



# It Don't Mean a Thing, If It Ain't Got That Swing: Why Gas Flexibility Is High on the Agenda for Russia and Europe

## Introduction

The question of flexibility is always important for the gas industry because of the seasonal nature of gas demand. Flexibility is a major concern in Europe because of declining indigenous production which had provided a significant amount of seasonal swing in the past. Historically, the production swing by the Groningen field was key to flexibility in Northwest Europe. With gas output at the field down more than 30 Bcm in just three years, a lot of this flexibility has been lost. European gas imports have grown, but they have a flatter seasonal profile than consumption. Moreover, and not only in the past few years, Europe's growing call on gas has been met with rising gas imports from Russia, and the seasonal demand swing has been also secured by flexible Russian gas deliveries.

In the past five years Russia acted as a swing gas supplier for Europe. After the lull of 2014-16 in 2017-18 Russia ramped up its gas production and exports to Europe. An obvious, but often forgotten, characteristic of a recovery, however, is that the ability to constrain and then quickly revive production is different from the ability to increase it beyond the previously achieved level. With faster-than-expected European gas market rebalancing and tightening in 2018-19, the question is: will the call on Russian gas exceed available domestic supply in the near term? This brings the issues of production capacity and flexibility of Russia's gas in meeting Europe's needs into the spotlight.

Will Russia have enough gas flexibility in the future? Recent research demonstrated that the 'safety cushion' of massive spare gas productive capacity in Russia has been quickly shrinking<sup>1</sup>. This paper extends the analysis to the demand side and looks at how Russia meets its own flexibility requirements in the domestic market. Could peak domestic demand for gas in Russia introduce constraints on seasonal export flow flexibility? And what is the best way to address the problem – by upstream investments in additional capacity or downstream investments in storage?

The concerns are exacerbated by 'Problem-2020' – the possibility of a major Russian-Ukrainian gas transit crisis (following the expiration of the existing transit contract at the end of 2019) with the risk of an extended cutoff of Russian gas imports to Europe. This focuses even greater attention on the issue of flexibility requirements and gas storage capacity both in Europe and in Russia. In the end, Europe's choice boils down to three options: to continue relying on Russian gas as the main source of flexibility; to focus on imports of LNG; to invest in expansion of its storage facilities; or to use some combination of all three.

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<sup>1</sup> Yermakov, V. (2018). 'Shrinking surplus – the outlook for spare gas productive capacity', Oxford Energy Insight 42.

The aim of this paper is four-fold:

- to research the evolution of flexibility requirement by Russia's domestic market
- to assess in which proportions Russia has used production and storage to ensure it has enough flexibility on the supply side
- to evaluate the need for additional flexibility in the future
- ultimately, to answer the question as to whether Russia is going to have enough flexibility, or will it face the trade-off between satisfying its own peak demand and responding to possible higher export calls on its gas?

## Russia's climatic patterns and gas demand

Weather is an important driver of Russian gas consumption. For Russia, with its climatic pattern of extremely cold winters and hot summers, the peaks are exacerbated leading to wide seasonal swings in gas consumption. The variations in temperature drive industrial and residential natural gas demand owing to the needs for space heating and, to a much lesser degree for Russia as a northern country, cooling.

Very high levels of gas penetration in Russia mean high elasticity of gas demand to changes in temperature. The reported level of gasification in the country in 2018 was 68.1% (71.4% in the cities and 58.7% in the rural areas) with 28.5 million apartments and private houses, 31.6 thousand industrial sites, and 326,100 utilities units (boilers) connected to Gazprom's gas network<sup>2</sup>.

In the Russian power system, the main user of gas in the country, thermal generation plants produce the bulk of electricity (68% of total electricity production in 2017). Combined heat and power plants (CHP) constitute almost half of this share. The fuel mix for the thermal power plants is dominated by natural gas with 71% of the total in 2017. It varies substantially by region, reflecting regional supply characteristics. Gas constitutes about half of the fuel mix in the European part of the country, over 70% in the Urals, but is almost not present in Siberia and the East, where the thermal plants are using mostly coal.

The temperature patterns for Russia exhibit vast seasonal range that increases toward the country's interior. Extreme winter cold is characteristic of most of Russia; the frost-free period exceeds six months only in the North Caucasus and varies with latitude from five to three months in the European section to three months to less than two in Siberia. The net result is the dominance of two seasons, winter and summer, over brief springs and autumns. Figure 1 identifies Russia's federal districts and key regions.

In the process of research for this paper a dataset of monthly regional temperatures was built utilizing the data reported by the System Operator of Russia's electricity system for different regional areas of the country (see Figure 2). This dataset was then used to calculate heating degree days (HDDs) for each of the respective zones<sup>3</sup>.

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<sup>2</sup> Gazprom in figures, 2018

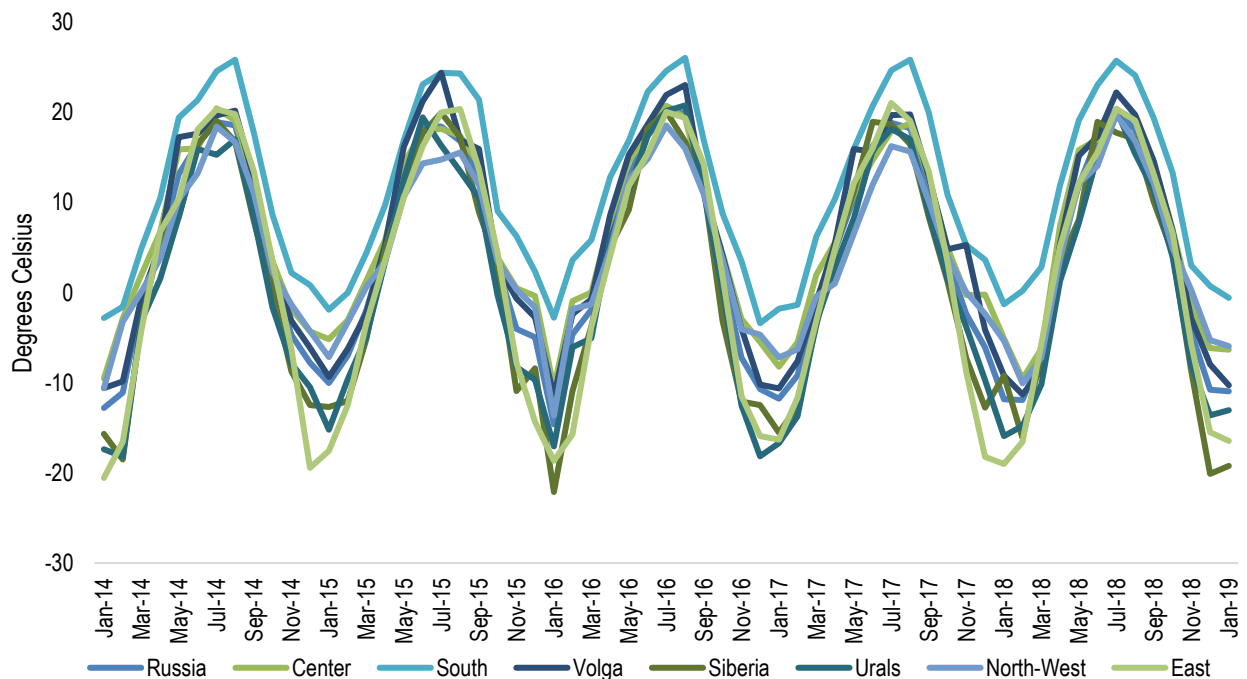
<sup>3</sup> A degree day is calculated as the difference between a reference temperature and the average of the daily temperature. If the difference is positive it is counted as HDD. For this calculation a reference temperature of 12.3 degrees Celsius was used. HDDs were then summed up on a monthly and yearly basis.

**Figure 1: Russia's federal districts and key regions**



Source: guideofftheworld.com

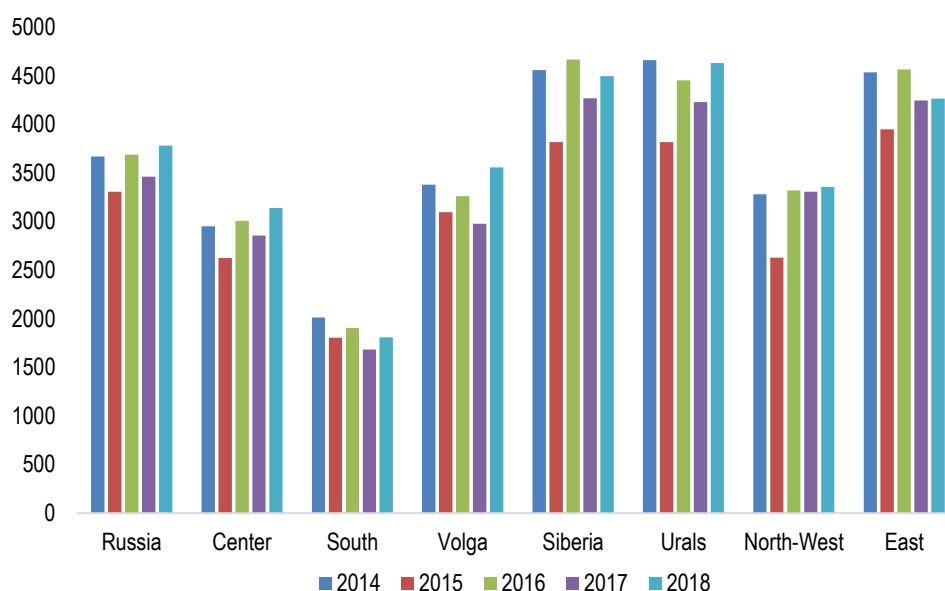
**Figure 2: Monthly average temperatures in main regional areas of UES of Russia**



Source: Author, data from System Operator of Russian electricity system

The HDD data for Russia is a good general indicator for year-on-year changes in temperature and produces a correlation with gas demand. For example, the years 2014, 2016, and 2018 were colder, and the years 2015 and 2017 milder for most of Russia's regional areas (see Figure 3).

**Figure 3: Heating degree days (HDD) for main regional areas of UES of Russia**



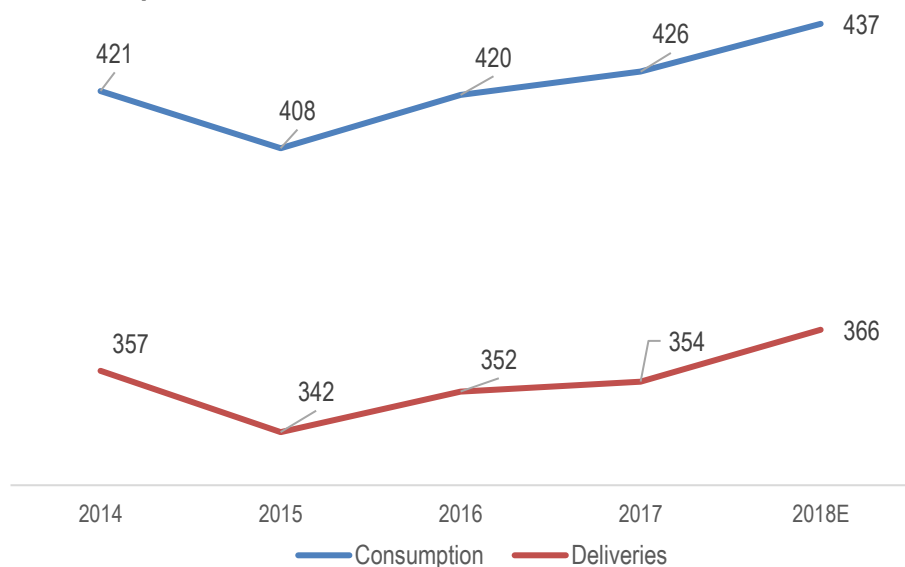
Source: Author's calculation

The difference between colder 2014 and warmer 2015 and between colder 2018 and warmer 2017 amounted to about 12 Bcm of gas consumption and deliveries. In 2017, the year-on-year growth happened during a relatively warm year because it was the year when Russia resumed economic growth after recession.

