Appendix A: Oil Producers and Regional Distributors Are Also Independent Gas Producers

Ivan Nazarov

The term "independent gas producer" comprises not only companies that are primarily gas producers, such as Novatek and ITERA (see Chapter 1), but also oil companies and regional gas monopolies. Both of these types of entity control a sufficient resource base to develop gas production and to become significant players in the domestic gas market.

Russian oil companies and APG

Russian oil companies operate in the upstream sector of the Russian gas industry because they are the biggest producers of a type of gas, associated petroleum gas (APG), which is one of the by-products of oil extraction. APG is a mixture of gaseous and vaporous hydrocarbon and non-organic components dissolved in the liquid mix lifted up the well shaft—that is, it comes out of the ground along with the oil. It is mostly methane but is also rich in heavier compounds as well as acidic chemicals and helium. Marketable APG can be extracted from this mix via processing.

APG is an important source of raw materials such as gasoline and wide hydrocarbon fractions that are used in the petrochemical and manufacturing industries to produce rubber, plastics, high-octane gasoline components, and other products. APG itself can be used to enhance the productivity of oil wells by being reinjected. APG can also be burned to generate electric power needed for local oil production site and to generate heat for on-site or local usage. Russian oil companies developing remote oil wells in Siberia paid virtually no attention to APG—which was not surprising, for most oil production sites have inadequate capacity to gather and process this gas. Instead, the gas was wasted, burned away in gas flares. In fact, it is not uncommon for the settlements near the oil production sites to be heated by peat or firewood while being illuminated by a nearby gas flare. The precise scale of APG flaring in Russia is not known. According to an estimate by the US National Oceanic and Atmospheric Administration, Russia flared an estimated 35 bcm of natural gas in 2010—equivalent to 6% of gas production in Russia and 30% of total volumes of APG flared globally in that year.[1]

At least 80% of the APG is produced by the largest five Russian oil companies: TNK-BP, Rosneft, Surgutneftegaz, Lukoil, and Gazpromneft. In 2009 the Russian state took steps to put an end to this intolerable waste by approving significant increases of fines for unmetered gas flaring and heavy penalties on those who used less than 95% of the gas; these rules were put into effect in 2012. It was hoped that the 95% goal would be reached by 2013—this would generate at least 20 bcm/year of natural gas. But as of 2011 the average utilization rate was only 75.4%. The good news was that Surgutneftegaz achieved the 95% goal in 2011 and TNK-BP had reached 83% by late 2012. The bad news was the state-owned producers, Rosneft and Gazprom's oil division, lagged at 51% and 69%, respectively (Korzhubaev et al. 2012). As a result, the Russian government postponed putting the 95% APG utilization rule into effect until 2015.

The other bad news was that the 75.4% average in 2011 was actually down from 84% in 2009. This can be explained partly by the growing oil production on the eastern Siberian sites, which generally lack APG processing, transportation, and APG utilization infrastructure, and partly by the growth of gas-to-oil ratio in the new oil and gas fields, called the gas factor. Between 2005 and 2012 the gas factor for Russian oil producers grew on an average from 124 to 135 cubic meters per ton of extracted oil, implying an increasing need for APG utilization. Indeed, the alternative costs of APG non-utilization have dramatically increased and created incentives to find ways to use this gas and to install the required infrastructure.

Imposing more stringent anti-flaring measures and fines has been discussed, yet such measures are unlikely to solve the real problems. APG can't use the existing gas transportation network because the existing pipelines' specs are incompatible with the chemical composition of APG. But producers can't be expected to invest in special processing infrastructure if they can't be sure of an acceptable rate of return and the availability of transport capacity in the pipelines. The solution would be to build dedicated pipelines, but this is too costly for IGPs. Improving gas transportation capacities and growing domestic gas prices will probably do more to end the waste of APG than punitive measures.

Some Russian oil companies also produce genuine natural gas. Lukoil's fields produced 14 bcm in 2011. Rosneft, the biggest oil company in Russia, produced 12.3 bcm of natural gas in 2010 and has estimated reserves of 1.57 Tcm. Although all Russian oil companies produced only 40 bcm in 2010, they expect their gas production projects to produce approximately 120 bcm/year by 2020. The oil producers could capture up to 40 bcm/year of extra gas production by reducing the amount of APG currently wasted in flares (Henderson 2012).

