entsog

european network
of transmission system operators
for gas

ENTSOG
WINTER SUPPLY OUTLOOK

2023/2024

Including Summer 2024 Overview

Contents

Executive Summary

In line with Art. 8(3)(f) of Regulation (EC) 715/2009, ENTSOG has undertaken an assessment of the European gas network for the upcoming winter (1 October 2023 to 31 March 2024). The analysis investigates the possible evolution of supplies and UGS inventory along the season as well as the ability of the gas infrastructure to meet the demand, especially to face high demand situations. ENTSOG has used a sensitivity analysis to check if the European gas infrastructure is able to handle the winter season under two different weather conditions: Reference Winter and Cold Winter.

Winter preparedness is repeatedly one of the most important topics being discussed by energy stakeholders, and following findings of previous analysis it needs to be considered as early as possible. That is why in this report ENTSOG offers a wide variety of different sensitivities, include not only for this winter assessment but also for the longer term preparedness.

On the basis of the interest expressed by institutions and stakeholders, ENTSOG has run an overview analysis for the summer 2024 season (1 April 2024 to 30 September 2024). This analysis addresses two different perspectives – active anticipation of the 90% target at the end of the investigated period (full gas year, 12 months simulation), and the conservative 30% stock level at the beginning of summer season. The analysis investigates the possible evolution of supplies and injection to UGS along the following summer season as well as the ability of the gas infrastructure to meet the demand.

Russia's invasion of Ukraine has triggered energy security concerns in Europe. Therefore, ENTSOG additionally assessed the dependence of the EU on the Russian supply during winter 2023/24 and summer 2024. ENTSOG further developed its model and topology, for the first time in more detail, including Moldova in its simulation and improving representation of exports to Ukraine. Endeavours aimed at further improvements will be continued. ENTSOG also assessed different cases of LNG availability for Europe.

Winter Supply Outlook 2023/24 main findings

- On 1 October 2023, the EU gas storage facilities reached 96% on average which translates to 1,091 TWh (highest amount of gas stored within the last 5 years). The high storage filling level (56%) at the beginning of injection period, decrease in gas consumption over the year and dedicated measures introduced by the Member States, together with the individual users behaviour, contributed to the record volume of gas in storage at the beginning of the winter period.
- The gas infrastructure, including the projects that have been commissioned during this year and the expansions to be commissioned over the upcoming winter, are boosting energy security in the EU and allow for a more efficient cooperation among the Member States. However, under specific circumstances, some possible supply limitations and bottlenecks are identified.

Reference Winter[1] scenario (1 October to 31 March 2024)

- In the case of the Reference Winter, the European gas network enables the demand to be met and still to keep more than 30% stock level (on average) in all underground gas storage facilities by the end of the winter season in April 2024. Under assumptions of demand and supply in the Reference Winter case, infrastructure enables 56% of storage level on average.
- LNG supply and supply from Norway represents the largest sources of supply for Europe and Contracting parties. Assuming availability of different gas sources, gas demand can be satisfied without supplies from Russia. In the case of Low LNG availability, pipeline supplies from Russia[2] would improve overall situation.
- However, in the case of a peak day in the Reference Winter demand scenario, most Member States are exposed to a limited risk of demand curtailment (11% - within the range of high price demand response).

Winter supply dependence assessment in the Reference Winter scenario – supply disruption from Russia (1 October to 31 March 2024)

- Despite the absence of Russian supplies, Europe could still save more than 30% of its total working gas volume at the end of the Reference Winter case. Under assumptions of demand and supply in the Reference Winter scenario with full Russian pipeline disruption, the infrastructure enables 47% of storage level on average. Peak day demand curtailment would increase to reach 14% in many Member States when no gas is flowing from Russia at all.
- In case of full Russian disruption of pipeline flows to Europe the different LNG supply assumptions translate directly to the possibility to reach or not meet the storage target, and could contribute to saving higher storage stocks in all storage facilities before the end of April 2024.
- Enhanced capacities, provided by TSOs, would contribute to the increase of import route capacities from the Caspian Area, as well as boost the possibility for the cooperation between Germany and Austria, Belgium, the Czech Republic, and the Netherlands, as well as between Spain and France, contributing to the flexibility of LNG imports to the central part of Europe.

Cold Winter[3] scenario (1 October 2023 to 31 March 2024)

- In a Cold Winter scenario all European countries could be exposed to a risk of approx. 7% demand curtailment for the entire winter season leaving only 9% on average of the total working gas volume left in the storage facilities. This is a strategic reserve gas in storage which is not freely available on the market under normal conditions and represents 9% of

[1] The Reference Winter demand (from 1 October 2023 to 31 March 2024) is based on TSOs' estimates.
[2] The pipeline supply from Russia considers flow through TurkStream and via Ukraine.
[3] The Cold Winter demand is based on demand assumptions considered in ENTSOG's Union-wide Security of Supply Simulation Report 2021, i.e., the historical highest winter demand since the winter 2009/10 on country level.

the total European storage working gas volume in average. Some European countries are reserving a part of their own gas stock to be constituted as strategic reserves and used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves are depending on the country's specific regulation.

Only in case of 15% demand reduction, is the gas network is capable of satisfying the demand and reach at least a 30% stock level.