### Russian statistics on domestic consumption and regional gas deliveries: rebuilding the missing data

There are two main statistical sources that represent industry reporting on gas demand and available via the Central Dispatch Unit of the Fuel and Energy Complex (CDU TEK), a federal budgetary organization that collects and reports on a broad range of Russian energy data. The first one is the annual data series on gas consumption with structural and regional breakdown. The second one is the monthly data series on end-of-pipe gas deliveries via Russia's Gas Transportation System (GTS) with regional breakdown. Gas consumption data is net of technical use of gas in GTS which, in the past few years, has been in the range of 33-38 Bcm per annum (see Figure 4).

**Figure 4: Gas consumption and deliveries in Russia**

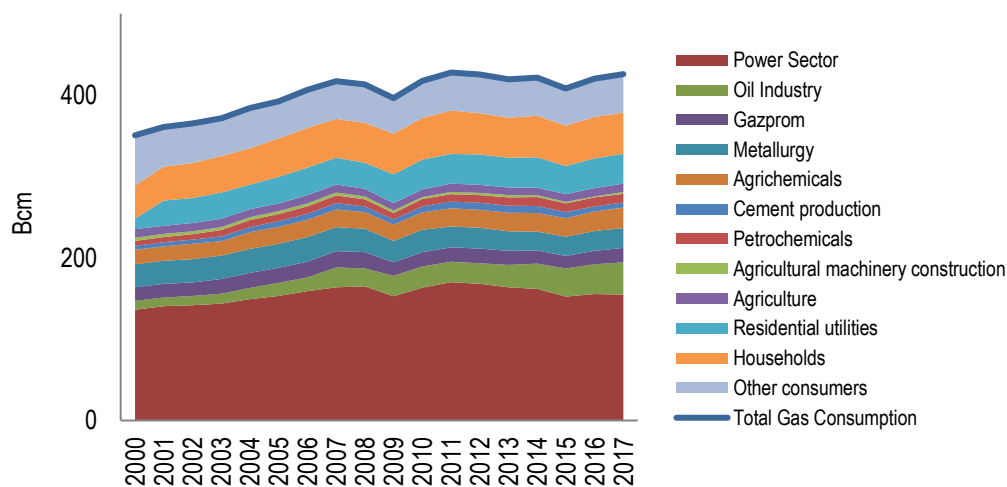


Source: CDU TEK and Gazprom

The statistical data series on regional gas deliveries via GTS were routinely available to analysts from 2002 to 2014. But starting in 2015, in an abrupt move, CDU TEK interrupted data release of several data series on the performance of Russia’s gas industry, including the one on monthly regional gas deliveries. Apparently, this occurred because Gazprom, the ultimate supplier of the data on the GTS operations, stopped passing on the related statistical series to CDU TEK, citing commercial sensitivity issues.

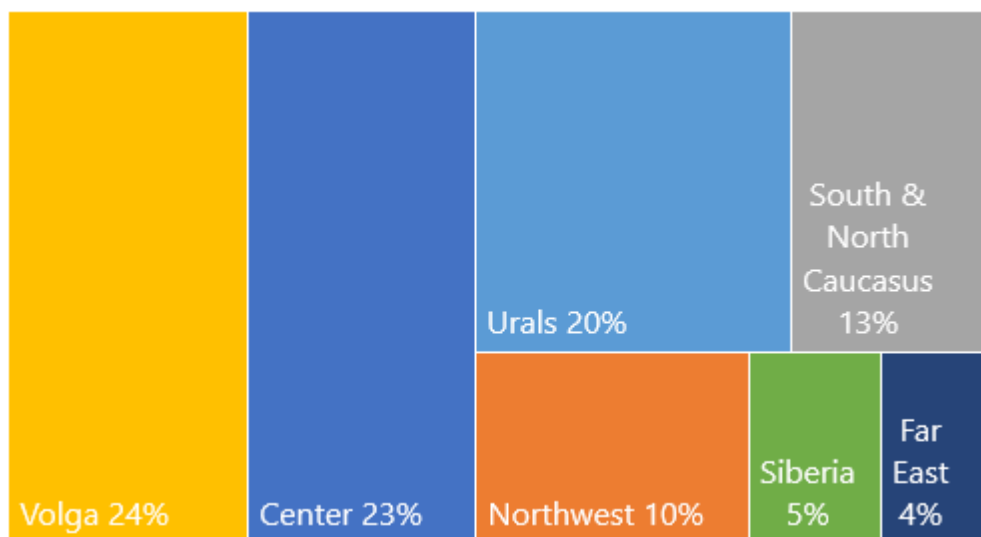
From this point on, the availability of disaggregated statistics on Russian gas consumption – never very good to begin with, owing to the long-standing tendency to focus on production numbers and disregard consumption data – has deteriorated. The summary data on total gas consumption and total gas deliveries is still provided by Gazprom and the Ministry of Energy in annual releases. CDU TEK still provides annual data on regional and sectoral gas consumption, but these statistics come with significant delay, up to two years. At present, the annual data for 2017 with regional and sectoral breakdown of gas consumption is available (see Figure 5 and Figure 6). But the up-to-date information on monthly regional gas deliveries is missing.

**Figure 5: Russia’s sectoral gas consumption**



Source: Author, data CDU TEK

**Figure 6: Regional shares of Russia's gas consumption by federal district in 2017**



Source: Author, data CDU TEK

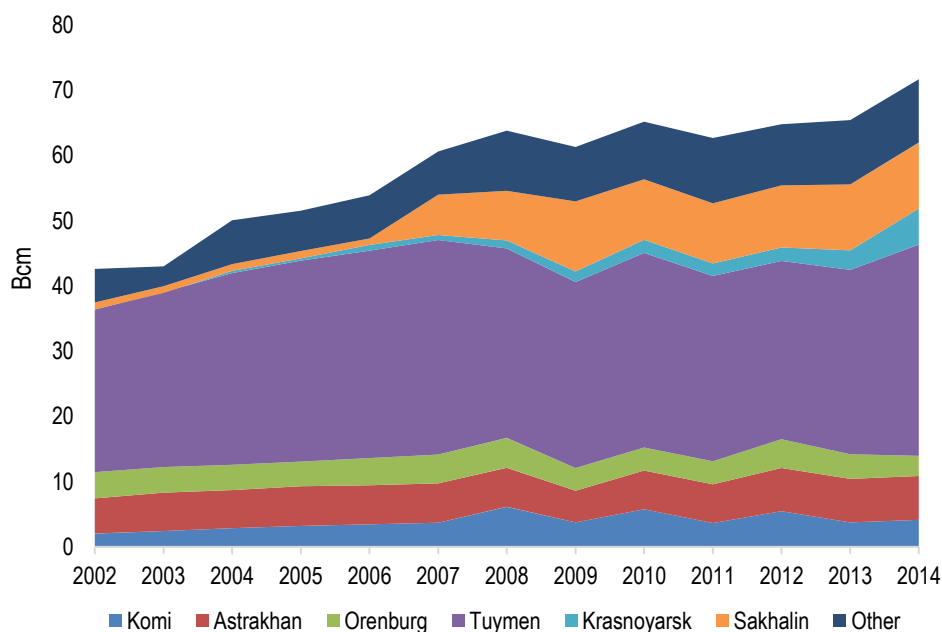
There are three broad segments, each accounting for about one-third of gas consumption in Russia. These are: electric power plants which use gas for electricity and heat generation within electric power; industry; and households and residential utilities.

Regionally, gas consumption is concentrated in the European part of Russia. Eastern Siberia and Russia's Far East combined consume less than 10% of the total.

The difference between gas consumption and end-of-pipe gas deliveries for Russia has been hovering between 60-70 Bcm per annum in the past ten years. The divergence stems from the use of gas outside of Unified Gas System (UGS) network, primarily that consumed by the oil and gas industries in the areas of production for local power generation, gas reinjection etc. It is noteworthy that, for most of the gas consuming regions in Russia in the UGS area, the data on gas consumption and gas deliveries do not differ or differ very little. The difference between gas consumption and gas deliveries has been concentrated in a handful of Russian regions, all of them being significant free gas and/or associated gas producers. The last year for which there is a breakdown of regional data on both gas consumption and gas deliveries is 2014 (see Figure 7).

This makes the challenge of recreating the monthly regional data on gas deliveries for 2015-2017 laborious, but relatively straightforward. There are two general drivers for changes in the amount of gas deliveries: one is, as discussed above, heating requirements driven by temperature dynamics; the other is structural change in consumption. Since the annual data on regional gas consumption has been reported for 2015-2017, this takes care of the structural change driver. The task then simplifies to recreating seasonality pattern for gas deliveries for each region. First, the reported data on gas consumption by region is adjusted to arrive at annual gas deliveries by region. As shown above, for 60 out of 70 Russian regions the difference between consumption and deliveries is either non-existent or relatively small. For the regions where this discrepancy is significant, the appropriate adjustments are made based on historical trends. Then the amount of annual gas deliveries for each region is distributed on a monthly basis throughout the year in accordance with historical correlation between gas deliveries and monthly heating degree days for the respective regions within the known annual amount.

**Figure 7: Difference between reported gas consumption and end-of-pipe gas deliveries via UGS**



Source: Author, data CDU TEK

For 2018 the task is more difficult because the data on regional gas consumption has not been reported. This data will only become available at the end of 2019. At present, the only guidance regarding Russia's gas deliveries for 2018 was the statement by Gazprom CEO Alexey Miller on 28 December 2018<sup>4</sup>. He said that gas deliveries via UGS in 2018 increased by 12 Bcm year-on-year, thus amounting to 366 Bcm.

This incremental increase for 2018 was distributed among Russia's federal districts based on relative temperature changes for each respective area. The following distribution by region was done proportionally relative to 2017 shares. For the last step, the monthly distribution throughout the year for each region was calculated by taking into consideration the temperature pattern in 2018 relative to previous years. As such, this approach misses possible structural changes that might have occurred in regional usage of gas in 2018 but represents the second-best solution to the problem of the missing data. With this caveat in mind, the addition of the estimated data on monthly regional gas deliveries to the reported monthly deliveries data fills an important statistical gap. The following analysis of Russia's gas flexibility is based on this dataset combining the reported statistics for 2002-2014 with the reconstructed numbers for 2015-2018.

## Gas seasonality patterns for Russia

There are several metrics commonly used to describe seasonality of gas demand:

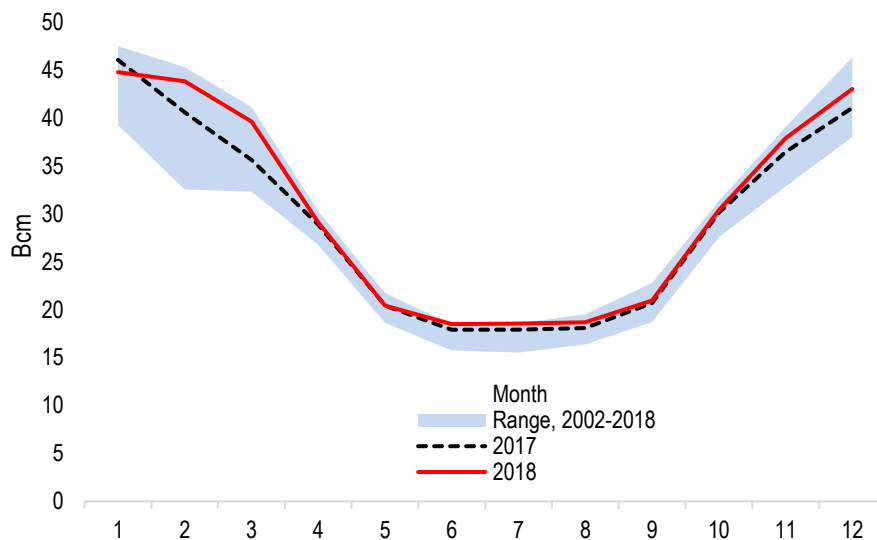
- The absolute swing in seasonal consumption by month (the difference between the highest and the lowest volumes of monthly consumption each year)
- Peak-to-trough ratios for monthly consumption (the ratio of December consumption to July consumption each year)
- Peak-to-average swings and ratios for gas consumption
- Trough-to-average ratios for gas consumption

<sup>4</sup> <http://www.gazprom.com/press/news/miller-journal/2018/192617/>

The combination of these tools provides a comprehensive assessment of seasonal patterns in gas demand.

