayandinskoye Field

Superposed sketch of productive deposits



Botuobinsky Pool,
Oil & gas condensate deposit
studied up to 85 %

Oil fringe of the Northern bloc, area – 247 km^2 (ORF = 0,259)

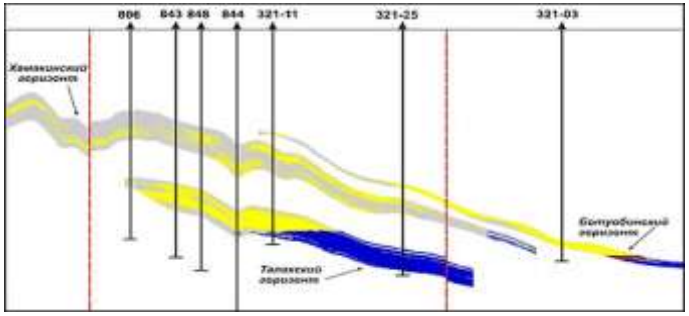
Oil fringe of the Southern bloc, Area – 20 km^2 (ORF = 0,122)

Talakhsky Pool,
Gas condensate deposit
studied up to 16 %

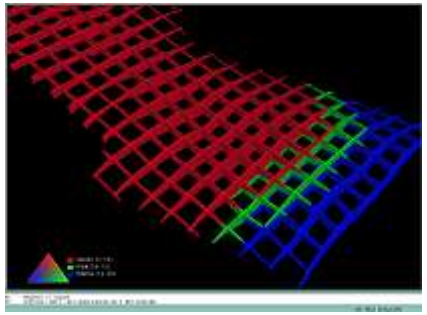
Khamakinsky Pool,
Gas condensate deposit
studied up to 34 %

License bloc area – 6 977 km^2.
Reservoir area – 120 × 22–30 km, height – 280 m,
Deposits are flat-lying, lithologically and tectonically masked.

Oil & gas condensate deposit of Botuobinsky Pool is featured with a thin oil fringe which in-situ reserves are estimated of 200 mln t