- In case of full disruption of Russian pipeline supplies and the Cold Winter situation, results show that withdrawal capacities of the gas storage facilities combined with the supply flexibility are not sufficient to cover the demand. With 9% on average of the total working gas volume left in the storage facilities (strategic reserve gas in storage which is not freely available on the market under normal conditions and represents 9% of the total European storage working gas volume in average), European countries would be exposed to a risk of a demand curtailment approx. 9 % during whole winter. Some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves is depending on the country's specific regulation.
- In case of full disruption of Russian pipeline supplies and Cold Winter, the combination of the enhanced capacities and a decrease in gas demand by 15% would allow the gas network to satisfy the demand and achieve a 27% stock level. Additional LNG supplies would be needed to improve the ability to at least maintain the 30% stock level by the end of March 2024 for all EU countries.

Summer 2024 overview main findings

<u>The Reference Summer[4] scenario (1 April to 30 September 2024) based on 5-year average demand from 2017 to 2021 with 15% demand reduction in the spirit of the coordinated demand reduction measures defined in the Council Regulation (EU) 2022/1369 of 5 August 2022</u>

- Starting from a stock level of 32%[5] on 1 April 2024, the capacities of the gas system combined with the supply flexibility of imports are sufficient to cover the EU demand but cannot reach an inventory target level of 90% at the end of the summer.
- **The yearly simulations show that at least a 46% level of working gas volume would be needed at the end of the winter season to reach the 90% target by the end of summer 2024 during the injection period**. That could be improved by additional measures such as demand response and additional gas supplies to Europe.
- In case of full disruption of Russian pipeline supplies, the 46% level of working gas volume at the beginning of injection period together with the combination of the enhanced capacities, decrease in 5-year average gas demand by 15% and strong LNG supplies would be necessary to reach 90% of the stock by the end of September 2024 for all EU countries.

[4] The Reference Summer demand (from 1 April to 30 September 2024) based on 5-year average demand (with -15% demand reduction) 2017-2021.
[5] The storage filling level is above 30% due to national strategic reserves in some countries.

Conclusions

- Current high storage levels, along with the gas infrastructure (already established infrastructure, newly commissioned infrastructure projects and enhanced cooperation between the operators) reduce the dependence on Russian supply, allowing for more efficient usage of storage facilities (for injection or withdrawal), and import, as well as the transit, of more LNG using new LNG terminals. In case of high demand events, additional measures might be needed.
- Storage facilities play an essential role to ensure security of supply, providing seasonal flexibility needed during the winter season. An early significant storage withdrawals will result in low storage levels at the end of the winter season. This might have a negative impact on the flexibility of the gas system. From the security of supply perspective, it would be important to inject gas during the summer season and keep storage at an adequate level until the end of the winter. However, some European countries are reserving a part of their own gas stock to be constituted as strategic reserves and used only for the purpose of mitigating demand curtailment. The availability of strategic storage reserves is depending on the country's specific regulation.
- In case of full disruption of Russian pipeline supplies during winter, additional measures might be needed to save significant volumes of the gas for the end of the season, and to avoid risk of demand curtailment in case of cold winter and peak demand situations. Simulation results showed that the introduction of possible measures, such as enhanced capacities, additional supplies, and a 15% decrease in gas demand, would avoid demand curtailment risks and allow for reaching an adequate storage level.
- Even in case of the full Russia pipeline supply disruption, cooperation between the countries and demand measures could allow for efficient injection during the summer 2024 in preparation for the next winter.
- To achieve a 90% storage filling level by the end of the next summer, it is necessary to retain more gas at the beginning of the injection season (an average of 46%) or import a larger amount of LNG compared to summer 2022.
- EU stock levels are considerably high at the beginning of October 1 2023 (96%). Additional storage flexibility could be secured by storing additional volumes in Ukrainian storage facilities, under a condition that this gas could be injected and later on withdrawn during the winter season and market participants would be willing to use it. Potential transit of gas through Ukraine between Member States could improve interconnectivity between the CEE and SEE regions.
- The disruption of the Balticconnector pipeline limits the possibility of Finland's cooperation with the Baltic States, but at the same time does not pose a significant risk to the security of gas supplies in the region.

Important:

ENTSOG's Winter Supply Outlook 2023/24 with Summer 2024 Overview is an assessment of the readiness of the gas infrastructure to cope with the upcoming winter and summer seasons under different scenarios, but this assessment is not a forecast of the expected gas supply situation and actual availability of gas from different sources is not guaranteed. The actual utilisation of the gas infrastructure, including the development of the gas storage levels, will be determined by the decisions of the market participants and influenced by external factors such as policy decisions.

Outlooks are not forecasts of the future. Rather, they identify potential resource adequacy risks at a specific point in time for the upcoming season which can be addressed proactively by preparation or mitigation measures. The identified risks are based on the assessment of a reference scenario and a variety of sensitivities, which consider uncertainties that could materialise.

1. INTRODUCTION

This edition builds on previous Winter and Summer Supply Outlooks. It covers two different weather demand scenarios for the winter season: Reference Winter and Cold Winter. The assessments related to the Cold Winter case are based on the demand data assumptions of ENTSOG's Union-wide Security of Supply Simulation Report 2021[6].