Russian gas deliveries demonstrate strong seasonality owing to a distinct heating season. Peak demand (with significant variation around the mean) falls on the coldest months of December, January, and February, while trough demand usually occurs in June, July or August (see Figure 8).

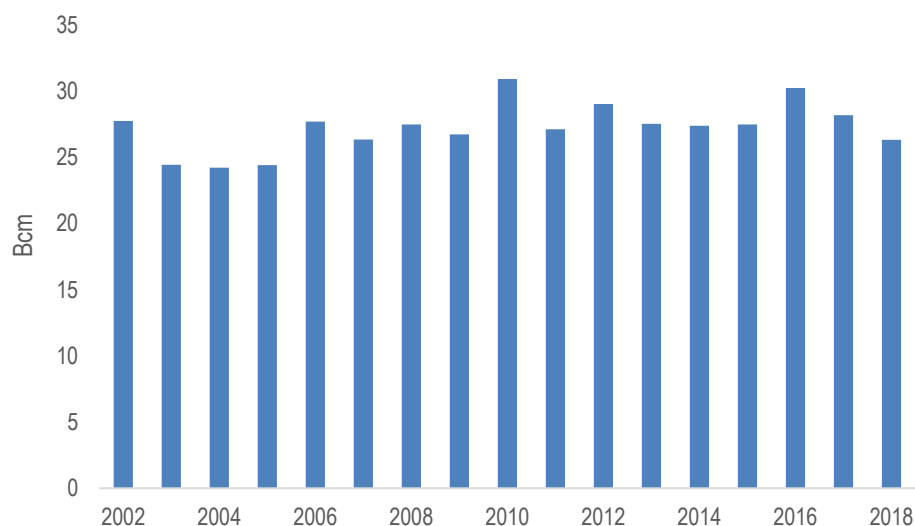
**Figure 8: Total Russian gas deliveries by month, 2002-2018**



Source: Author's modelling for 2015-18, CDU TEK for 2002-14

The absolute difference between the maximum and minimum demand months has been 26.3-30.9 Bcm over the past ten years (see Figure 9).

**Figure 9: Absolute difference between maximum and minimum levels of annual gas deliveries, Bcm**

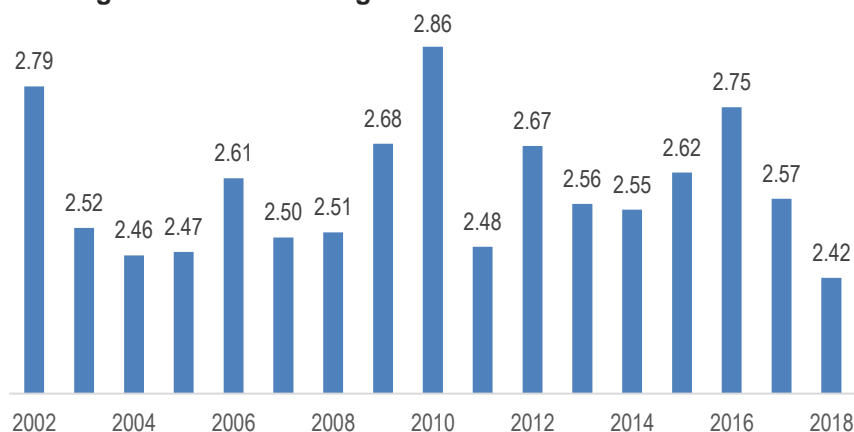


Source: Author's modelling for 2015-18, CDU TEK for 2002-14

Russian gas deliveries are thus typically about 2.4–2.9 times higher in the coldest months than in the warmest months of the year. (see Figure 10)



**Figure 10: Peak-to-trough ratio for Russian gas deliveries**

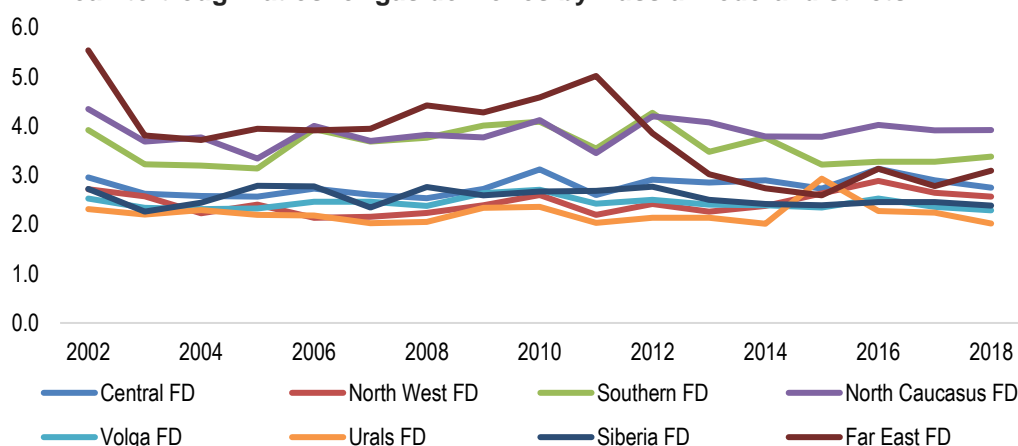


Source: Author's modelling for 2015-18, CDU TEK for 2002-14

It is noteworthy that the key difference between colder and warmer years and, correspondingly, higher and lower annual gas deliveries is the length of the cold weather during winter, not the peak demand. For example, the reported incremental 12 Bcm growth in gas deliveries in the year of 2018 compared with 2017 occurred primarily because February and March were significantly colder than usual, with increased gas use year-on-year. However, the absolute peak and peak-to-trough ratio were higher in 2017 than in 2018. The average peak-to-trough ratio for 2002-2018 for Russia was 2.6, implying little change in seasonality on a national level over the observed period.

With regards to regional differences in peak-to-trough ratio, much higher ratios can be observed for the Far East, South, and North Caucasus, than for European Russia and the Urals (See Figure 11).

**Figure 11: Peak-to-trough ratios for gas deliveries by Russian federal districts**

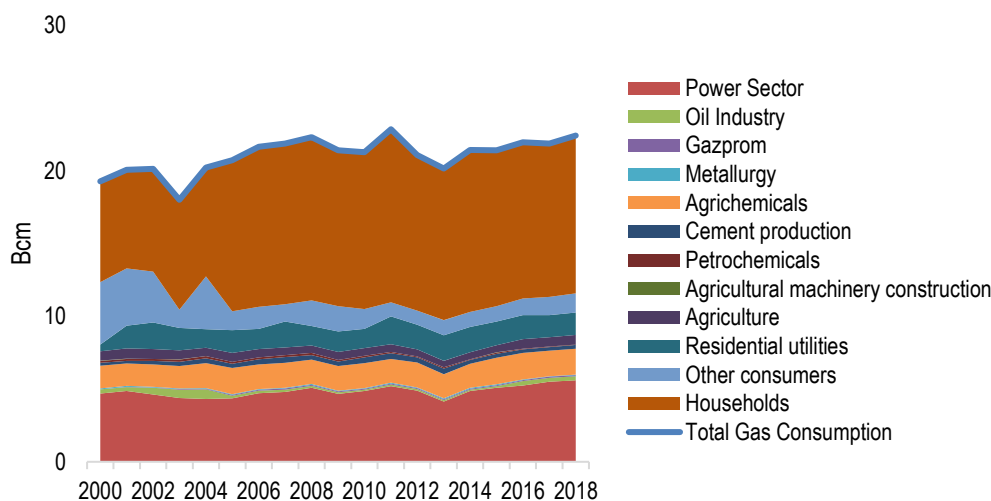


Source: Author's modelling for 2015-18, derived from CDU TEK data for 2002-14

This variation is primarily due to the composition of demand as regions with a high share of residential demand usually have high seasonality, while regions with a greater share of industrial gas consumption have lower seasonality.

The composition of gas consumption for North Caucasus federal district, with the highest seasonality among Russia's federal districts, shows that households account for almost half of gas use in the district (See Figure 12).

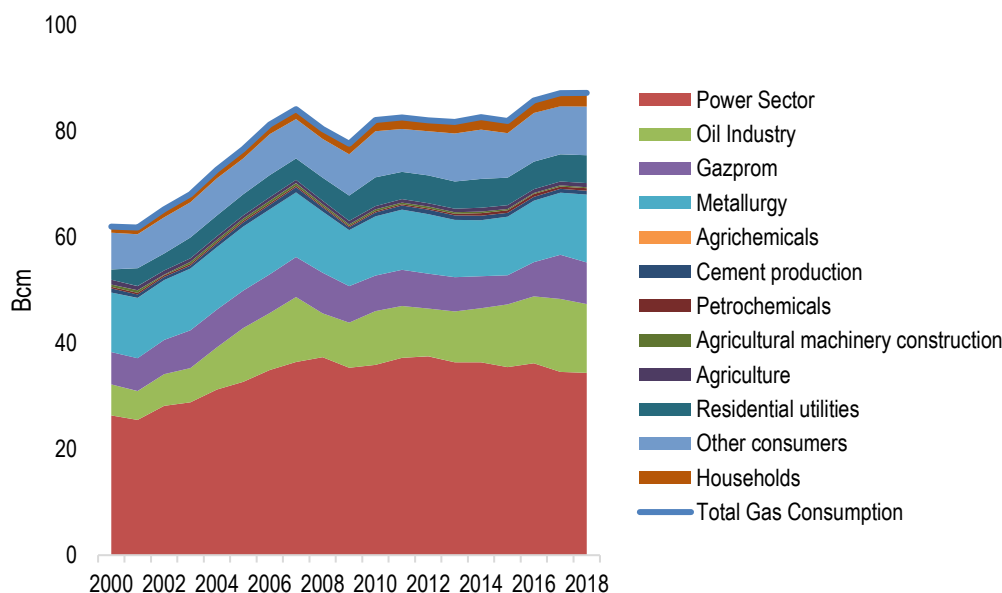
**Figure 12: Composition of gas consumption for North Caucasus federal district**



Source: Author, data CDU TEK, estimate for 2018

At the other end of the spectrum, the federal district with the lowest seasonality is Urals where gas use mostly occurs in the industrial sector (See Figure 13).