Geological cross-section of the field



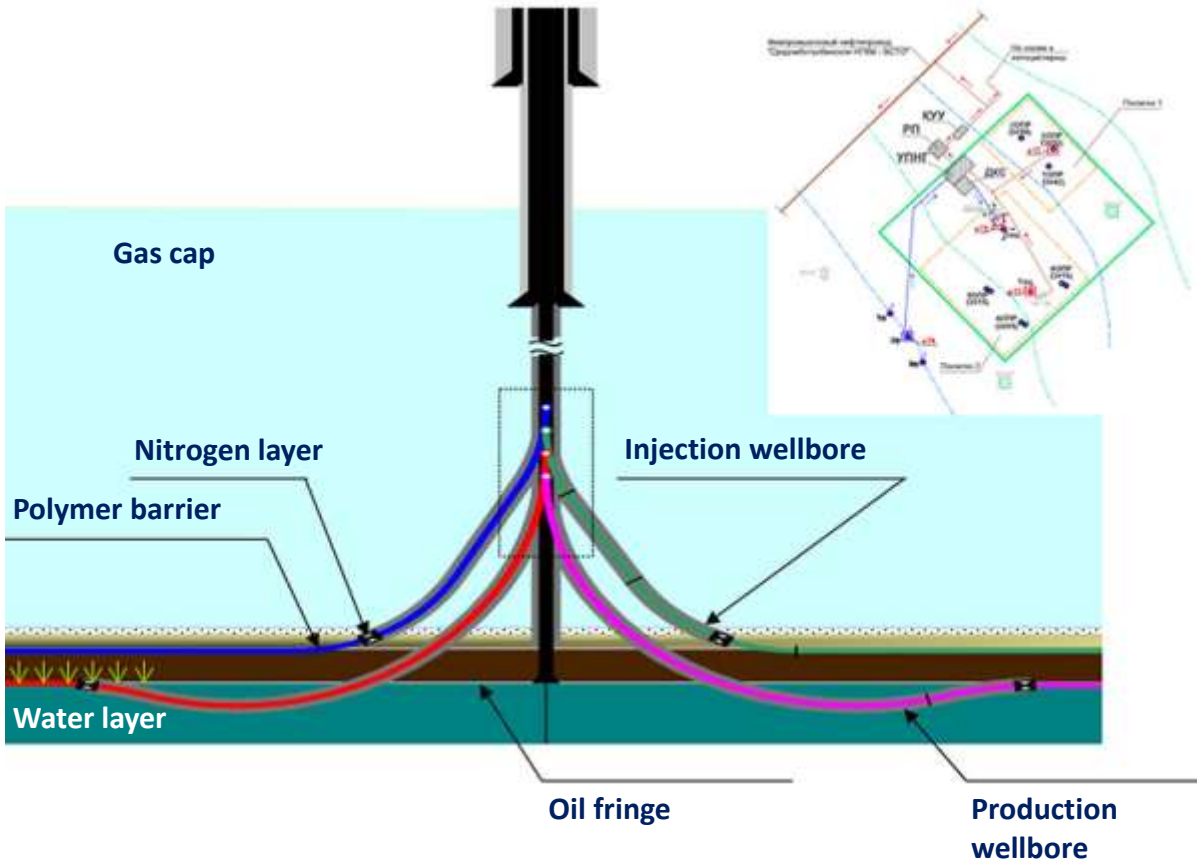
Fluids saturation distribution

Basic approaches to elaborating the concept of the Chayadinskoye OGCF development

- Phased development of productive deposits in Botuobinsky, Khamakinsky and Talakhsky Pools
- Deposits in Botuobinsky, Khamakinsky and Talakhsky Pools to be developed separately
- Putting into test operation the oil fringe of Botuobinsky Pool is a priority. During test operation barrier technologies to be tested. After finishing the test operation, selecting barrier technology and making oil-gas contact stable, industrial development of the gas condensate deposit and the oil fringe of Botuobinsky Pool shall be started simultaneously. Full utilization of associated oil helium containing gas by means of re-injection into to the gas cap of Botuobinsky Pool
- To ensure gas production gas condensate deposits of Khamakinsky and Talakhsky Pools shall be put into operation first. Afterwards the gas condensate part of the Botuobinsky Pool's deposit to be put into operation. Development of the gas condensate deposits will be phased: First phase – test production (will last up to 5 years), second phase – industrial production
- Preliminary separation of helium and nitrogen in the area of Chayadinskoye Field (Gas Processing Plant) and re-injection of helium concentrate into Khamakinsky Pool (southern bloc II)
- Joint usage of vertical, directional and multilateral multifunctional wells. Multiple drilling to be used as the landscape is featured with marshes and rocks. A scheme of centralized linear collection of hydrocarbon products should be implemented. Gas preparation (low-temperature separation) should occur in an integrated complex, which comprises Gas Processing Plant

Barrier technology for the thin oil fringes development using multilateral multifunctional wells

Multilateral multifunctional well



Technological restrictions while developing thin oil fringes:

- Thin layer and big area (over 250 km²);
- Abnormally low PT-conditions of reservoir (temperature and initial pressure);
- Lack of water sources, both – surface and underground, for water supply to the fields;
- Predominance of gas cap in the reservoir volume under the absence of pure oil zone (zones are gas-oil, gas-oil-water, water-oil);
- Traditional development technology requires a big number of production wells;
- High (> 0.25) oil recovery factor (ORF), approved by Federal authorities of the RF;
- To ensure high level of oil recovery the gas cap should be conserved.

Possible options for setting up underground storage of helium and helium concentrate in Eastern Siberia

Salt caverns:

- High CAPEX;
- Setting up takes long time;
- Initial concentration of helium concentrate is kept.

Small depleted gas fields:

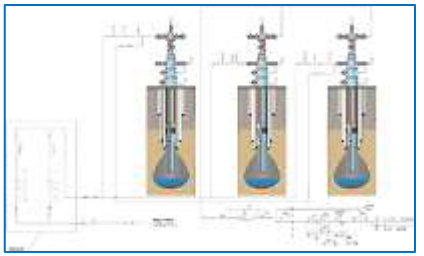
- Quick setting up;
- A facility situated closer to Gas Chemical Complex can be chosen;
- 20 % concentration of helium concentrate can be maintained;
- Availability of special leak-proof wells.

Re-injection of helium concentrate into one of blocks (locations, formations) of developed field:

- Possibility to start a field development immediately;
- Repeated helium recovery and re-injection;
- Losses due to leakage through normal field wells;
- Steady increase of helium concentration in natural gas (up to 5 %).

The only way for lasting storage of helium concentrate of big volume (≥ 5 bln m³) is making underground storage on the base of GC fields and OGC fields.