The Winter Supply Outlook 2023/24 with summer 2024 overview aims at assessing the ability of the European gas infrastructure to provide enough flexibility to meet different demand situations during the storage withdrawal season and sufficient flexibility to shippers during the storage injection season.

Russia's invasion of Ukraine has triggered energy security concerns in Europe. Therefore, ENTSOG additionally assessed the dependence of the EU on the Russian supply during winter 2023/24 and summer 2024 seasons.

ENTSOG also assessed different cases of LNG availability for Europe.

2. ASSUMPTIONS

The Winter Supply Outlook 2023/24 with summer 2024 overview is based on assumptions specific to the upcoming winter and summer seasons and short-term trends as detailed in the annexes. In any case, the actual withdrawal, injection, and supply mix will result from market behaviour and other external factors such as policy decisions.

The model assumes cooperative behaviour among Member States. This concerns (i) an equal sharing of eventual demand curtailments between the Member States if technically possibly, (ii) LNG supply distribution between terminals according to security of supply needs, and (iii)

[6] https://www.entsog.eu/security-of-supply-simulation

storage utilisation according to security of supply needs. However, the model does not factorize commercial supply agreements.

2.1. Infrastructure

A significant number of new gas infrastructure facilities were commissioned over the past year, with a notable emphasis on the buildup of new LNG import capacities, boosting energy security in the EU. The new FSRUs have been commissioned in Germany, Finland, the Netherlands, Italy in the second half of 2022 and first half of 2023.

The topology of the network model considers the existing European gas infrastructure, the firm technical capacities[7] provided by TSOs, which include maintenance plans known as of September 2023 and new upcoming projects as of their respective expected start of commercial operations. For example:

- Brunsbuettel Hafen and Stade FSRUs in Germany;
- Musel LNG terminal in Spain;
- Le Havre FSRU in France.

In the supply disruption scenario, those capacities may not reflect the situation accurately as gas flows and pressure may vary significantly from the usual operational conditions. However, in the disruption case of full Russian pipeline supply disruption studied in this report, some TSOs estimated and provided enhanced capacities to increase and maximise gas flow from Western to Eastern Europe.

In order to capture the influence of the UGS inventory level on the injection and withdrawal capacities, ENTSOG used injection and deliverability curves that were provided by GIE[8]. These curves represent a weighted average of the UGS facilities of each area (see **Annex A**).

2.2. Seasonal Demand

The Reference Winter demand (from 1 October 2023 to 31 March 2024) is based on TSOs' estimates and is provided on a monthly granularity level. An average daily demand has been considered within each month (see **Annex B** for country detail).

The demand for the Cold Winter is based on demand assumptions considered in ENTSOG's Union-wide Security of Supply Simulation Report 2021, i.e., the historical highest winter demand since the winter 2009/10 on country level. Cold Winter demand values have been updated in relation to the report from 2021 to consider the latest market conversions from L-gas to H-gas in Germany, France, and Belgium. A Cold Winter demand that is reduced by 15% is used as a sensitivity.

For comparison, **Figure 1 and 2** shows the European aggregated daily demand for the Reference Winter compared to the historical aggregated daily demand over the last five winters. It is compared with the respective Cold Winter demand, Cold Winter minus 15%

[7] According to EC Regulation No 715/2009 of 13 July 2009 'technical capacity' means the maximum firm capacity that the transmission system operator can offer to the network users, taking account of system integrity and the operational requirements of the transmission network; 'firm capacity' means gas transmission capacity contractually guaranteed as uninterruptible by the transmission system operator.
[8] https://www.gie.eu

demand, and the demand for the 5-year average winter seasons from 2017/18 to 2021/22 in units of GWh/day and TWh/season. While estimated demand is increased compared to the winter 2022/23 for all three assessed winter 2023/24 demand cases, the Reference Winter and the Cold Winter minus 15% demands are in the order of magnitude of the winter 2021/22 (-3.7% and +2.4% respectively). Also the Reference Winter demand is below 5-year average demand for the 2017/18 to 2021/22 winter seasons.