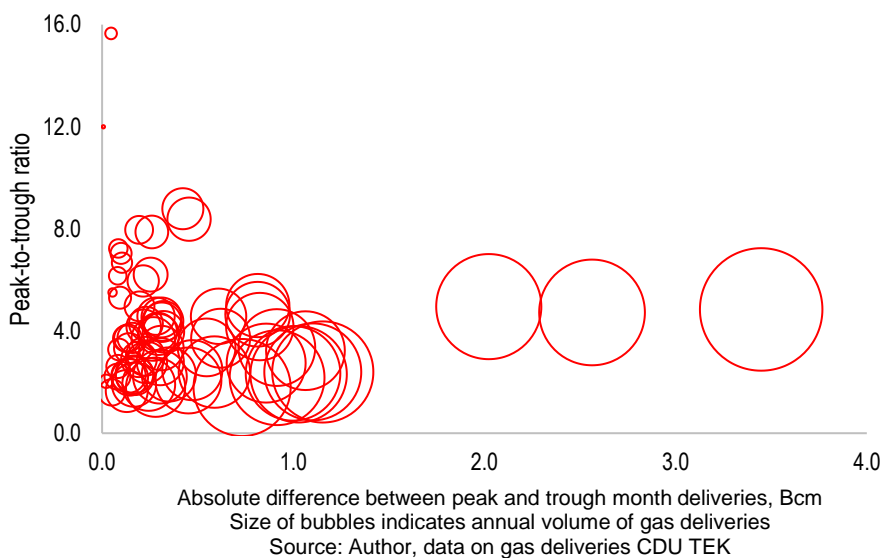
**Figure 13: Composition of gas consumption for Urals federal district**



Source: Author, data CDU TEK, estimate for 2018

Among Russia's individual regions there is considerable variation in the degree of seasonality in gas deliveries. In 2014, the last year for which the reported data is available, the national ratio of peak-to-trough consumption was 2.79. It is noteworthy that 46 regional subdivisions, or the so-called 'subjects' of the Russian Federation, out of 71 in the UGS zone had ratios above 2.8, indicating greater seasonality than Russia as a whole, and 14 regions had ratios above 5.0, indicating a very high degree of seasonality (see Figure 14).

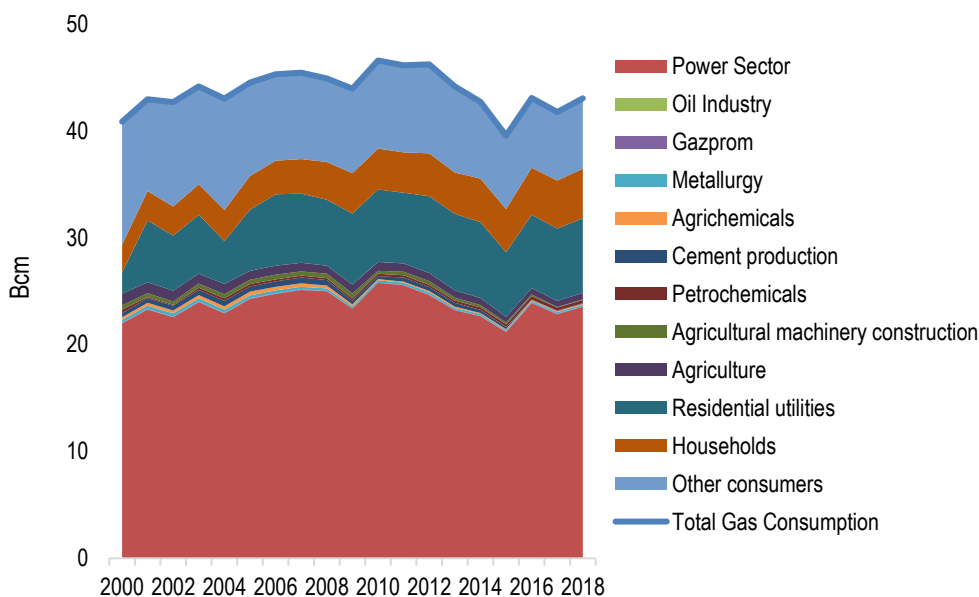
**Figure 14: Absolute swing in consumption and peak-to-trough ratios for Russian regions in 2014**



One clear outlier on this chart is the Republic of Kalmykia in Russia’s Southern federal district with an extremely high peak-to-trough ratio of 15.7. Households and residential utilities account for 95 per cent of end-of-pipe gas deliveries to Kalmykia which is one reason for high seasonality, another being a very continental climate with hot summers and occasionally very cold winters, especially in the northern parts of the republic where temperatures can drop to minus 35 degrees Celsius in January.

Three regions with high absolute levels of gas use and high absolute levels of the swing between highest and lowest months in terms of gas consumption are the city of Moscow, Moscow region, and Tyumen region. Among these, the city of Moscow and Moscow region combined represent the largest recipient of end-of-pipe gas deliveries via UGS in Russia accounting for 42.7 Bcm, on par with natural gas consumption in France. The composition of gas consumption for this agglomeration is presented in Figure 15.

**Figure 15: Gas consumption in Moscow region and the city of Moscow**



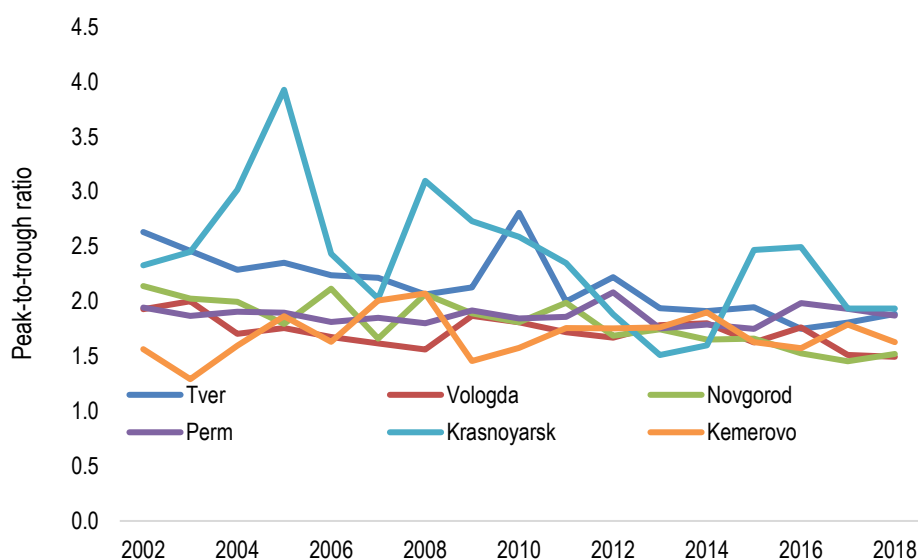
Source: Author, data for 2000-2017 from CDU TEK, author's estimate for 2018

The regions in a category of very high peak-to-trough ratios (above 5.0) include Ivanovo, Kursk and Tambov regions in the Central federal district, Karelia and Pskov regions in Northwest federal district, Adygeya and Rostov regions in the Southern federal district, Dagestan, Kabardino-Balkariya, Chechnya and Ingushetiya in the North Caucasus federal district, Altai in Siberia federal district, and Sakhalin in Far East federal district. What all these regions have in common is high gas use by households and residential utilities either directly, or indirectly, via supplies of gas to smaller combined heat and power plants that, in turn, serve predominantly residential customers with variable seasonal demand patterns.

Most Russian regions with even distribution of sectoral consumption among electric power, industry and residential users exhibit less seasonality, as should be expected. For these, the peak-to-trough ratio typically ranges from 2.0 to 3.0 – still a relatively high number compared to most of the world’s developed countries. As explained above, this is the result of the high share of gas in Russia’s primary energy balance and the northern continental climate.

Regions with consistently low seasonality (peak-to-trough ratio less than 2.0) throughout most of the study period include Tver, Vologda, Novgorod, Perm, Krasnoyarsk and Kemerovo (See Figure 16). Not surprisingly, these are industrialized regions which tends to lead to stable gas consumption during the year. The second common feature for these regions is the concentration of gas consumption in the power sector in large GRES – regional power stations that produce mostly electricity and therefore exhibit less seasonal demand variation than combined power and heat stations.

**Figure 16: Russian regions with low seasonality of gas demand**



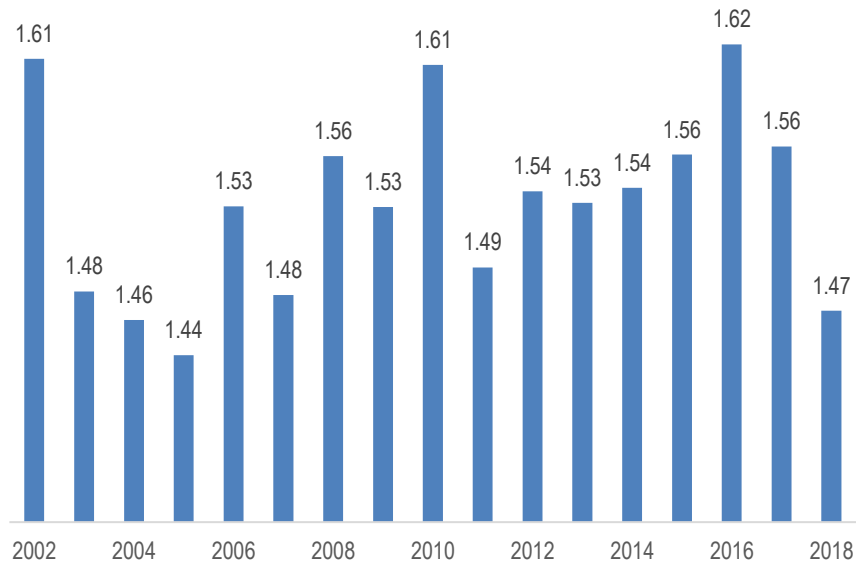
Source: Author’s modelling for 2015-18, CDU TEK data for 2002-14

For the most part, the regions with relatively low seasonality tend to have a greater share of industrial gas users, as mentioned above. This tends to help keep gas consumption even over the course of a year. Similarly, regions with high gas consumption by electric power, particularly those with large GRES, typically show less seasonality since demand for electricity is less seasonal than for heat. For example, Kostroma, Tver, Tatarstan, Ryazan, and Bashkortostan, where electric power generation is a large gas consumer (as opposed to many smaller combined heat and power plants or *teplotsentrali*), the seasonality ratios have been quite stable and much lower than the national average.

Peak-to-average ratio is useful for assessing the winter peaks of consumption. During the coldest months of the year, Russian gas consumption has been typically around 53 per cent higher than the average annual monthly consumption during 2002-2018 with occasional variations being higher than the average by 44 per cent in 2005 and by 62 per cent in 2012. This ratio remained relatively stable over the study period, just like the peak-to-trough ratio considered above (See Figure 17).

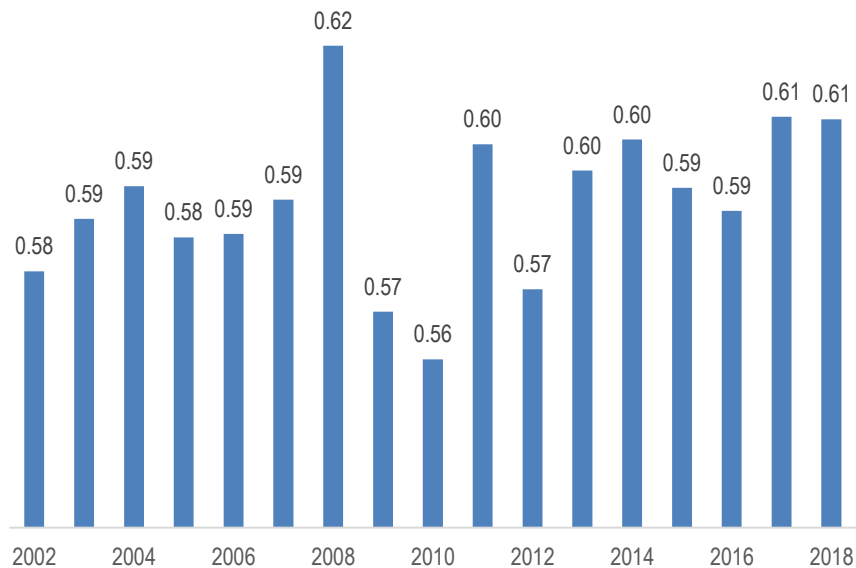
Similarly, the trough-to-average ratio describes the summer trough period. In the warmest months of the year, the amount of gas deliveries in Russia nationally has been around 59 per cent of the annual average. (See Figure 18).