The regional gas distributors

The Russian gas industry is physically segmented because several geographical regions are isolated from the main Russian gas transportation network. Some of these areas, especially those with hydrocarbon fields, have seen the emergence of local gas distributors that are in effect monopolists—vertically integrated companies that own production, transportation, and distribution capacity. Virtually all of them are state owned. Though their total gas production is less than 1% of the total Russian gas output, these gas companies ensure secure gas supplies to local industries and residents and therefore are important pieces of the Russian gas industry. They are mostly located in the Siberian and the Far East Federal Districts, the regions that have relatively sparse gas distribution infrastructure.

Siberia: Norilskgazprom and Taymirgaz

Norilskgazprom is the producer, transporter, and distributor of natural "dry" gas to local industry near the city of Norilsk, in the northern portion of Krasnoyarsk, which is the largest federal subject within the Siberian Federal District. Norilskgazprom was established in 1968 in response to the deteriorating economics of the local industry brought about by high dependency on expensive coal and diesel fuel. Norilskgazprom owns three major local gas fields—the Messoyakhinsk, the South-Soleninsk, and the North-Soleninsk. No figures are available on the annual output of these fields, but it is known that their production is declining: gas-seam pressures have dropped to 20%–60% since the 1960s, when production in these fields started.

Norilskgazprom is a stand-alone system with over 1,000 kilometers of pipeline, capable of transmitting more than 5 bcm/year at nominal throughput. Its network comprises two trunk lines and two interconnectors that supply gas to Norilskgazprom's main customers, which are local industries. All these pipelines are above ground and so are much less vulnerable to corrosion than underground pipelines. They can also be much more rapidly built.

When Norilsk Nickel, a mining and metallurgy company, needed to ensure a reliable fuel supply, it established, in 1998, a gas-field developer, Taymirgaz, in cooperation with Norilskgazprom. Taymirgaz owns the Pelyatkinsk gas field (242 bcm) and supplies about 1.7 bcm natural gas to the nickel factory annually.[2] Norilskgazprom provides transmission services and participates in development and maintenance of the field's infrastructure. Pelyatkinsk should stabilize gas supply to Norilsk Nickel and other nearby industries in the medium term.[3]

Yakutia: YATEK and ALROSA

East of the Siberian Federal District is the huge Yakutia Republic, part of the Far East Federal District. YATEK (formerly Yakutgazprom), established in 1967, is the main natural gas producer in central Yakutia and owns about 200 bcm worth of total proven reserves. It owns licenses to develop and exploit deposits in a number of fields, some of them yet to be surveyed and explored. YATEK's output of natural gas is 1.6 bcm/year—86% of Yakutia's gas output. It provides all the gas needed by the city of Yakutsk and also supplies industrial customers in central Yakutia.[4]

YATEK sends its gas through the transmission grid of Sakhavostokneftegaz, a wholesale buyer and transport company that is owned by the republic's local government. Sakhavostokneftegaz is responsible for the development, maintenance, and expansion of the transmission network. With more than 2,200 kilometers of trunk and lateral pipelines and over 3,300 kilometers of inter- and intra-settlement lines, the network spans the entire region and ensures access to gas for local industry and settlements.

Sakhavostokneftegaz's greatest challenge is the extreme environmental and climatic conditions, especially winter–summer temperature swings of up to 75 degrees, subzero temperatures, and floods. The core two-line Mastakh-Yakutsk pipeline, transiting rough terrain of lakes, rivers, and bogs, has been in operation for 40 years. Constant maintenance is the only way to head off disruptions in the gas supply. Since 2001 Sakhavostokneftegaz has been deploying, segment by segment, the third line of this trunk line, which has much greater throughput capacity than the existing two lines. YATEK is actively developing underground gas-storage facilities to smooth the very uneven load on production capacities and the pipeline network that results from the extreme seasonal temperature swings.