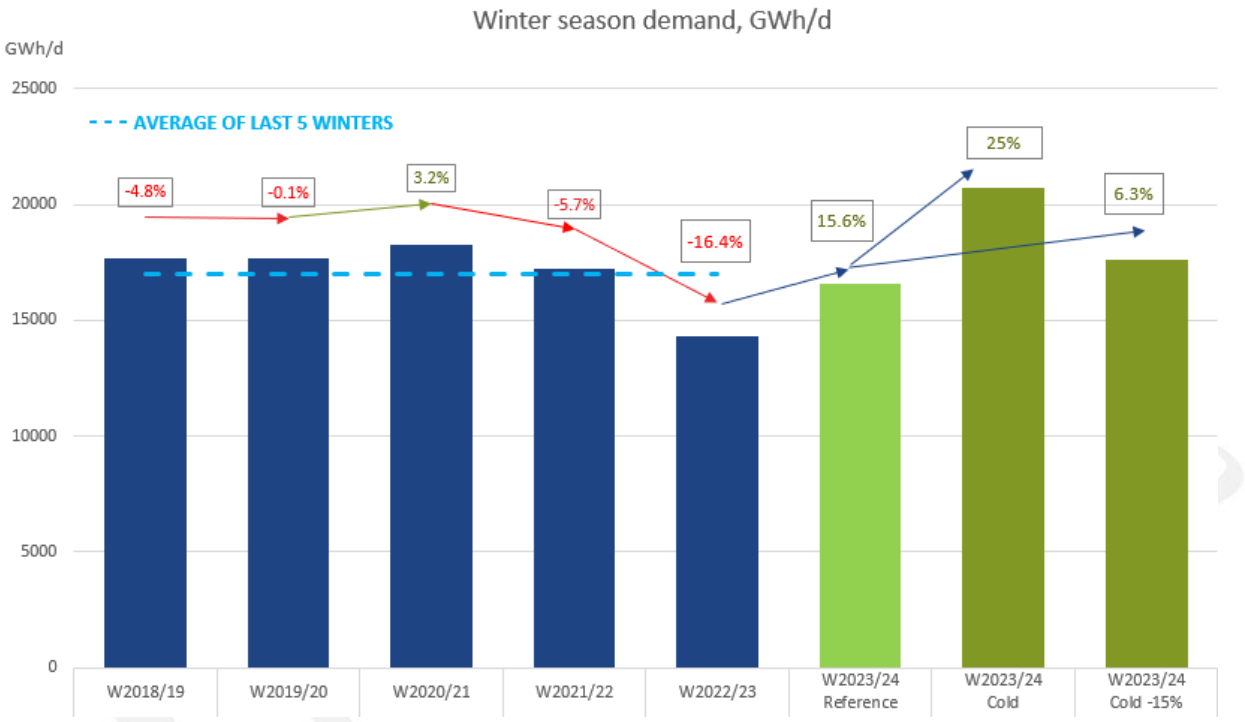


Figure 1. - European daily average winter demand comparison with Winter 2023/24 (forecast), Cold Winter demand, Cold Winter with 15% reduction, GWh/d

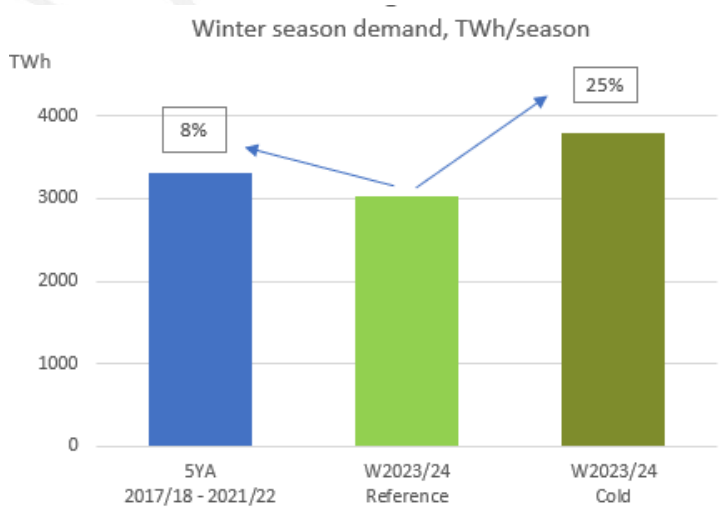


Figure 2. - Reference Winter 2023/24 (forecast) demand comparison with Cold Winter demand and 5-year average for period 2017/18 - 2021/22, TWh

The Reference Summer demand (from 1 April 2024 to 30 September 2024) is calculated as the average historical demand of the five summer seasons from 2017 to 2021 reduced by 15% in the spirit of the coordinated demand reduction measures defined in the Council Regulation (EU) 2022/1369 of 5 August 2022. The Reference Summer demand values have been updated for the simulations in this report to consider the latest market conversions from L-gas to H-gas in Germany, France, and Belgium. An average daily demand has been considered for each month (see **Annex B** for country detail).

For comparison, **Figure 3** shows the European aggregated daily demand for the Summer 2024 overview and the historical daily demand over the summers of the years 2018 to 2022.