**Figure 17: Peak-to-average ratio for Russian gas deliveries**



Source: Author's modelling for 2015-18, CDU TEK for 2002-14

**Figure 18: Trough-to-average ratio for Russian gas deliveries**

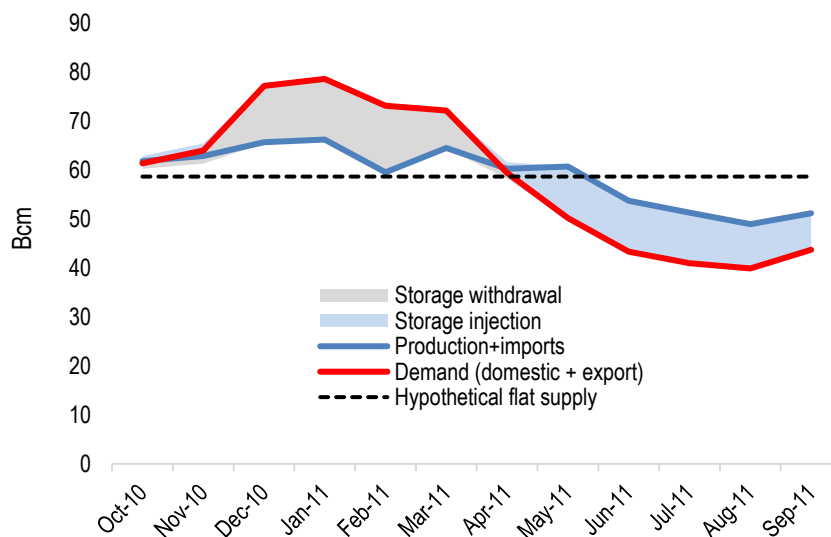


Source: Author's modelling for 2015-18, CDU TEK for 2002-14

## Seasonal shape of gas demand for Russia and flexibility needs

The typical seasonal shape for Russian gas deliveries determines the amount of seasonal flexibility requirement that is usually provided by a combination of production swings and gas withdrawal from storage. Figure 19, based on the monthly data for the season of 2010-11, demonstrates that during the cold months the production profile is higher than the average for the year and storage is used for withdrawal. During the warm months production declines and the amounts of gas produced over and above demand are injected into storage.

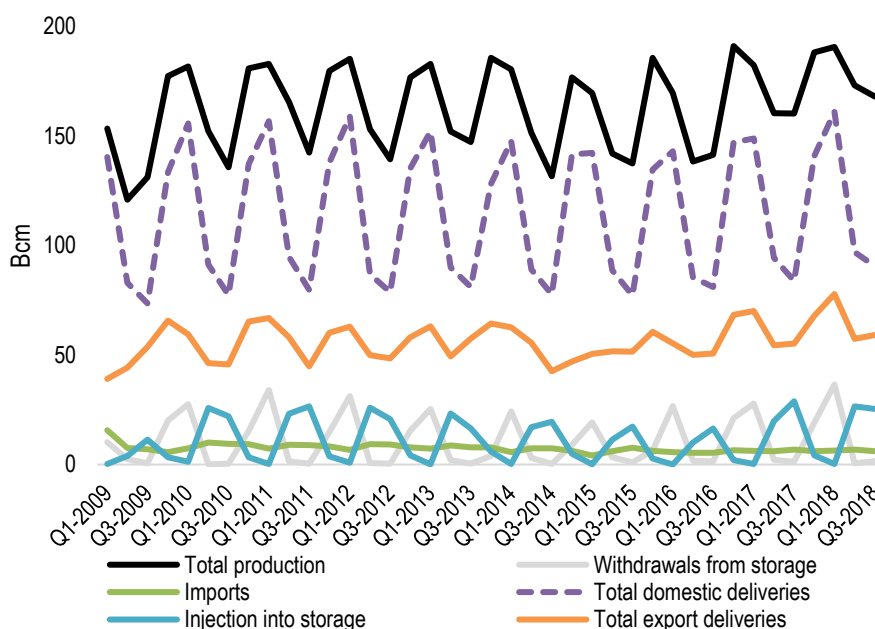
**Figure 19: Seasonal shape of Russian demand, supply and storage dynamics, 2010-2011**



Source: Author, data from CDU TEK

In addition to gas storage use, Russia swings its gas production seasonally to provide flexibility (See Figure 20).

**Figure 20: Seasonality in Russian production, consumption, export and storage**

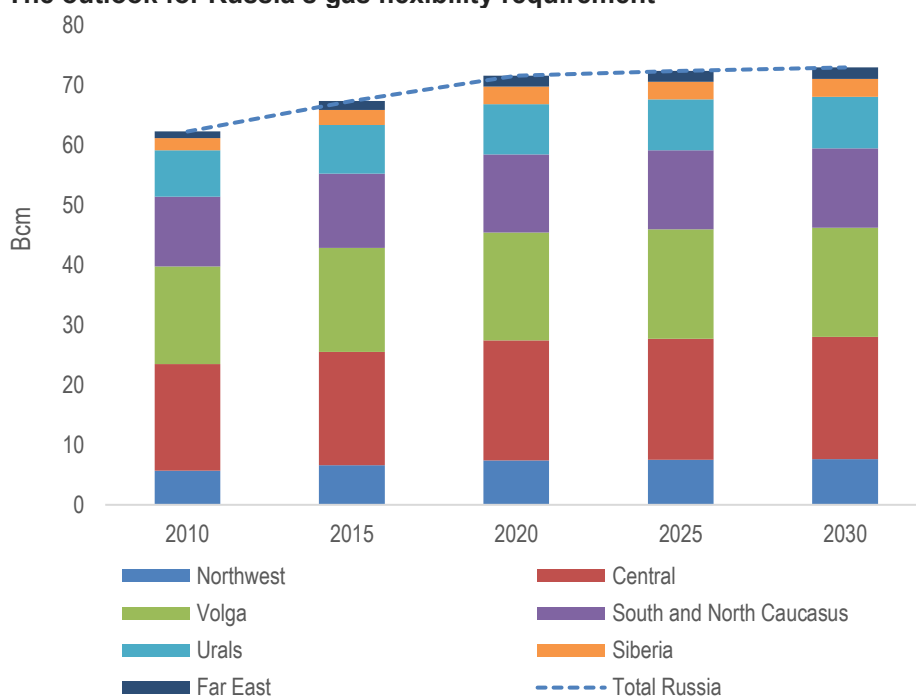


Source: Author, data CDU TEK

In this paper the flexibility requirement for Russia was calculated as the size of the seasonal swing in total usage of gas in Russia between cold season (Q1-Q4) over a hypothetical flat quarterly supply profile necessary to meet demand for the whole year. In the period since 2009, the calculated flexibility requirement has been between 46.2 and 63.6 Bcm. Normalizing for differences in annual deliveries within this period it ranged between 13.1 to 18.1 Bcm per 100 Bcm of gas deliveries via UGS.

The projections of flexibility needs to 2030 by federal district contained in the materials of the General Scheme of Russia's Gas Industry Development suggest a relatively limited growth for the period which should allow Gazprom to meet its targets with the ongoing storage expansion program (See Figure 21).

**Figure 21: The outlook for Russia's gas flexibility requirement**



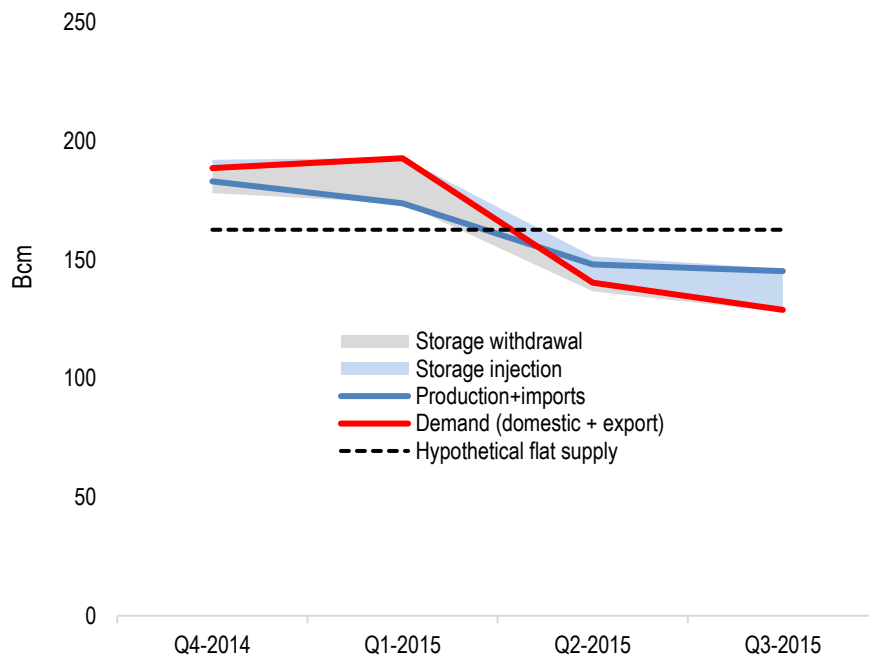
Source: General Scheme of Russia's gas industry development to 2030

Russia's seasonal flexibility needs are achieved by using gas storage and by seasonal swings in production. During the period of extremely high surplus of productive capacity in Russia (2014-2016) increasing output and shutting it down seasonally was used extensively.<sup>5</sup>

The contribution of production swings has declined recently, and the role of storage increased. Comparing the gas seasons of 2014/15 and 2017/18 presented in Figure 22 and Figure 23 provide an illustration of the flatter production profile in the past year in response to higher demand for Russian gas overall. As noted earlier, it was the export side of demand that resulted in the greater call on storage to meet the higher flexibility requirement.

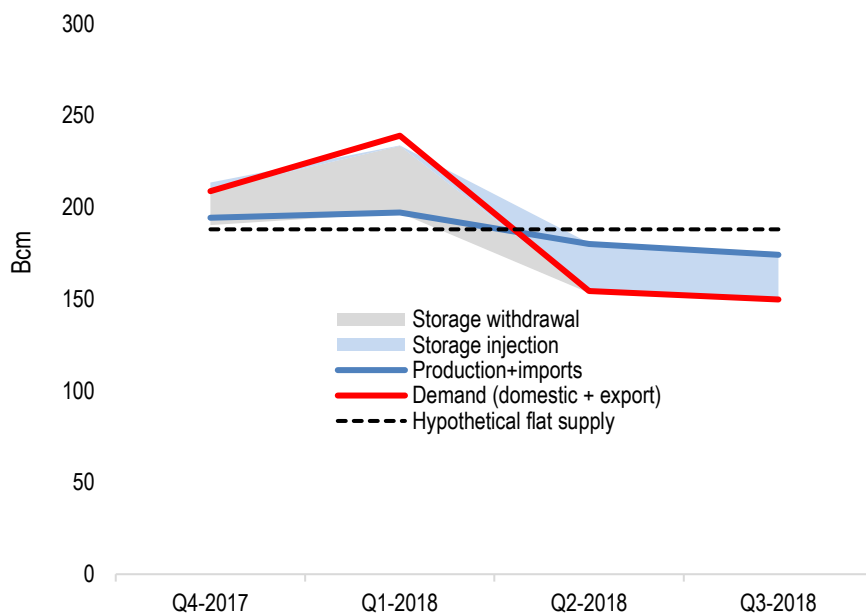
<sup>5</sup> See Yermakov, V. (2018). 'Shrinking surplus – the outlook for Russia's spare gas productive capacity'. OIES Insight 42.

