TRANSMISSION INFRASTRUCTURE DEVELOPMENT IN RUSSIA
(Response to Natural Gas Demand Growth)

A.G. Ananenkov

Russia
ABSTRACT

Growing natural gas demand drives fast development of the global gas industry over the first decades of the XXI century. According to consumption growth rates, gas (2.4% annually) is set to outrun other energy sources (oil – 1.6%, coal – 1.4%). The highest rates of gas consumption increase will be typical for China (5.5% annually), African countries (5.0% annually), South Asia (4.7%), Latin America (4.3%). The demand growth in the OECD countries will be far slower (West Europe – 2.1%, Asia Pacific – 2.3%, USA and Canada – 1.7%).

Uneven natural gas concentrations over the planet stipulate the development of transregional and transcontinental gas main networks and ever continuous progress of the liquefied natural gas industry.

Favorable geographic location, tremendous natural gas resources, and gas mains construction experience enable Russia to deliver gas both to traditional consumers in Europe and new customers in Asia Pacific. It is well known that we’ve decided to construct the North European Gas Pipeline and intend to build the South European Gas Pipeline that will enhance the reliability of Russian gas supplies to Europe. New fields development in East Siberia and the Far East allows us to launch the construction of a new gas transmission pipeline that will carry gas to China and Korea, and the development of liquefied natural gas industry provides for its delivery to other Asia Pacific countries, and also to the countries of North and South America (Fig. 1).
TABLE OF CONTENTS

Abstract

1. New gas production regions and gas transmission infrastructure development

2. Gas supplies to regions and development of gas distribution networks

3. Technical and technological problems of the gas transmission infrastructure development

4. List of figures
1. New gas production regions and gas transmission infrastructure development

Steady progress of the Russian gas industry relies on a sound resource base. By its gas reserves Russia takes the global lead, embracing 34% of all the explored gas reserves worldwide. The natural gas initially-in-place in Russia is evaluated at 236 tcm, including only 13.5 tcm of the cumulative production, and 48 tcm of explored reserves. Explored gas reserves are mainly concentrated in West Siberia (77.4%). Major probable and possible resources are located in West and East Siberia, the Far East, and the Kara, Barents and Okhotsk Seas offshore (Fig. 2). JSC Gazprom operates the world’s largest gas transmission system (Fig. 3).
Gas mains already exceed 150 thousand kilometers in length, and the installed capacity of compressor stations has come up to 44 million kilowatt.

More than 84% of Gazprom’s basic production assets are concentrated in the gas transmission sector.

The existing system of Russian gas mains ensures transmission of projected gas volumes to Russian, CIS and foreign consumers for the next few years.

West Siberia remains the gas industry’s main resource base gas production center for the foreseeable future (Fig. 4).
However, the largest fields of this region – Medvezhye, Urengoyskoye, and Yamburgskoe - are in the final stage of their development, and gas production decreases here by 20-25 bcm/y (Fig. 5). In the next 5-6 years this fall will be outweighed by the gas production increase from the Zapolyarnoye and other fields of the Nadym-Pur-Taz region.
The development of the Yamal Peninsula fields is a further step onward. These very fields represent a strategic resource base for this country's future gas requirements. Without their development there are no other perspectives beyond 2010 to boost domestic gas production. Local explored gas reserves average 11 tcm and expected annual production is 250 bcm. However the development of this region's fields requires considerable investments. This is caused by both the field remoteness from the existing gas mains system and the necessity to solve a range of the most complicated tasks while constructing gas wells and upstream infrastructure in the permafrost soil area, laying gas pipelines, and implementing new engineering solutions and technologies ensuring nature preservation in severe Arctic conditions.

Naturally, a new gas transmission system is needed to pipe the Yamal gas into the Unified Gas Supply System of Russia (Fig. 6). This capital-intensive gas transmission system should be designed through state-of-the-art gas transmission technologies, with the maximum use of high pressure advantages.

The Russian Arctic shelf has a potential to maintain a high level of domestic gas production in the long run. By 2030 the local gas reserves and production are estimated to increase by 15 tcm and exceed 250 bcm/y respectively. The Shtokman field with planned large-scale production of liquefied natural gas is a top priority target in the Arctic offshore development process.