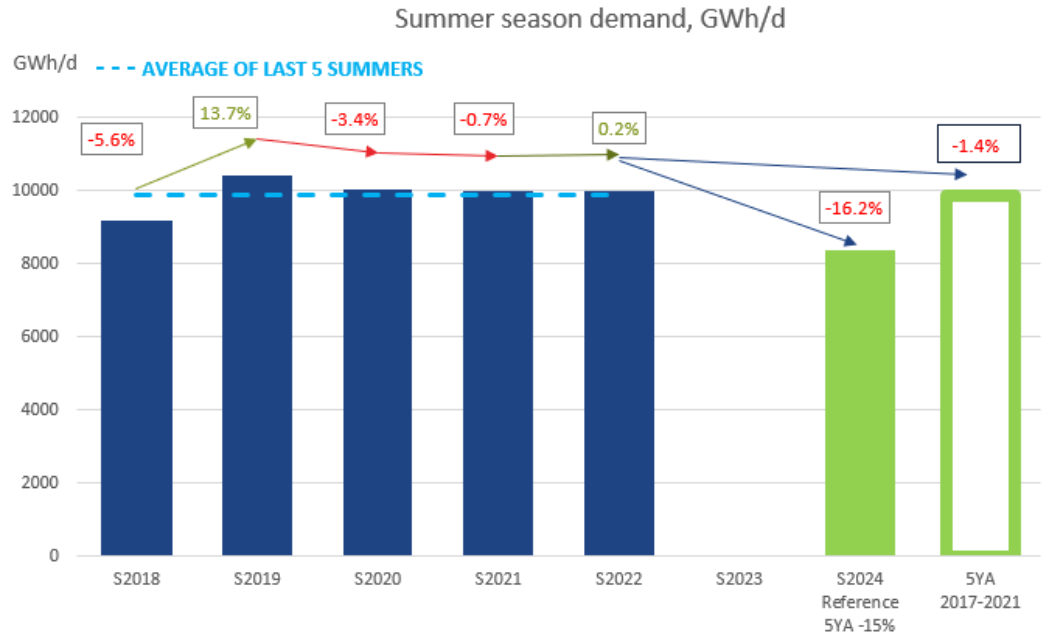


Figure 3. - European daily average summer demand comparison with Summer Reference (5-year average -15%), GWh/d[9]

2.3. Peak Demand

Two high demand situations are considered: Peak Day demand and 2-Week Cold Spell. They are defined in the table below:

Period	Occurrence of the demand provided by TSOs
Peak Day	One day (peak day) of exceptionally high demand, occurring with a statistical probability of once in 20 years
2-Week Cold Spell	A period of two weeks of exceptionally high demand, occurring with a statistical probability of once in 20 years

[9] Forecast values for the summer 2024 overview were not collected from TSOs due to the long period prior to the summer season and the difficulty of estimating for TSOs (the data collection process was initiated in June 2023).

The Peak Day and 2-Week Cold Spell demands are used to check if the withdraw capacity from the UGS facilities is sufficient with such events when the storage levels are reduced and their maximum withdraw capacity is therefore not available.

Figure 4 shows the European aggregated 2-Week Cold Spell demand. Reference Winter[10] and Cold Winter[11] demand values as well as sensitivities for Cold Winter with 15% demand reduction are compared with the historical demand over the last five winters.

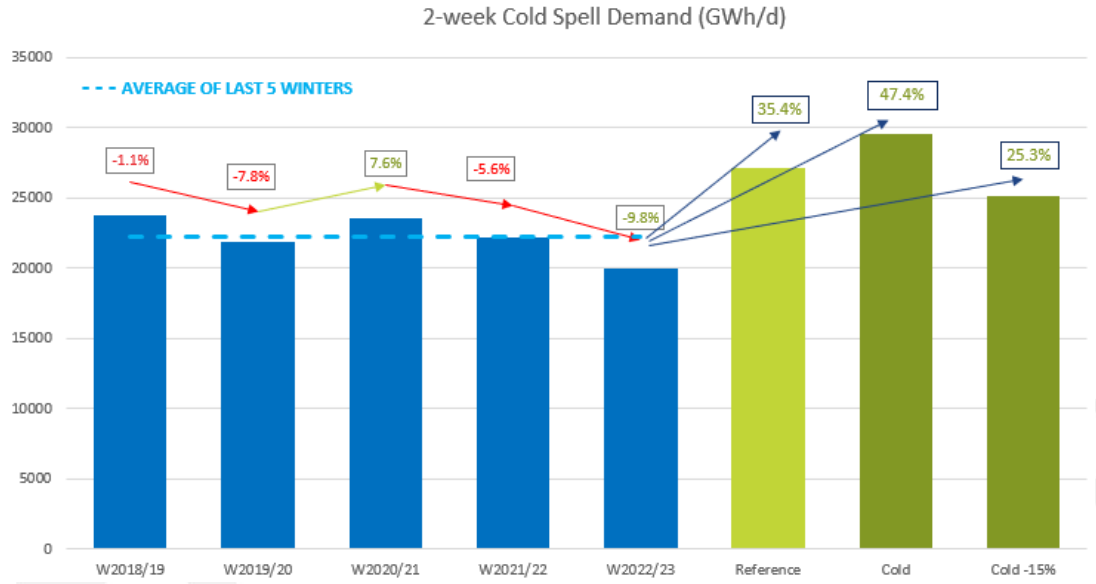


Figure 4.- European 2-week demand history comparison with Reference Winter 2023/24 (forecast), Cold Winter and Cold Winter with 15% reduction 2-Week Cold Spell demand, GWh/d

The 2-Week Cold Spell demand for the Reference Winter is higher than that observed during the last winter (+35.4%). In the event of a 2-Week Cold Spell during a Cold Winter, the demand could be 47.4% higher than in winter 2022/23; in the case of a 15% demand reduction, it could be higher by 25.3%

Figure 5 shows the European aggregated Peak Day demand. Reference Winter[12] and Cold Winter[13] demand values as well as sensitivities for both cases with 15% demand reduction are compared with the historical demand over the last five winters.

[10] The 2-Week Cold Spell demand for Reference Winter is based on TSOs' estimates.
[11] The 2-Week Cold Spell demand for Cold Winter is based on demand assumptions considered in ENTSOG's Union-wide Security of Supply Simulation Report 2021.
[12] Peak Day demand for Reference Winter is based on TSOs' estimates.
[13] Peak Day demand for Cold Winter is based on demand assumptions considered in ENTSOG's Union-wide Security of Supply Simulation Report 2021.