**Figure 22: Gas season 2014-2015**



Source: Author, data from CDU TEK

**Figure 23: Gas season of 2017-2018**

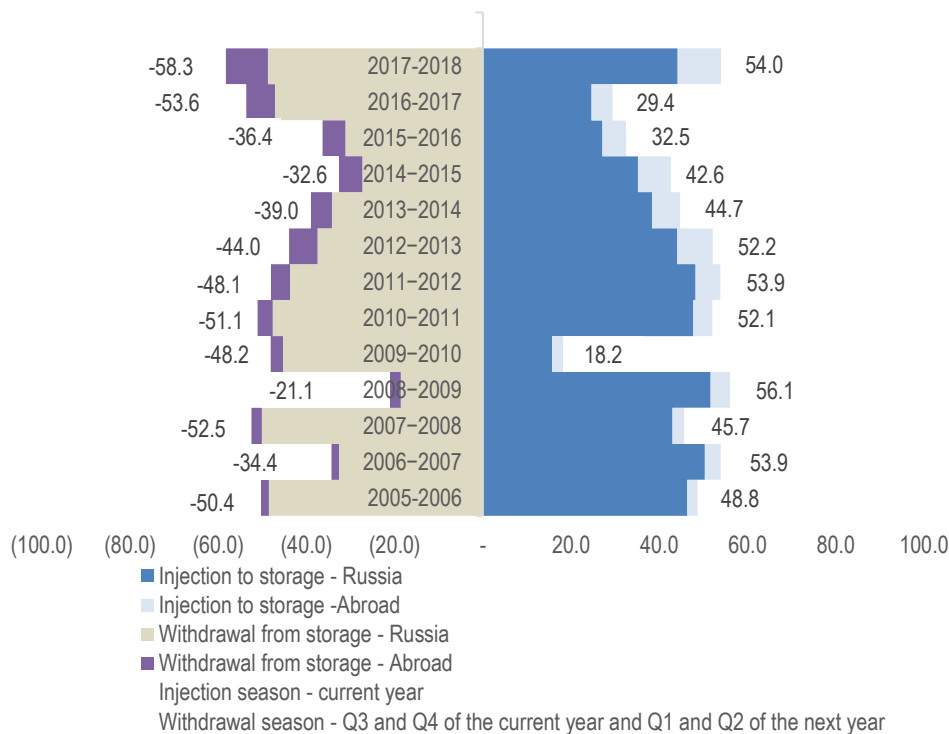


Source: Author, data from Gazprom

It is also noteworthy that over the 2015-2016 and 2016-2017 gas seasons, gas withdrawals from storage significantly exceeded injections. Storage levels had to be replenished, which led to a sharp increase in gas storage re-fill during Q3 and Q4 of 2017 and Q1 and Q2 of 2018 (see Figure 24).



**Figure 24: Gas storage use by Gazprom (Bcm)**



Source: Author, data from "Gazprom in Figures"

## Russia's gas storage facilities

The key functions of the gas storage facilities are as follows: evening out seasonal loads in Russia's UGS; assisting in regulation of seasonal differences in domestic and export deliveries; holding gas reserves for anomalous cold snaps or major accidents; or disruptions with production or imports.

There is no formal monopoly on gas storage in Russia, but all existing operations belong to Gazprom, the owner of the unified gas transportation pipeline network that forms a single technological complex with storage facilities. As of the start of 2018 Gazprom operated 26 underground storage facilities in 19 regions within Russia (See Figure 25).

### Russia's main gas storage facilities

**Kasimovskoye.** The largest gas storage built in an aquifer, Kasimovskoye is in Ryazan region, 250 kilometers south of Moscow. It is key to providing flexibility in Central Russia and covers 30-35 per cent of the daily gas needs for the city of Moscow and the Moscow region combined. The active gas storage capacity is more than 9 Bcm, the number of active wells is 287, and the maximum daily productivity amounts to 100 million cubic meters which is comparable with daily gas consumption in Moscow.

**Kanchurinsko-Musinskiy complex** in Bashkortostan republic in the Volga federal district was created in the depleted gas condensate field. After reconstruction in 2010, the storage capacity increased to 5.5 Bcm.

**Severo-Stavropolskoye** in Stavropol kray is key to gas supply in the South and the Caucasus and for ensuring reliability of export deliveries. With 90 Bcm of total capacity, it is the world's largest gas storage facility created in a depleted gas field.

**Kushchuovskoye** in Krasnodar kray is another large gas storage facility in the North Caucasus in a depleted gas field.

**Figure 25: Gas storage facilities in Russia**

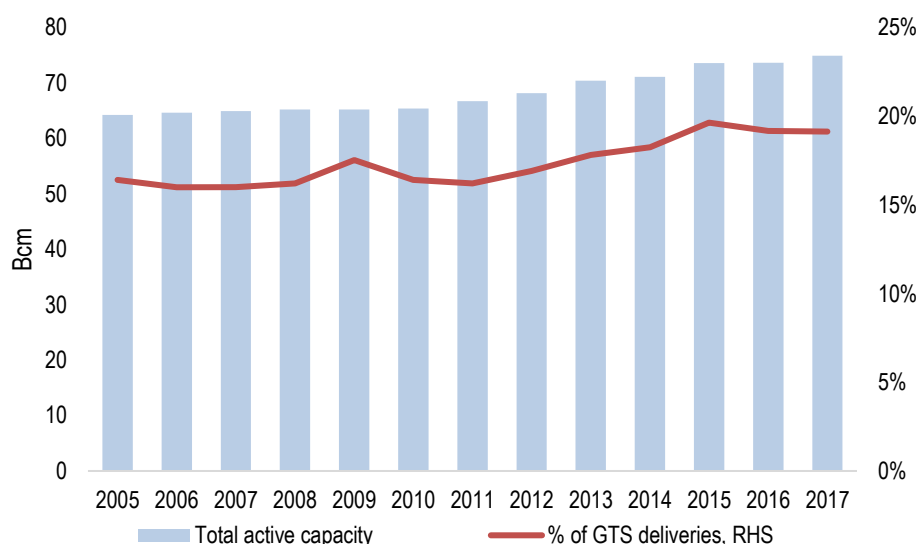


Source: Gazprom

With one exception, nearly all Russian gas storage capacity is in gas-consuming areas in European Russia rather than in the main gas-producing area in West Siberia. The bulk of this capacity (17 facilities) is in depleted gas fields, while the remaining are in aquifers (8 facilities) and one (a new facility in Kaliningrad) is in salt cavern. Because of this, the bulk of capacity is in the North Caucasus and Volga regions (old gas-producing areas), and there is a possible deficit of capacity in the main gas-consuming regions (Central Russia, Northwest, and Urals), where suitable geology for storage is lacking.

The active capacity of the storage facilities in the Russian Federation amounts to 74.9 Bcm as reported at the beginning of 2018. The key characteristics of the amenities include 2694 operational wells and an installed compressor capacity of about 900 megawatts at 215 units. Since 2005 the storage capacity has increased by 16.6 per cent and currently accounts for 21.2 per cent of domestic gas deliveries via GTS (See Figure 26).

**Figure 26: Russia's active gas storage capacity**



Source: Author, data from 'Gazprom in Figures 2017'

The General Scheme of Russia's gas industry projects that the necessary amount of active storage capacity in Russia will be 87.7 Bcm by 2030. This amount includes a significant reserve margin for anomalously cold winters and emergencies. The detailed outlook for Russia's gas storage requirements up to 2030 is presented in Table 1.

**Table 1: Outlook for gas storage capacity in Russia to 2030**

	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>2020</u>	<u>2025</u>	<u>2030</u>
Working gas inventories in storage	58.5	60.9	61.5	62.2	63.2	63.8	70.5	71.1	71.9
Reserve for anomalously cold winter (15% of working gas inventories)	8.8	9.1	9.2	9.3	9.5	9.6	10.6	10.7	10.8
Emergency reserve (7% of working gas inventories)	4.1	4.3	4.3	4.4	4.4	4.5	4.9	5.0	5.0
Necessary active storage capacity	71.4	74.3	75.0	75.9	77.1	77.8	86.0	86.7	87.7

Source: General Scheme of Russia's Gas Industry Development to 2030

Gazprom's underground gas storage strategy focuses on renovation and replacement of older units as well as improving the flexibility of the system by constructing small, peak load balancing gas storage facilities in salt caverns to maintain deliverability rates during increased gas withdrawal periods through to 1 February (the estimated date of the extreme low temperature during the season). Gazprom's plans also focus on adding underground gas storage capacity to the regions where flexibility needs are the greatest, including the Northwestern, Siberian, and Far Eastern federal districts of the Russian Federation. In its annual report for 2017 Gazprom mentioned a total of 47 planned underground gas storage capex projects in Russia (including well workovers and drilling, expansion and upgrades of the GTS connections), of which 36 projects aim to sustain the achieved capacity through upgrades and retrofits, four to expand existing capacity, and seven to construct new gas storage facilities (peak load balancing facilities and facilities in the regions with a shortage of storage capacity). Plans to 2030 include commissioning total gas storage capacity of 4.77 Bcm, 11 compressor plants with an aggregate capacity of 228 MW, and construction of 130 wells.

Gazprom's reported capital expenditure for underground gas storage amounted to Rubles 35.5 billion (US \$531 million) in 2016 and Rubles 37.7 billion (US \$647 million) in 2017. Most of the money was spent on salt cavern construction at the Kaliningradskoye and Volgogradskoye facilities, renovation of the Sovkhoznoye, upgrade of gas evacuation capacity from Severo-Stavropolskoye and new wells drilling. In 2017, production facilities were commissioned at Punginskoye, Kaliningradskoye and Sovkhoznoye with a combined increase in active capacity of 1.3 Bcm. At Punginsky a compressor station with a capacity of 32.0 MW was added and 24 wells connected and at Krasnodarskoye renovation works were carried out. In 2018 capacity commissioning continued at Volgogradskoye and Sovkhoznoye.

It appears that Russian gas storage facilities currently enjoy a healthy reserve margin on a national level. In 2017 the maximum aggregate daily deliverability was registered on 8 February at 590.5 MMcm. The maximum daily productivity at the start of the 2016/2017 withdrawal season was 801.3 MMcm. It went up to 805.3 MMcm by the start of the 2017/2018 withdrawal season, and to 812.5 MMcm by the start of the 2018/2019 season to reach record highs in the history of the Russian gas industry. The amount of the working gas inventories in November 2018 was reported to be 72.27 Bcm<sup>6</sup>.

<sup>6</sup> <http://www.gazprom.com/press/news/2018/november/article468431/>

With this level of productivity about a third of winter seasonal needs in the country can be covered by storage withdrawals. The significant effort by Gazprom to enhance the storage capacity in Russia over the past five years has been paying off with the greater reliability of the system. Since 2011 there has not been any instance when domestic industrial consumers were forced to restrict demand during cold weather.

Russia's seasonal flexibility requirements have been relatively stable over the past ten years growing slightly in line with growth in domestic demand. This is linked to the composition of Russia's gas demand that also has not changed much. Russia has been using the combination of production swing and storage use to meet the seasonal profile of demand.