Another gas producer established mainly to meet the needs of a gas-hungry industry is ALROSA-Gas, a 100% subsidiary of the major Russian diamond producer ALROSA, located in the Yakutsk region of the Yakutia. Founded in 1998, ALROSA-Gas is developing the Srednebotuobinsk gas deposit (46 bcm). Ninety-four percent of its gas is used by the diamond industry and the rest by local power and heat suppliers in western Yakutia. ALROSA-Gas owns a one-line trunk line and a net of lateral pipelines with total length of 686 kilometers that can transit up to 1 bcm of gas a year from the main production site.

Geographical isolation and lack of competition allowed ALROSA-Gas to gain a toehold in the local economy. Its hopes of developing its export potential to the other regions of Russia's Far East focus on the planned Yakutia-Khabarovsk-Vladivostok interregional trunk line.

Even though the total gas production by these companies is small, they are an integral part of local economies and serve particular needs of the industrial clusters located in the vicinity of gas resources. The closer the gas deposits are to such industrial clusters, the greater the autonomy of gas production and transportation from the inter-regional network. This proximity means savings on infrastructure. Under the pressures of hasty industrial growth in the USSR, these local monopolies made sound economic sense.

Notes

1. US Energy Information Administration, "Russia, Analysis," updated September 18, 2012 (www.eia.gov/countries/cab.cfm?fips=RS, "Gas flaring").
2. Taymirgaz, "Annual Report 2011" (www.tgaz.ru/files/2-5-2-1.doc, 9, 12).
3. Norilskgazprom, "Kompaniya Sevodnya" [The company today] (www.ngaz.ru/company/about).
4. Yatek, "Godovoi Otchet 2011" [Annual report 2011] (www.yatec.ru/content/documents/file/yatek_ar_2011_071112.pdf, 8).

References

Henderson, J. 2012. "Is a Russian Domestic Gas Bubble Emerging?" *Oxford Energy Comment*, Oxford, UK: Oxford University, The Oxford Institute for Energy Studies, March.

Korzhubaev, A., D. Lamert, and L. Eder. 2012. "Problemi i Perspektivi Effektivnovo Uzpo'zobaniya Poputnovo Neftyanovo Gaza v Rossii" [Problems and prospects for the effective use of associated petroleum gas in Russia] *Bureniye i Neft* [Drilling and oil] (online journal), April 2012 (http://burneft.ru/archive/issues/2012-04/1 [see English translation by Google]).

Appendix B: Unified Gas Supply System: Maintenance and Expansion of Pipelines and Gas Storage

Ivan Nazarov

As described in Chapter 1, the Unified Gas Supply System (UGSS) consists of pipelines (at the macro-, middle, and micro-levels), compressor stations, gas-processing plants, and underground storage facilities. Maintenance and development of the UGSS—in particular, the pipelines and the storage facilities—present some challenges for the future.

Aging pipelines

The life expectancy of a gas pipe generally depends on the quality of the pipeline segments' steel and the welding, the geometry of the conduit it lies in, environmental factors, and the operating pressure. Wear and tear may progress unnoticed inside the pipe until the critical moment when their accumulated effects cause the pipe to fail. Obviously, the oldest pipelines are very susceptible to these risks, especially in the harsh northern climate.

The domestic segment of the UGSS has been in operation since the 1960s, and despite construction of new pipelines, the average age of the system's pipelines is increasing. Comparison of the age distribution of pipelines in 2006 and 2012 shows that at least 38% of the trunk pipelines became older than 30 years and another 37% entered the 21–30 years age group by 2012 (see Figure AppB.1). During the same period the share of the younger pipelines—up to 20 years old—decreased by 16 percentage points and the mean pipeline age increased from 22 years in 2006 to 27 years in 2012. These age dynamics reflect a low rate of new pipeline construction—and the fact that the domestic pipeline network is still operational demonstrates that comprehensive programs of timely maintenance and repair have been effective. The available data on the rate of failures and leakages show that since 2002 the annual number of failures had dropped by a factor of 4, to 7 per 1,000 kilometers in 2010. In late 2011 the Ministry of Energy of the Russian Federation reported that only 40%–50% of trunk pipeline repairs planned for the year had been completed, which was reflected in a rise in the number of failures—12 in 2011.[1]

Need to expand major pipelines

Gazprom has major pipe expansion projects in Yamalo-Nenets. It is constructing almost 2,500 kilometers of gas pipelines to connect the developing