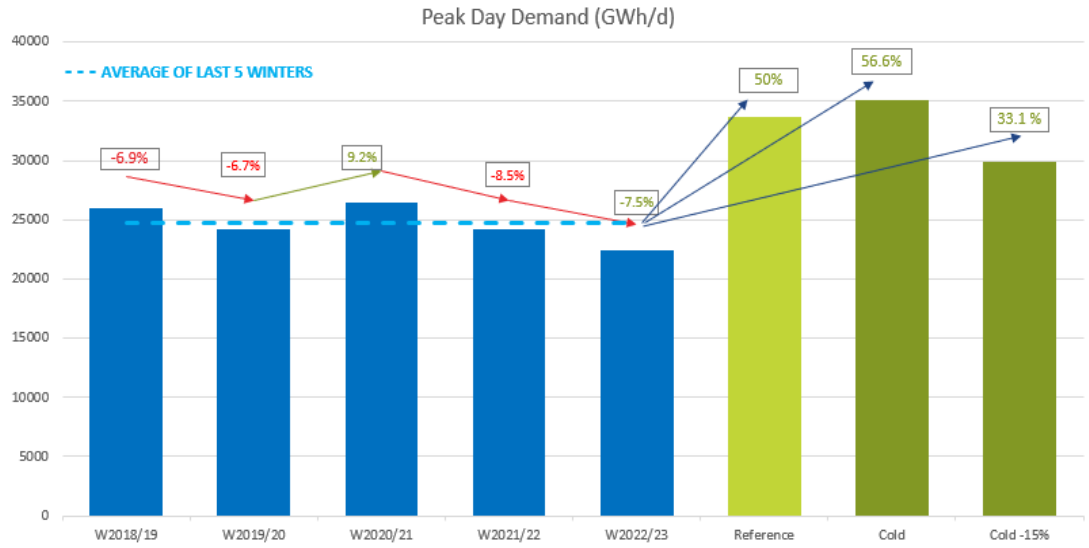


Figure 5.- European Peak Day demand history comparison with Reference Winter Peak 2023/24 (forecast), Cold Winter Peak and Cold Winter Peak with 15% reduction demand, GWh/d

Due to the mild previous winter, the Peak Day demand for the Reference Winter is higher than that observed during the last winter (+50%) and higher than the average of the last five winters. In the event of a Peak Day during a Cold Winter, the demand could be higher by 56.6% compared to the winter of 2022/23; in the case of a 15% demand reduction, it would be 33.1% higher.

2.4. Import supply potential

The maximum supply potentials of the different sources providing gas to the EU are based on the historical availability over the last five years (Caspian Sea, Algeria, Reference LNG) or based on TSO information (Libya, Norway) or the observed flows of the last year (Russia). Maintenance works on Norwegian gas fields is considered in the report in line with the published maintenance plan for September 2024[14].

Supply limitations are set for different cases (monthly values for winter and summer seasons, weekly values for the 2-Week Cold Spell case, daily values for the Peak Day case) so that the maximum flows from each source cannot exceed reasonable levels based on historical observations.

The Russian pipeline supply potential is based on the last year's flows. It is thereby limited to flows through TurkStream and observed flows through Ukraine. In order to assess the EU dependence on Russian gas, all simulations minimised the use of this supply source to the possible extent. Other supply sources are used therefore in priority. There is also a sensitivity assuming a total disruption of Russian pipeline supply.

For LNG, three different cases of supply availability are considered: (1) Reference LNG supply, (2) Low LNG supply, and (3) Maximum LNG supply.
The maximum supply potential for seasonal assessments is by default (if not specified by TSOs or Russian pipeline supply or a LNG sensitivity) calculated as the maximum 30 days rolling

[14] Gassco website: https://umm.gassco.no/

average supply from this source over the last five years per season. The Reference LNG supply case is calculated as explained above (maximum 30 days rolling average), while the Low LNG supply case is based on the five-year average historical flows per season. The Maximum LNG supply case is only limited by the European LNG terminal regasification capacities and TSO network capacities and not by the availability of importable LNG.

<table>
<tr><th></th><th>National Production</th><th>UGS</th><th colspan="2">LNG</th><th>Caspian, Algeria, Norway, Libya, Russia</th></tr>
<tr><td>Winter Season</td><td>TSO forecast for winter</td><td rowspan="5">Limited for each country (or zone) by the stored volumes and the deliverability associated with the inventory level.</td><td colspan="3">Limited for the whole winter period at monthly level to the maximum 30 days rolling average of the last 5 winters[15].
For LNG, three different cases of supply availability are considered: (1) Reference LNG supply, (2) Low LNG supply, and (3) Maximum LNG supply.</td></tr>
<tr><td rowspan="4">2-Week Cold Spell</td><td rowspan="3">TSO forecast for high demand situations</td><td>Week 1</td><td rowspan="4">Limited to the maximum 14 days rolling average of the last 5 winters.</td></tr>
<tr><td>Limited to the observed February flow in the model plus additional LNG that can be taken from the tanks to be shared with week 2.</td></tr>
<tr><td>Week 2</td></tr>
<tr><td>Limited to the maximum 14 days rolling average of the last 5 winters plus additional LNG that can be taken from the tanks to be shared with week 1.</td></tr>
<tr><td>Peak day</td><td>Limited to the maximum daily supply of the last five winters plus additional LNG that can be taken from the tanks.</td><td>Limited to the maximum daily supply of the last five winters.</td></tr>
<tr><td>Summer Season</td><td>TSO forecast for summer</td><td colspan="3">Limited for the whole summer period at monthly level to the maximum 30 days rolling average of the last 5 summers[16].
For LNG, three different cases of supply availability are considered: (1) Reference LNG supply, (2) Low LNG supply, and (3) Maximum LNG supply.</td></tr>
</table>