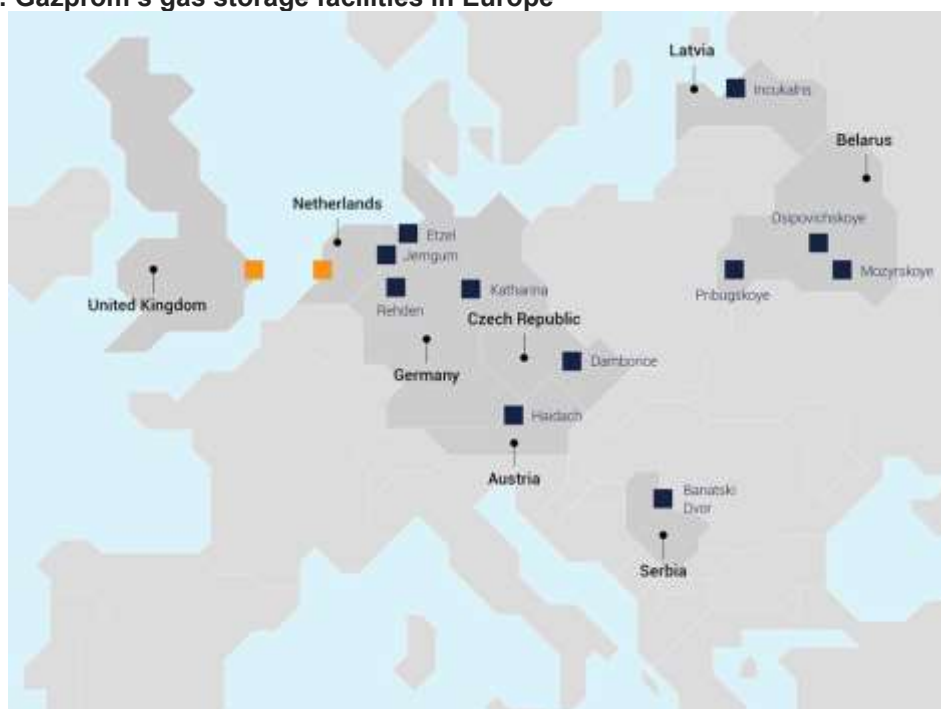
The winter supply is usually organized by the principle of substitution: the response in the regions located far away from main centres of supply necessarily comes from storage which is later replenished. The seasonal demand in regions in closer proximity to the supply centres is covered by production swings. This is understandable: the average transportation distances for domestic gas supplies in Russia exceed 2300 kilometers, and average distances to export markets exceed 3000 kilometers and many foreign destinations are over 4000 kilometers, so it normally takes several days to ship gas over these long distances.

During the years when aggregate demand for Russian gas declined and Russia had lots of spare production capacity, especially between 2014-2016, the production swings were more pronounced. When the pendulum swung back on the demand side in 2017-2018, the supply side response was followed by the flattening of the production curve throughout the year, indicating limitations on peak production capacity for Russian gas. This, in turn, has led to greater reliance on storage for meeting the peaks.

## Gazprom's gas storage facilities in Europe

Gazprom also is a shareholder of 12 gas storage facilities in Europe, particularly in Austria, Germany, Republic, and Serbia (See Figure 27).

**Figure 27: Gazprom's gas storage facilities in Europe**



Source: Gazprom

Table 2 outlines the evolution of the operations of these facilities.

**Table 2: Operations of Gazprom gas storage facilities abroad, 2005-2018**

	Injection season, Q1–Q4												
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b>Gas injection into UGSFs abroad,</b>													
<b>FSU countries</b>													
Armenia	84	101	87	89	70	46	23	127	29	69	41	37	71
Belarus	–	–	–	–	–	–	748	941	929	962	917	857	949
Latvia	1,467	1,589	135	1,300	588	1,640	1,568	1,600	1,537	1,907	1,550	1,250	255
<b>Total injection (FSU countries)</b>	<b>1,551</b>	<b>1,690</b>	<b>222</b>	<b>1,389</b>	<b>658</b>	<b>1,686</b>	<b>2,339</b>	<b>2,668</b>	<b>2,495</b>	<b>2,938</b>	<b>2,507</b>	<b>2,144</b>	<b>1 275</b>
<b>Far abroad countries*</b>													
Austria	440	449	945	859	474	581	1,094	1,407	1,472	1,304	710	684	2,223
Great Britain	77	294	415	529	226	234	225	224	227	224	224	–	–
Hungary	–	–	–	–	–	–	–	–	–	700	–	–	898
Germany	375	1,143	1,111	1,385	584	705	155	2,150	1,464	886	797	654	1,840
The Netherlands	–	–	–	–	328	854	1,583	1,277	617	1,313	1,177	1,195	1,782
Serbia	–	–	–	–	–	–	279	336	94	118	–	–	13
Slovakia	–	–	–	–	–	–	–	–	–	–	–	–	738
France	–	–	–	274	250	298	–	–	–	–	–	–	–
Czech Republic	–	–	–	–	–	–	–	–	–	–	–	105	191
Short-term contracts for storage in European UGSFs	–	–	–	–	–	–	–	–	–	–	–	–	910
<b>Total injection (far abroad countries)</b>	<b>892</b>	<b>1,886</b>	<b>2,470</b>	<b>3,046</b>	<b>1,862</b>	<b>2,672</b>	<b>3,336</b>	<b>5,394</b>	<b>3,874</b>	<b>4,545</b>	<b>2,908</b>	<b>2,638</b>	<b>8 594</b>
<b>Total for the season</b>	<b>2,443</b>	<b>3,576</b>	<b>2,693</b>	<b>4,435</b>	<b>2,520</b>	<b>4,357</b>	<b>5,675</b>	<b>8,062</b>	<b>6,368</b>	<b>7,483</b>	<b>5,416</b>	<b>4,783</b>	<b>9,869</b>

\* Gas injection of Gazprom Group for contracts of OOO Gazprom Export.

	Withdrawal season, Q3–Q4 and Q1–Q2 of the next year												
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
<b>Gas withdrawal* from UGSFs abroad</b>													
<b>FSU countries</b>													
Armenia	73	78	64	80	24	21	127	18	67	23	11	31	48
Belarus	–	–	–	–	–	–	784	841	813	850	815	879	959
Latvia	911	213	288	683	1,009	1,659	1,530	1,411	1,318	1,542	1,257	1,087	141
<b>Total withdrawal (FSU countries)</b>	<b>984</b>	<b>291</b>	<b>352</b>	<b>763</b>	<b>1,033</b>	<b>1,680</b>	<b>2,440</b>	<b>2,270</b>	<b>2,198</b>	<b>2,415</b>	<b>2,083</b>	<b>1,997</b>	<b>1,148</b>
<b>Far abroad countries**</b>													
Austria	200	200	653	382	480	544	983	1,534	1,172	836	820	1,481	1,986
Great Britain	–	371	422	228	318	435	225	224	227	224	224	–	–
Hungary	–	–	–	–	–	–	–	–	–	700	–	–	898
Germany	661	887	952	790	731	482	717	2,342	1,124	753	978	937	2,116
The Netherlands	–	–	–	–	–	–	–	–	–	405	1,130	1,981	1,533
Serbia	–	–	–	–	–	–	34	146	68	1	12	1	45
Slovakia	–	–	–	–	–	–	–	–	–	–	–	–	673
France	–	–	–	274	249	300	–	–	–	–	–	–	–
Czech Republic	–	–	–	–	–	–	–	–	–	–	–	105	183
Short-term contracts for storage in European UGSFs	–	–	–	–	–	–	–	–	–	–	–	–	975
<b>Total injection (far abroad countries)</b>	<b>861</b>	<b>1,459</b>	<b>2,027</b>	<b>1,673</b>	<b>1,778</b>	<b>1,760</b>	<b>1,959</b>	<b>4,246</b>	<b>2,589</b>	<b>2,919</b>	<b>3,164</b>	<b>4,504</b>	<b>8,410</b>
<b>Total for the season</b>	<b>1,846</b>	<b>1,750</b>	<b>2,380</b>	<b>2,436</b>	<b>2,811</b>	<b>3,440</b>	<b>4,399</b>	<b>6,516</b>	<b>4,788</b>	<b>5,334</b>	<b>5,247</b>	<b>6,501</b>	<b>9,558</b>

\* Excluding volumes sold in UGSFs

\*\* Gas withdrawal of Gazprom group for contracts of OOO Gazprom Export.

Source: Gazprom

In the former Soviet Union (FSU) countries, Gazprom operates storage facilities in Belarus (Pribugskoye, Osipovichskoye, and Mozyrskoye), Armenia (Abovanskaya underground gas storage station), and Latvia (Inčukalns). As at 31 December 2017, the operating gas reserves in FSU-based gas storage was 3.0 Bcm, with a daily productivity of 55.6 MMcm.

In Europe, Gazprom's main facilities are in the following countries: Austria (Haidach), Germany (Jemgum, Rehden, Katarina, and Etzel), Serbia (Banatski Dvor), the Netherlands (Bergermeer), and the Czech Republic (Dambořice). The volume of operations has expanded greatly, especially since 2012. In the 2017/18 season both injections and withdrawals set records.

Gazprom's target for its European storage is to bring the working capacity to at least 5 per cent of annual export volumes by 2030, with a focus on constructing its own storage capacity. The plans include expansion of aggregate working gas capacity at the Katarina facility in Germany and Dambořice facility in the Czech Republic.

## Should Europe be worried about Gazprom's ability to meet the growing call on its gas?

Russia's gas storage capacity and productivity seem to be enough for meeting the flexibility requirements in Russia and Gazprom's contractual obligations in Europe at present. But what about the future? There are several issues to consider.

First, in 2017-18, Russia's European exports reached their maximum contracted levels in total and started to exceed them for some countries. At present, the combined annual contract quantities (ACQ) of Russian gas supply contracts with Europe are around 200 Bcm (Russian standard). Until recently Russian gas exports to Europe were hovering around 80-85 per cent of the maximum annual contract quantities, but now Gazprom is looking at a new situation. Speaking at the Saint Petersburg International Gas Forum on October 4, 2018, Gazprom CEO Alexey Miller said:

'In 2018 Gazprom will set a new record for gas supplies to Europe. ...The total will cover 100 per cent of our obligations to our partners. This is a new frame of reference without a doubt. We need to reflect on that. Meanwhile, the demand for Russian gas continues to grow. ...We now have a seller's market in the gas sector. This is new. We didn't have that ten or five years ago'.<sup>7</sup>

### Monetizing flexibility

One consequence of a higher call on Russian gas in Europe is a higher and flatter level of export monthly deliveries since the available capacity in the trough season is generally higher. In 2018, capacity utilization of key export pipelines, especially direct routes to target markets, was extremely high. In fact, Nord Stream's reported utilization exceeded 100 per cent in the past year, and Blue Stream utilization was close to 100 per cent. This, however, removes important leverage that the buyers of Gazprom gas used to have with respect to opportunities for price optimization. To explain the last point, Gazprom's contract prices are still predominantly oil-indexed and have a significant time lag (6-9 months). Many European buyers managed to obtain price discounts from Gazprom and even modify their contracts by including partial hub price indexation during the times of slack demand on the continent between 2011-2015, but Gazprom, in its public statements, still argues that oil indexation remains the key principle of its contracts in Europe. Furthermore, there is embedded volume flexibility in Gazprom's European contracts with significant range between minimum and maximum nominations by the buyers. Flexible contracts normally contain a price premium over interruptible ones. Gazprom's long-term contracts (LTCs) historically have not had an explicit premium for flexibility. Any significant movement of oil price will have a predictable impact on Gazprom's formula-based gas prices in six to nine-month's time. For example, the price for Brent crude performed a rollercoaster ride in the second half of 2018 – it went up from \$72/bbl in mid-August to \$86/bbl in early October and then dwindled to \$50/bbl by the end of December. As a result, the formula-based oil-linked price of Gazprom gas (assuming nine-month time lag and 11 per cent oil indexation) would go up from about \$8/MMBtu in mid-May to about \$10/MMBtu in early July 2019, but then would start falling to the low point of around \$6/MMBtu by the end of September 2019. In the buyer's market of the past, Gazprom's clients in Europe would reduce their nominations to the minimum levels during the summer and then would ramp them up in the fall to reduce the average annual acquisition price and obtain the necessary flexibility. But in the tight market of today the necessity to procure scarce volumes may leave little room for such price optimization strategy. On the contrary, the situation opens possibilities for Gazprom to start monetizing the flexibility of its supply. The actual test of this opportunity, of course, depends on developments on the LNG market. The launch of several new LNG projects in 2019 may yet result in LNG surplus in Europe in the second half of this year with downward pressure on hub prices.