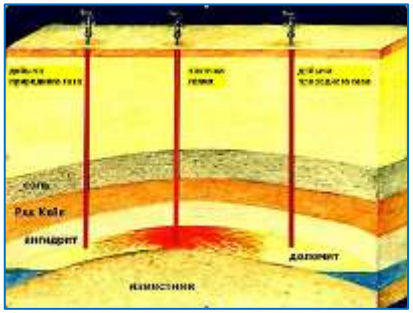
Orenburg Helium Storage



Storage figures:

- Reservoir geometrical volume – 257 ths m^3;
- Gas capacity – ~ 45-55 mln m^3;
- Max pressure – 18,0 MPa;
- Min pressure – 5,0 MPa;
- Compressor performance – 2000 m^3/hr;
- Pump performance – 40 m^3/hr

Helium storage in Cliffside Field (USA)



Storage figures:

- Reservoir – Bush Dome, reservoir height – 170 m, area ≈ 4500 ha.
- Main gas production formation in Bush Dome, where helium concentrate is stored – Brown dolomite, formation depth – 1000 m.
- Initial helium content in natural gas – 1,8 %.
- Initial gas volume in Brown dolomite – 8,26 bn m^3.

Distribution of gas processing and gas chemical facilities in Eastern Russia till 2030 (under consideration)

Resource base for gas processing & gas chemical industry in Eastern Siberia and the Far East

Krasnoyarsk Centre

Constituent	%, vol.
Ethane	5,3
Propane	2,02
Butanes	0,84
Nitrogen	27,5
Helium	0,63

Constituent	%, vol.
Ethane	7,31
Propane	2,34
Butanes	1,23
Nitrogen	6,39
Helium	0,09

Irkutsk Centre

Constituent	%, vol.
Ethane	4,56
Propane	1,08
Butanes	0,54
Nitrogen	1,57
Helium	0,21

Yakutsk Centre

Constituent	%, vol.
Ethane	4,93
Propane	1,72
Butanes	0,68
Nitrogen	6,53
Helium	0,53

Sakhalin Centre

Constituent	%, vol.
Ethane	4,30
Propane	1,80
Butanes	1,05
Nitrogen	0,33

Potential gas processing facilities in Eastern Russia

Gas processing centres	Yearly rated capacity*, bln m^3	Availability of target constituents for ensuring rated loads, ths t/year		Additional requirements
		C_{2+B} (up to)	C_{3+B} (up to)	
Primorsk Centre *(Vladivostok city)*	15	1 800	990	To meet contract requirements on calorific value of LNG C_{2+B} fraction should not be separated from gas flow
Amursk Centre *(Blagoveshchensk city)*	45	5 350	2 550	To consolidate resources of Krasnoyarsk and Irkutsk Gas Production Centres
Irkutsk Centre *(Sayansk city)*	5	480	200	Regional project
Krasnoyarsk Centre *(Boguchany town)*	10	1 530	700	Regional project, enhanced nitrogen recovery from gas flow is needed to meet GOST-5542 (national standard) requirements

* Provided that facilities are loaded at rated capacity for over 30 years

Processing of hydrocarbons to be recovered in Eastern Siberia fields requires new technologies

HC fields in Eastern Siberia and the Far East are featured with high helium (from 0,2 to 0,8 % vol.) and nitrogen (from 2 to 30 % vol.) content as well as with the presence of heavier and more valuable constituents: **ethane, propane, butane, $C_{5+в}$ fractions**, and also with carbon dioxide. The presence of helium, nitrogen and valuable for ethane gas chemistry constituents (ethane, propane, butane) requires new technologies:

- **energy saving cryogenic technology** for recovery $C_{2+в}$ fractions, helium extraction and nitrogen removal, therefore:
- **gas treatment technology** for its further transportation and low-temperature separation which implies higher cleaning and dewatering of gas flow at lower cost and longer equipment life time.

Gazprom VNIIGAZ LLC has developed the relevant technologies which have been successfully tested in field conditions.









Conclusions

- Gas industry development in Eastern Russia contributes to their economic development and provides an opportunity to enter the gas market of the Asian-Pacific region
- The development of unique reserves of East Siberian fields requires a comprehensive approach: from geology, development, inter-field and trunk hydrocarbon transmission, underground gas storage and valuable non-hydrocarbon components to feedstock processing
- Total gas in place of the East Siberian region amounts to 32,9 TCM, including possible reserves (C1 category) – 2,6 TCM, probable reserves (C2) – 1,6 TCM, indicated and geological resources (C3+D) – 28,7 TCM, exploration degree – 8 %. Gazprom VNIIGAZ forecasts the growth of discovered gas reserves in 2011–2035 at 5÷6 TCM
- Current explored gas reserves of the East Siberian region and forecasted reserves growth can ensure the production capacities of 60 ÷ 70 BCM/year by 2020
- Basic fields of the Irkutsk and Yakutiya gas production centres (Kovykhtinskoye GCF and Chayadinskoye OGCF respectively) by balance gas reserves belong to unique.

THANK YOU

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