Table 1. – Gas supply maximum availability definitions

The maximum supply potential for assessments of the 2-Week Cold Spell cases is by default (if not specified by TSOs or Russian pipeline supply or a LNG sensitivity) calculated as the maximum 14 days rolling average supply from this source over the last five years. The Reference LNG supply case is calculated as explained above (maximum 14 days rolling average), while the Low LNG supply case uses the relationship between the seasonal Reference LNG supply potential and the seasonal Low LNG supply potential and applies it to the Reference LNG supply potential for the 2-Week Cold Spell case. The Maximum LNG supply case is only limited by the European LNG terminal regasification capacities and TSO network capacities and not by the availability of importable LNG. In all 2-Week Cold Spell cases, the

[15] The Russian pipeline supply potential is based on the last year's flows.
[16] The Russian pipeline supply potential is based on the last year's flows.

modelling accounts for the additional amount of LNG that can be withdrawn from the tanks (see **Annex A**).
The maximum supply potential for assessments of the Peak Day cases is by default (if not specified by TSOs or Russian pipeline supply or a LNG sensitivity) calculated as the daily maximum from this source over the last five years. The Reference LNG supply case is calculated as explained above (daily maximum), while the Low LNG supply case uses the relationship between the seasonal Reference LNG supply potential and the seasonal Low LNG supply potential and applies it to the Reference LNG supply potential for the Peak Day case. The Maximum LNG supply case is only limited by the European LNG terminal regasification capacities and TSO network capacities and not by the availability of importable LNG. In all Peak Day cases, the modelling accounts for the additional amount of LNG that can be withdrawn from the tanks (see **Annex A**).

For each of the winter and summer demand profiles and high demand situations in the winter season, specific maximum gas supply availabilities are used in the report as defined in **Table 2:**

GWh/day			DZ	LNG	LNG Low	LNG Max	LY	NO	CA	RU
Winter Season	Max per 30 days		1124	5852	3538	Regas. capacity	190	3800	376	750
High Demand [17]	2-Week Cold Spell	Week 1	1190	[18]	[18]	[18]	213	4000	382	1000
		Week 2	1190	6036	3650	Regas. capacity	213	4000	382	1000
	Peak day		1266	7470	4517	Regas. capacity	263	4000	400	1050
Summer Season	Max per 30 days		1133	3732	2360	Regas. capacity	156	3800 / 2830[19]	464	700

Table 2. – Maximum supply potential, GWh/d

Note: the supply assumptions (supply potential) are based on the supply observed in the last periods and should not be considered as a forecast. The actual supply mix will depend on market behaviour and other external factors. Moreover, the model does not factorize supply commercial agreements.

European domestic production

Regarding the European domestic production**,** **Figure 6** and **Figure 7** provide a comparison between the last five winter and summer seasons and the national production forecasted by the TSOs for winter 2023/24 and summer 2024 (see **Annex B** for monthly details). Domestic production is following a long-term dwindling trend, primarily due to the end of production in October 2023 of the largest gas production in the EU – the Netherlands' Groningen field. However, UK gas production is in the same range after rising in 2022 due to a number of factors, including the commissioning of new fields in the Southern North Sea.

[17] Limited to the observed supply potential plus additional LNG that can be taken from the tanks.
[18] Limited to the observed February flow in the model plus additional LNG that can be taken from the tanks to be shared with week 2.
[19] Supply potential for SEP 2024 (according to maintenance plane).

In the winter 2023/24, domestic production is estimated to decrease by 8% compared to the previous winter, while for summer 2024, it is forecasted to decline by approximately 16% compared to summer 2022.

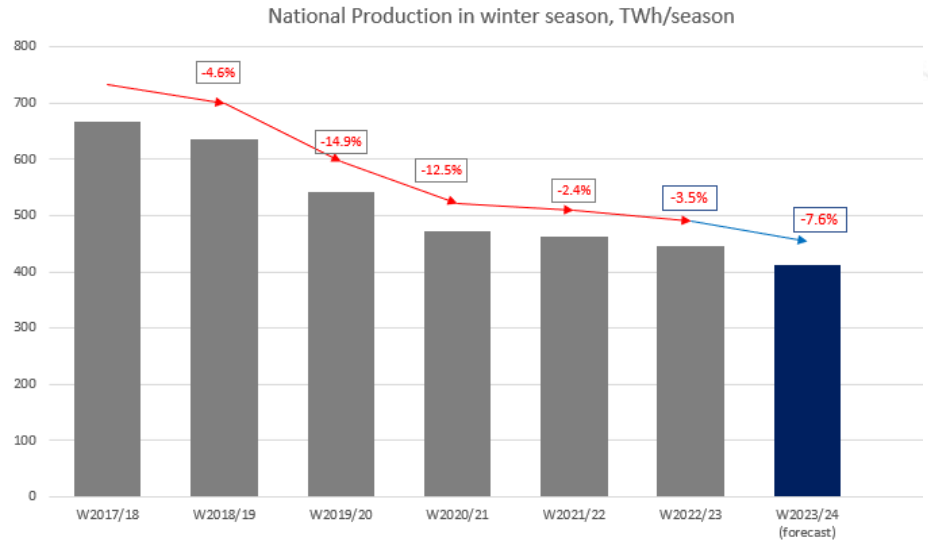


Figure 6. - European national production comparison with Winter 2023/24 (forecast), TWh