Flexibility can be provided by the buyer, the seller, or even a third party, but the implications of each option for European gas trade can be very different. Investments by gas buyers in building interconnectors and additional storage in Europe could generally be in line with an unbundled gas market model envisioned by the European Commission; however, the extension of the vertical value

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<sup>7</sup> <http://www.gazprom.com/press/news/miller-journal/2018/494533/>

chain by major gas importers to Europe may not correspond to the proposed design. The issue is how to reward investments in storage capacity by independent players via market instruments. Alternatively, to ensure stability of supply and to be able to react quickly to significant swings in demand, gas producers would need to develop transportation systems and expand gas storage facilities in the end-user markets.

### Period of maximum stress

Second, the scenario of an extended winter cold snap that happens simultaneously in Russia and in Europe must be analyzed. Cold snaps are always a stretch for the gas supply system. It is instructive to review the past instances when the European and the Russian gas networks had to operate under maximum stress.

Two of the most vivid stress tests for Eurasian gas were a cold February of 2012 and the ‘Beast from the East’ of late February-early March of 2018. The weather introduced a real-life experiment that stress-tested the gas supply and delivery systems of Russia, Europe, and the transit countries. As a result, the issues of peak capacity and seasonality of gas demand moved to centre stage as Russia, the FSU countries, and Europe went through a serious check of their fuel ‘battle readiness’.

### 2012 – a wakeup call for Russia

Most of Russia and Europe had to deal with an extended cold snap lasting almost three weeks, from the end of January and through the first half of February 2012, when temperatures throughout the region were 5 to 10 and sometimes 15 degrees Celsius lower than normal. Temperatures of minus 30 degrees Celsius occurred in Russia, Belarus, and Ukraine. The cold was less extreme in Europe, but the Danube River froze as well as the Grand Canal in Venice, something that had not happened for the past 80 years.

Gazprom’s European clients, including Italy, Germany and Romania, reported that daily imports of Russian gas plunged 30 per cent for a few days, prompting them to turn to alternative suppliers and storage. Natural gas spot prices in Europe almost doubled at the beginning of February 2012, spiking above \$600/Mcm. Italy, positioned at the end of the supply chain, experienced extended shortfalls in gas deliveries. Part of the problem was the suddenness of the gas demand spike: the unexpected and prolonged cold snap came after much warmer-than-usual weather in December 2011 and most of January 2012.

A supply crisis was averted in Russia, where daily gas supplies reached new, previously unthinkable all-time highs of over 2 Bcm on 28 January 2012 and stayed above that record threshold for a few more days in February. For almost three weeks, domestic gas demand exceeded levels of 1.8 Bcm per day that in 2010 had triggered the imposition of so-called ‘Schedule One’ restrictions on gas deliveries to (interruptible) industrial customers in favour of maximum supplies to households and public utilities<sup>8</sup>.

Gas supplies to Russian power companies reached 0.70 Bcm per day at the beginning of February, compared with 0.64 Bcm per day during the winter of 2010/11 that had triggered gas supply restrictions for this category. To meet higher demand for generation, power stations were required to use reserve fuels (mainly mazut) instead of gas. Overall Russian gas consumption in February reached 54.5 Bcm, up by 14 per cent, or 6.8 Bcm, year on year (corrected for a leap year effect, the increase was still 10 per cent).

In 2012 no restrictions were introduced on gas use in Russia because Gazprom was instructed to make the home market a priority. To meet the spike in demand, Gazprom raised its daily gas production to a peak of slightly above 1.6 Bcm per day and increased storage withdrawals to a new record of 0.57 Bcm

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<sup>8</sup> In Russia, in periods of peak demand (usually caused by extreme winter cold weather), nominations by interruptible gas consumers (e.g., industrial users and power plants) may be capped or restricted for a limited time to satisfy the priority of gas supplies to residential users and public utilities; during this time the interruptible consumers switch to the so-called reserve fuel (fuel oil) that they are obligated to have.

per day. All other sources of gas production were at maximum capacity as well, and overall gas production in Russia in February 2012 exceeded 60 Bcm.

Meanwhile, as bitterly cold temperatures set in across much of Russia, Ukraine, and Europe in February, demand for gas in Europe also surged, straining the gas delivery chain and putting in question Gazprom's ability to respond swiftly to higher daily gas demand in certain European countries. The contrast was striking: during January 2012, Gazprom was exporting an average of 0.45 Bcm a day, 15 per cent below the daily average for the same period in 2011 (0.528 Bcm per day). But at the end of January, the export call on Gazprom spiked and by 7 February reached 0.51 Bcm. This was still below comparable volumes in 2011, but it was the speed with which demand grew along the whole supply chain that created problems. The Russian domestic market trumped exports. Gas deliveries in Russia exceeded all-times highs, with 2 Bcm per day at the end of January/beginning of February. Previously, Gazprom would introduce gas supply limits for industrial users and power plants during such winter peaks, forcing these interruptible consumers to use reserve fuels (mazut). In practice, this allowed Gazprom to increase peak season supplies to export markets where it has the highest margin. Prime Minister Putin, who was running for the presidency that year, instructed Gazprom to make the home market a priority destination and to meet external demand for Russian gas only after domestic market needs had been fully met.

The supply crunch in February 2012 exposed weak links in Gazprom's gas storage system. Historically, Russia relied on the western Ukraine storage facilities to support its gas exports to Europe, especially during the winter months. These are the largest gas storage facilities within Europe, located at Ukraine's western border. However, following several incidents of 'disappearance' of Russian gas in Ukrainian storage, from 2010 Gazprom stopped using the facilities and began to develop its own gas storage system in Europe. The process of creating new gas storage facilities in European countries was in its early stages in 2012 which left some of Gazprom's clients exposed to limitations in their ability to meet peak demand.

An important result of the early 2012 test was a demonstration that the Eurasian gas systems can operate relatively effectively even under severe stress. Despite temporary shortfalls in deliveries, apparently no contractual obligations were broken, and Europe was largely able to meet the extra demand by digging into its own natural gas storage reserves. Traded markets reacted appropriately to the surge in demand: prices spiked, gas flowed to the higher priced markets (where transmission capacity allowed it), storage capacity was drawn down hard, and interruptible customers were curtailed. Traded volumes increased markedly with records set in most markets.

In retrospect, it is clear that the problems some European countries experienced were due to a delayed response by Gazprom rather than to insufficient supply capacity. The gas did not get delivered to all places that wanted it on short notice. The crisis pointed to certain inflexibilities on the part of Gazprom and provided several important lessons as to why this happened and how to avoid this situation in the future. Alexander Medvedev, deputy chairman of Gazprom, admitted that Gazprom was lacking the gas storage space in Europe which was needed to cover unexpected demand spikes in the years to come. As a result, 2012 prompted a strategic decision by Gazprom to drastically expand its storage capabilities in Europe as shown earlier in the paper.

## **2018 – a wakeup call for Europe and UK?**

The extreme weather that rolled across Europe at the end of February-beginning of March 2018 was dubbed the 'Beast from the East' - in reference to the freezing air that blew in from Siberia. Gas markets in North West Europe experienced short-term gas shortages and price spikes. In the UK the situation became especially worrying as the challenge of the coldest weather in 30 years combined with a sharp reduction in flexibility as a result of closure of the Rough storage facility in the North Sea. Rough used to have capacity for providing about 10 per cent of daily gas demand in the UK. In North West Europe, low end-winter storage levels, limited LNG stocks and restricted Groningen output also caused TTF prices to spike, resulting in a narrowing of the TTF-NBP spread as the cold snap set in, which caused a fall in Interconnector and BBL exports to the UK.



On each of the days that experienced severe cold, the UK system opened short of gas, primarily because of very high levels of demand – which were 35 per cent above normal – but also because of limited storage and LNG availability as well as supply disruption in flows of gas from Norway and the UK Continental Shelf.

Undersupply in the UK peaked on 1 March, when the system opened short and gas price at NBP went up to over \$30/MMBtu. In response, the National Grid issued a gas supply warning, the first one in eight years. The deficit warning was, in effect, for just one day but was helpful in leading some big industrial users to reduce gas demand to facilitate continued supply to residential users. Coal-fired power plants were running at full capacity in the UK during the cold snap relieving some pressure on gas-fired power plants.

By 2 March 2018, available LNG supplies and storage withdrawals in the UK were effectively exhausted. If the cold spell had lasted another week, there could have been serious interruptions but luckily, by 5 March, Spring had arrived lifting the pressure on the European gas system.

During this period Gazprom sharply increased gas exports to Europe, setting new daily records each day from 21 February to 28 February until they reached 0.7 Bcm. Utilization of Nord Stream, Europol and Blue Stream was already very high, and most of the incremental increase in exports of Russian gas to Europe came via Ukraine (where transit flow went up 30 per cent). Russian gas turned out to be the only source of gas for Europe that could be ramped up at short notice.

At the same time, one of the LNG deliveries to UK came from Yamal LNG, a new Russian Arctic project launched just few a months previously. In the future, this project, the closest LNG supplier to the UK market, could emerge as an important alternative source of gas flexibility for northwestern Europe.

The important lesson from ‘The Beast from the East’ was the identification of the weak link in the UK’s strategy of replacing declining supply from the North Sea with LNG and disregarding storage expansion. Indeed, historically the UK maintained low gas storage which has not been a problem so long as North Sea production capacity could provide flexibility. But now the deal is different. LNG imports are less secure than domestic supplies, and it may take too much time for the price developments to incentivize the flexible LNG shipments to come to the rescue in case of gas shortage. Or rather, it would require a significant price spike to cause the diversion of cargos to the region, and LNG still may arrive too late. In short, there is little alternative to domestic storage if a similar situation of a cold spell at the end of the winter season repeats itself. The problem is that this is precisely the period when storage levels might be exhausted.

Besides, the key driver for storage replenishment, the winter-summer spread in prices at the European hubs has been narrow in the past couple of years, suggesting low economic incentive for spring and summer injection. Developments on the gas storage side during the summer of 2019 will be an important signpost for energy security in Europe during the winter of 2019/20.

## Summary and conclusions

With a shrinking gas surplus in Russia and rising seasonality/peaking requirements in Europe, Gazprom’s balance is going to get tighter. Gazprom has been responding to both concerns. It has been expanding its gas storage capacity in Europe to make sure it can meet its current contractual obligations. The expansion of peaking production capacity at Bovanenkovo early this year is designed to reach Europe via the new high-pressure large diameter pipelines through the short route across northern regions of Russia and then onto Nord Stream 2. At the same time, high levels of European demand for Russian gas also require that the Ukrainian transit route continues operations after 2020, even in a reduced format. The Ukrainian route might continue its function as a significant provider of flexibility for the European gas market, but the host of controversial issues around the new gas transit contract with Gazprom is likely to keep the situation up in the air for most of this year. Besides, current Ukrainian legislation expressly forbids Russian investment in its gas assets, so modernization of the Ukrainian GTS and the use of Ukrainian storage is an opportunity for European companies that would

be willing to accept the risks of such investments. Gas flexibility will remain a key concern for Europe, because of declining indigenous production. At the same time, increasing the call on Russian pipeline gas imports to Europe, above and beyond the current levels of about 200 Bcm per annum, would require finding a new long-term balance of interests between buyers and sellers that would probably require monetization of the flexibility embedded in Gazprom contracts but not reflected in current pricing arrangements.

European buyers of gas would be wise to invest in their own flexibility rather than to rely on Russian pipeline gas to bail them out during cold snaps. Europe's alternative choices are: LNG, including the supplies from Yamal LNG, the closest to Europe; demand management; more responsible plans regarding the retirement of coal-fired power generation capacity; and, most importantly, expanding domestic storage capacity in end use markets, especially in high demand regions. The combination of these policies could ensure Europe's energy security and address the concern of growing dependency on Russian gas.