Advanced gas production rates are projected in eastern Russia. East Siberia including the contiguous Far East regions is set to become Russia's second important gas production area in the future.

The tasks set by the Energy Strategy before the gas industry in the country's east are as follows:
- accelerated development of the industry;
- development of new large gas production areas and centers in the region;
- Russia’s access to the gas markets of Asia Pacific.

The ability to implement these tasks is guaranteed primarily by a solid resource base of the region. 25% of the country’s initially-in-place natural gas resources comprising more than 59 tcm are situated in the east of Russia.

Moreover, the East Siberian and Far Eastern offshore contains another 14.5 tcm of contingent gas resources particularly abundant in the Okhotsk Sea and Sakhalin Island offshore.

Based on said resources the Energy Strategy stipulates that under favorable conditions annual gas production in East Siberia and the Far East may increase up to 50 bcm by 2010, and up to 110 bcm by 2020 (Fig. 7).

![Graph showing prospects of gas production in East Siberia and the Far East](attachment:graph.jpg)

The backbone of eastern Russia’s promising gas supply system will be the so-called Central Mains linking basic fields of East Siberia and the Far East, and connecting them with the Unified Gas Supply System of Russia (Fig. 8). By 2020 eastern Russia will see the development of a regional Unified Gas Production and Transmission System to be established based on the Central Mains in several stages, which will enable to optimize investments and “attach” all basic fields of the region to corresponding target markets without undue interference.
For the balanced development of the Russian gas industry and for preserving of state interests in this sphere it is necessary to timely boost the capacity of the country’s gas transmission system. The most important projects in the gas transmission system (GTS) development in Russia and foreign countries are the following ones: Northern Tyumen Region – Torzhok gas pipeline, Yamal – Europe gas pipeline system, the development of Central Asia – Centre system facilities, the North European Gas Pipeline, and the above mentioned gas supply system of the Russian East.

2. Gas supplies to regions and development of gas distribution networks

Special attention is given to the construction of a gas pipeline system linking basic fields with consumption centers and connected with gas mains. Such system configuration will help ensure reliable and uninterrupted gas supply.

Gas distribution systems are developed based on general schemes of gas supply. The general schemes are devised with the account of the rational gas share in regional energy supply mixes, energy saving, maximum use of local fuel and energy resources (Fig. 9).
Currently, gas distribution networks are close to 360 thousand km in length. Every year new Russian regions start receiving pipeline gas (Fig. 10). Sufficient gas supply is an important element of the regional socioeconomic development. The utilization of natural gas will provide for meeting crucial economic, social and environmental challenges of regional development.
The development of new fields situated in remote and hard-to-reach areas leads to elaborate gas transmission to consumers. Together with the development of the pipeline transmission system, other methods of gas processing and transmission are considered nowadays.

Alternatively to the pipeline gas transmission there are plans to apply gas liquefaction technologies and transmit LNG to consumers by special tankers; to launch chemical processing of gas into synthetic liquid fuels with their subsequent transmission by conventional tankers and oil pipelines, as well as to compress gas for further transportation (Fig. 11).

3. Technical and technological problems of the gas transmission infrastructure development

The most promising technological solutions for new gas pipelines are the following:

- increasing working pressure (more than 7.4 MPa);
- using pipes with smooth inner lining;
- incorporating gas compressor units with increased efficiency, reliability and optimal layout.

In terms of the energy capacity and intensity of its gas transmission system, JSC Gazprom is in line with all the worldwide gas transmission companies taken together. 263 compressor stations with 707 compressor shops are operated within the system.

The installed capacity of over 4,000 gas compressor units (GCU) accounts for 44.0 million kilowatt.
GCU are operational at the following technological facilities: midstream compressor stations, upstream booster stations and compressor stations of underground gas storages.

Said powerful compressor stock has been accumulated in almost fifty years. Therefore a really wide variety of drive sizes, technological modifications and layout solutions is present.