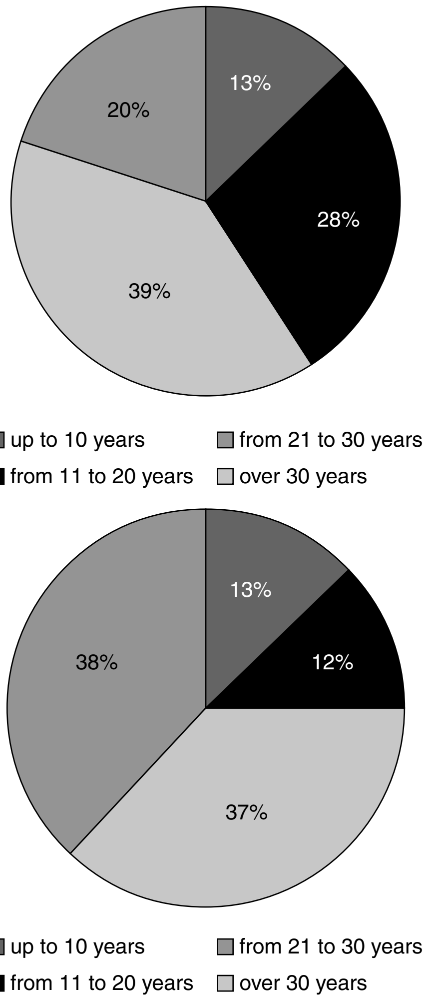

Figure AppB.1 Comparison of age distribution of UGSS trunk pipelines in Russia, 2006 and 2012 (as percentage of total pipeline length)
Source: Authors, based on Gazprom (2006, 37; 2012, 42).

production complex on the Yamal Peninsula to its supply chain. This includes the technologically challenging 1,100-kilometer transport complex connecting the Bovanenkovo gas field to the existing pipeline joint near Ukhta.[2] Tying the Kharasoveyskoye and other Yamal fields into the production cluster will require six pipelines in the Bovanenkovo-Ukhta corridor, eventually bringing the annual throughput up to 300 bcm by 2030. Pipelines from the Ob-Taz Bay offshore fields with 75 bcm/year of throughput capacity will be connected to the operational transmission infrastructure in the Nadym-Pur-Taz by 2015 (Stern 2009). Thus, gas from the western and northern Yamal will be routed via the Bovanenkovo-Ukhta pipeline and gas from the southern Yamal and Ob-Taz Bay fields will flow into the existing infrastructure of the Nadym-Pur-Taz region.

Major UGSS expansion projects in Russia's Far East are an integral part of the economic development of that huge region. Gazprom started construction of the Sakhalin-Khabarovsk-Vladivostok inter-regional trunk pipeline in 2007. When completed, this route, about 1,800 kilometers long, will connect offshore gas production sites near the Sakhalin Peninsula via two underwater lines across the Nevelskoy Strait to the existing Komsomolsk-on-Amur—Khabarovsk pipeline and then to the city of Vladivostok. Throughput rate is planned to reach 30 bcm/year by 2020, thereby giving domestic users access to gas and enabling the potential expansion of Gazprom's exports to the Asia-Pacific countries (Japan, China, and Korea). This pipeline will play a significant role in achieving the goals set in the Long Term Energy strategy of the Russian Federation, which sets a target of annual gas production of 150 bcm in the Far East by 2020.[3]

The "Gasification" of Russia

In Russia, "gasification" (*gasifikatsiya*) doesn't mean turning a liquid into gas. It means bringing gas to all corners of the country. The "gas paradox" of Russia refers to the stunning contrast between the country's extraordinary gas reserves and its status as a major gas producer and exporter, and the actual level of gas accessibility. Outside European Russia, gas access is uneven to nonexistent. In some areas with extensive hydrocarbon reserves and developed production sites, people are still heating their homes with firewood. The Russian state has made universal gas access a priority, and despite the occasional incompetence of the regional authorities in fulfilling their part of the gasification compact, a serious effort is under way to consign Russia's "gas paradox" to history.