The comparison of JSC Gazprom and foreign gas transmission companies’ compressor stock structure helps draw the following conclusions:

- the US gas transmission system includes more than 1,000 compressor stations (CS). However their total capacity is almost 4.5 times less than that of Russian one. A considerable amount of piston type units (nearly 70%) is used. The compressor stock of the US gas transmission system can not be compared with JSC Gazprom’s stock either by its structure, or by its age;

- the Canadian and European gas transmission systems were formed approximately at the same time as the Russian one, therefore they have much more technological resemblance;

- the main features of Russian compressor stations are a high concentration of facilities and project unification – there are no equally powerful CS in the world;

- European and Russian CS basically have gas-turbine drives;

- statistical reliability criteria for European and Russian station units are generally comparable;

- efficiency criteria of European and Russian CS are also generally close. The share of modern highly efficient gas turbines of new generation is in both cases relatively small so far.

The current conception of the development and reconstruction of compressor stations is based on the following basic provisions:

- prevailing use of the gas-turbine drive with an output of 2.5 to 25 Megawatt;

- application of new-generation energy-saving equipment (the performance index is 32 – 40%), which at the same time will provide for the solution of several problems: decrease of the nitric oxides and carbon dioxide atmospheric emissions, the down-sizing of the CS sanitary protection area;

- application of standardized technical solutions;

- consolidation of GCU power units aimed to reduce maintenance costs;

- creation of modern automated systems based on the unified technological basis.

Starting from 1990 JSC Gazprom has been developing and implementing five-year programs on the reconstruction and technical upgrading of gas transmission facilities.

In 2002 the Company approved the third industry Comprehensive Program with about RUR 230 billion of total investment.

The program embraces all GTS technological complexes, including the following ones: the transmission part, compressor stations, energy and water supply systems, gas pipeline cathodic protection, automatic control and telemechanic systems, technological communication systems.

The technological effect from said GTS reconstruction manifests in the growth of its productivity by 35 bcm/y and the decrease of direct gas inputs into the gas transmission support needs by 5 bcm/y.
Currently the General Scheme of the gas industry development until 2030 is close to its completion. The Scheme pays considerable attention to the reconstruction and technical upgrading of gas transmission facilities.

The General Scheme implies bringing the flow capacity of the gas transmission system in line with the gas production levels set as the gas industry targets.

The gas transmission system loading for the future is subject to the expected gas production changes in JSC Gazprom’s production companies and independent gas producers. Projected loading should be backed by a relevant flow capacity of the gas transmission system.

Reconstruction volumes of compressor facilities predicted for the period until 2030 are estimated to be some 40.5 million kilowatt and 50 thousand km for the transmission part.

Annual investments in the reconstruction of GCUs until 2030 are evaluated to be more than USD 2 billion. Investments in the reconstruction account for nearly 25-30% of the aggregate amount slated for the development of the entire “Gas Transmission” subindustry until 2030.

It is worth mentioning in conclusion that in 2020 the Russian share in the global gas production and international gas trade is predicted to reach 20% and 30-35%, respectively.

The above optimistic forecast shows that the Russian gas industry will continue to be a solid foundation of the country’s economy and will retain its position in the world gas market.
4. LIST OF FIGURES

1. Fig. 1 – Directions of Russian Natural Gas Supplies
2. Fig. 2 – Gas Resources of Russia by Federal Districts
3. Fig. 3 – JSC GAZPROM Gas Transmission System
4. Fig. 4 – Emerging Role of Yamal Gas in Total Russian Production up to 2030
5. Fig. 5 – JSC GAZPROM Major Gas Deposits Maturity
6. Fig. 6 – Basic Layout of Yamal GTS Under Construction (designed for full operational load of 250 bcm/year)
7. Fig. 7 – Prospects of Gas Production in East Siberia and the Far East
8. Fig. 8 – Central Mains of Prospective Gas Supply System
9. Fig. 9 – Structure of Krasnodar Kray Gas Supply Sources
10. Fig. 10 – JSC GAZPROM Regional Gas Supply Systems Development Program for the Russian Federation
11. Fig. 11 – Alternatives to Pipeline Transmission of Natural Gas