The country-wide gasification program is about the construction of the distribution pipeline grids on the middle and micro levels. This program secures Gazprom's position as a domestic downstream gas distributor and provides for stable future revenue flow from sales by increasing the overall consumer base. Of course, Gazprom also benefits from the positive public image of being a caring and responsible company.

Most of the actual work of expanding the gas delivery infrastructure is being done by the major intra-regional gas distributors, but since Gazprom owns them, Gazprom gets the glory. Other gas industry players are part in the process, but their role is considerably smaller and they concentrate their efforts within regions of their production. In the Yamalo-Nenets and Sverdlovsk regions of the Urals Federal District, the independent gas producer ITERA is building feeder gas pipes and inter-settlement distribution pipelines. The other principal IGP, Novatek, through the purchase of a local gas distributor, assumed responsibility for gasification of the Chelyabinsk region, in the southwestern area of the Urals Federal District.

Cooperation between Gazprom and local authorities takes place on a wide range of measures aimed at increasing local availability of gas and coverage of the UGSS. Gazprom builds pipelines between isolated settlements and the local authorities lay street-wide networks and hook end-users to the grid. Between 2005 and 2011 the regional gasification programs expanded the gas supply network by 1,292 inter-settlement pipeline segments with total length of at least 18,500 kilometers. Of these, 1,048 are in rural areas—at least 16,000 kilometers of new pipe. In human terms, this translates to grid access to gas for more than 546,000 households in more than 2,500 remote villages. In these years the average country-wide gas accessibility went from 54.2% to 63.2%. The urban gasification level grew by 9 percentage points, to 70% in 2011; the rural figure rose by 11 percentage points, to 47%.[4] Gazprom's gasification of Russia is a somewhat slow-paced but steady process.

The vast region of eastern Siberia and the Far East has abundant natural gas reserves, but its gasification level, 6%, significantly lags behind the country-wide average. Less than 3% of rural settlements have access to gas.[5] In addition to the mind-boggling distances, other factors are the low population density and the harsh climate in this geographical region, and the consequent high cost of creating gas access. Nevertheless eastern Russia is not neglected in the current gasification programs. According to the technical details of the gasification concept, local gas distribution networks are expanded only in case it is economically reasonable to extend their coverage, but otherwise no new grids are deployed. In remote regions unconnected to the UGSS, gas is supplied from autonomous local sources through local distribution grids. Autonomous local gas sources include small explored hydrocarbon reserves or purpose-built gas storage facilities, which are supplied with fuel in liquefied form from the nearest lateral pipeline of the UGSS.[6]

Gas-storage facilities

The UGSS also needs to develop its gas-storage infrastructure: increase the system's storage capacity, the density (number of locations), and the productivity of underground gas storage facilities (UGSs). A developed network of underground gas storage facilities helps to balance the load on the UGSS, making it possible to level off seasonal gas consumption fluctuations through withdrawals from UGSs in the winter and injections into them in the summer. The clustering of gas production in the northern European part of Russia and the relatively insufficient total capacity of gas-storage facilities undermines reliable gas delivery to consumers and creates imbalance in the whole complex of the UGSS as a transportation network.

Most UGSs are in depleted gas fields, water aquifers, and salt caverns, all of which can be "repurposed" to be used as UGS facilities. This conversion involves installing wellheads (called wells) and other infrastructure so that gas can be injected into and withdrawn from a UGS facility. Withdrawing gas from a gas storage and putting it into distribution is similar to extracting it from the original gas field. It must be cleaned and "dried" before it can be routed to the trunk and other pipelines.

- *Depleted gas reservoir formations* are best suited for conversion to UGSs because there are existing wellheads, pipelines, and equipment to handle the gas, but they are often located far from areas of consumption.

- *Water aquifer reservoirs* are also used as UGSs. Aquifers are porous and permeable underground rock formations that act as natural water reservoirs. Gas can be injected into some of these formations, but they require significant investment for geological exploration and the installation of wellheads and equipment. Also, large volumes of gas remain unrecoverable after injection into aquifers.
- *Salt caverns* are well suited to natural gas storage. When a suitable salt deposit is discovered, a cavern is made by "salt cavern leaching": holes are bored in the deposit, water is injecting into it, and as it leaches through the salt it dissolves enough of it to create a hollow space. These UGSs are designed for small volumes of storage with frequent cycles of gas injections and withdrawals.[7]

Two important parameters of the reliability of a gas storage network are its working capacity and the maximum daily withdrawal rate. The working capacity shows the potential of the gas storage system to smooth out seasonal demand fluctuations and provide flexibility of gas supply. (Each UGS requires a certain "base" level of gas—also called a cushion—to maintain adequate pressure for withdrawals. The working capacity is the maximum gas storage capacity less this base.) The withdrawal rate indicates the reliability of gas delivery in peak loads and under various emergency situations. In 2005 Gazprom adopted a plan to expand the UGSs' maximum daily withdrawal rate to 758 mcm by 2010–11, but it failed to reach this goal because of the world economic crisis and the sharp demand fall in 2009. As a result, the number of gas storage facilities, their capacity, and the number of wells to inject gas into and withdraw from underground storages remained virtually unchanged from 2007 to 2011 (see Table AppB.1). As of the end of 2012, Gazprom's total working capacity was 66.3 bcm and its maximum daily withdrawal rate was 671 mcm.

On December 20, 2012, there was a record-breaking cold snap in Russia. Gazprom reached the historic record withdrawal rate of 670.7 mcm a day, which was just shy of the maximum withdrawal rate of 671 mcm a day. It became evident that the gas storage capacity was just barely large enough—there was no margin of safety. In response to this situation Gazprom has adopted a new program for developing its underground storage facilities by 2020. They plan to upgrade and modernize existing storage facilities, to improve their productivity and expand their total capacity. They also plan to construct new facilities to add 18 bcm of new working capacity by 2015 and to increase the maximum daily withdrawal rate to 1 bcm a day by 2020.[8]

Table AppB.1 Gazprom's underground gas-storage facilities in Russia

	2007	**2008**	**2009**	**2010**	**2011**
Number of UGS facilities	25	25	25	25	25
Total working capacity (bcm)	64.9	65.2	65.2	65.4	66.7
Number of wells at UGS facilities	2,614	2,615	2,601	2,564	2,602

Source: "Underground Gas Storage Facilities" (www.gazprom.com/about/production/transportation/underground-storage).

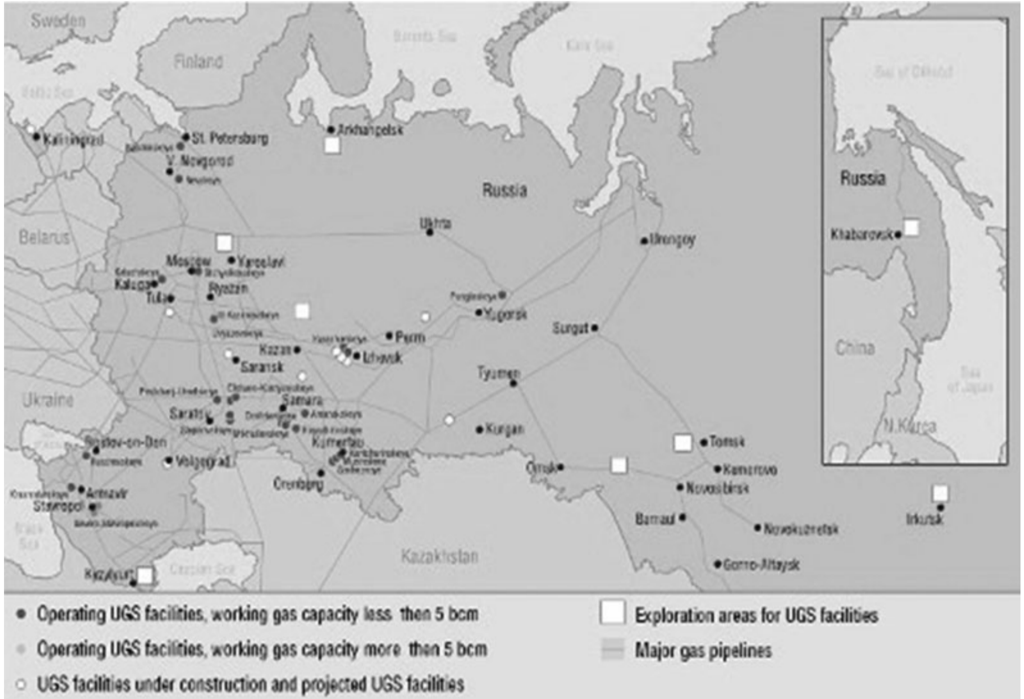

Figure AppB.2 Gazprom's operational and planned UGS facilities in Russia
Source: "Underground Gas Storage Facilities" (www.gazprom.com/about/production/transportation/underground-storage).

The geographic diversification of UGS facilities is just about as important as the capacity. Optimal spatial allocation of gas storage capacities requires careful placement of storage facilities at underloaded junctions and lateral pipelines within the delivery grid. The main challenge is to situate UGS facilities near end-users for rapid responses to peak loads caused by unanticipated demand spikes, especially those caused by extreme weather. Currently 25 storage facilities are clustered in the industrial regions of Russia, near big cities, among which 17 have been converted from depleted gas fields and 8 from aquifers. Construction is under way to increase capacity in those heavily populated areas, and also to create capacity at a number of locations in Russia's Far East, where UGS facilities will be constructed in suitable formations such as depleted gas fields and salt deposits. West of the Urals, Gazprom is currently constructing new storage facilities in the Volga River basin, near Bednodemyanovsk and Volgograd; near Kaliningrad, on the Baltic Sea coast; and in Udmurtia, east of Moscow. By 2015 the company plans to begin construction of new facilities near Novomoskovsk, south of Moscow; in the Kurgan region in the South Urals; and in the Republic of Tatarstan. Gazprom also plans to begin exploring eastern Siberia and the Far Eastern Federal District to find suitable formations for construction of new underground gas storages in these remote territories (see Figure AppB.2).

Notes

1. Gazprom, *Gazprom in Questions and Answers* (online book) (http://eng.gazpromquestions.ru/fileadmin/files/2013/view_version_eng_25.06.2013.pdf, 40).
2. Gazprom, "Megaproyekt Yamal" [Yamal megaproject] (www.gazprom.ru/about/production/projects/mega-yamal).
3. Gazprom, "Sakhalin-Khabarovsk-Vladivostok" (www.gazprom.ru/about/production/projects/pipelines/shvg).
4. Gazprom-MezhRegionGaz, "Gasifikatsiya regionov Rossiskoy Federaltsi" [Gasification of regions of the Russian Federation] (http://mrg.ru/node/16).
5. Gazprom-MezhRegionGaz-Novosibirsk, "Gasifikatsiya naselennikh punktov dalnevo vostoka ostayetsya na niyzkom urovnye" [Gasification of population centers of the Far East continues on a low level] (www.nrg.org.ru/about/news/detail.php?ID=1496390).
6. Pousenkova (2010); Gazprom-MezhRegionGaz, "Gasifikatsiya regionov Rossiskoy Federaltsi" [Gasification of regions of the Russian Federation].
7. For further reading on UGSs, see "Natural Gas Storage" (http://en.wikipedia.org/wiki/Natural_gas_storage#Aquifer_reservoir).
8. Gazprom, "Underground Gas Storage Facilities" (www.gazprom.com/about/production/transportation/underground-storage).

References

Gazprom 2006. *Gazprom Annual Report*. Moscow: OAO Gazprom (http://tools.euroland.com/arinhtml/RU-GAZ/2006/AR_ENG_2006.pdf).

Gazprom. 2012. *Gazprom in Figures 2008–2012, Factbook*. Online book. Moscow: OAO Gazprom (www.gazprom.com/f/posts/55/477129/gazprom-reference-figures-2008-2012-eng.pdf).
Pousenkova, Nina. 2010. "Rossikii 'Gazprom' v gazpromovskoy Rossii" [The Russian "Gazprom" in Gazprom's Russia]. *Istoria Novoy Rossii* [Contemporary Russian history] (online magazine), 2008 (www.ru-90.ru/node/1320).
Stern, Jonathan. 2009. "Future Gas Production in Russia: Is the Concern about Lack of Investment Justified?" *Report*. Oxford, UK: Oxford University, Oxford Institute for Energy Studies.

Index

Note: Locators followed by the letter 'n' refer to notes.