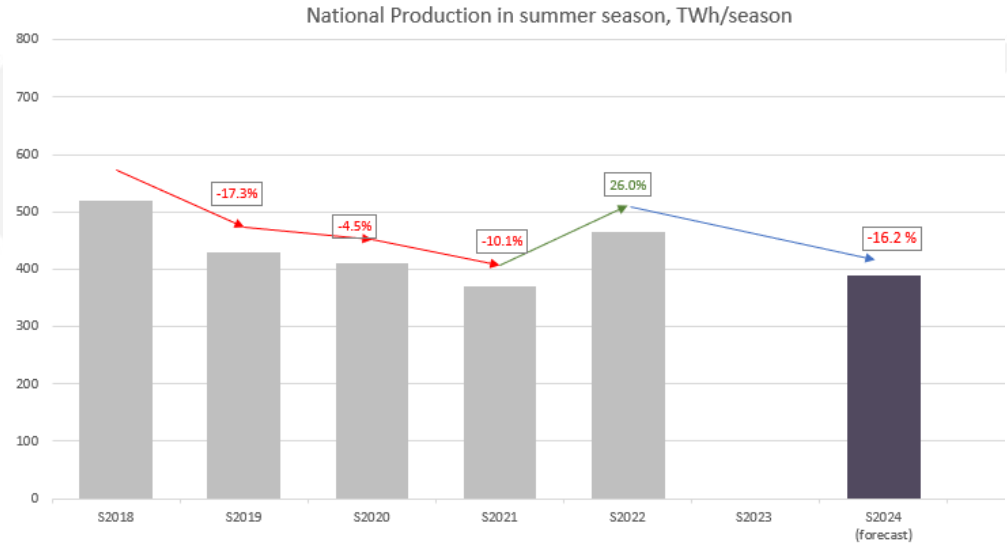


Figure 7. - European national production comparison with Summer 2024 (forecast), TWh

Consideration of non-EU countries

When assessing the supply adequacy at European level, ENTSOG takes into account the interactions with the countries neighbouring the EU: the United Kingdom, Switzerland, North Macedonia, Serbia, Bosnia Herzegovina, Ukraine, Turkey, and Moldova.

The analysis considers non-EU countries, including the Energy Community contracting parties, taking into account the geography and the actual supply situation:

- The United Kingdom, Switzerland, Bosnia and Herzegovina, North Macedonia, Serbia are included in the modelling perimeter. Serbia and North Macedonia won't cooperate in case of full Russia supply disruption.
- Export to Ukraine and Moldova is based on the expected forecast provided by the Ukrainian TSO and the Energy Community Secretariat respectively.
- Export to the Kaliningrad region of Russia is not considered.
- No export towards Turkey was considered. Caspian and Russian gas is considered to be transported through Turkey into the EU. While gas flows through the IP Strandzah 1 were observed in September 2023, the exact source of this gas as well as the associated technical capacity are not evident. Therefore, such additional imports from Turkey into the EU are not considered in this report.
- Albania, Montenegro and Kosovo are not connected to the gas grid.

2.5. Storage inventory

Storage behaviour in the modelling is defined as follows:

- **Winter Supply Outlook 2023/24**. The actual gas storage level on 1 October 2023 according to the AGSI+ platform[20] is used. A target storage level of 30% is defined for each storage facility. This target storage level should be reached at the end of the withdrawal season (31 March 2024). This target is not mandatory. This means that the storage level goes below 30% on 31 March 2024 if otherwise demand could not be satisfied by other supply sources.

Sensitivity analyses were also conducted with a maximum target. In these analyses, the model was allowed to exceed 30% to determine how high the storage level could potentially reach.

- **Summer 2023/24 overview.** A target storage level of 90% is defined for each storage facility for the end of the injection season (30 September 2024). This target is not mandatory. This means that the storage level goes below 90% on 30 September 2024 if otherwise demand could not be satisfied by other supply sources. The simulation is performed for a whole gas year, i.e., from 1 October 2023 to 30 September 2024. Additionally, simulations are performed for the summer season with an initial storage filling level of 30% for each storage facility on 1 April 2024.

Some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves. This means that strategic reserves remain available to reduce or even avoid demand curtailment in some countries. Availability of strategic storage reserves is depending on the country's specific regulation.

On 1 April 2023, the EU gas stock level reached the maximum of the range of the past 5 years with 625 TWh. The decrease in gas consumption - as a result of relatively mild winter weather,

[20] https://agsi.gie.eu

high prices effect, dedicated measures introduced by the Member States and individual users' behaviour - contributed to the record volume of gas in storage.

On 1 October 2023, the European underground gas storage reached 96% of its filling level, equivalent to 1,102 TWh, achieving the EU's storage target of 90% two months ahead of the end of the injection period. Stocks were already high after the withdrawal season of 2022/23 and have accumulated more slowly than usual during the last months of the injection period.

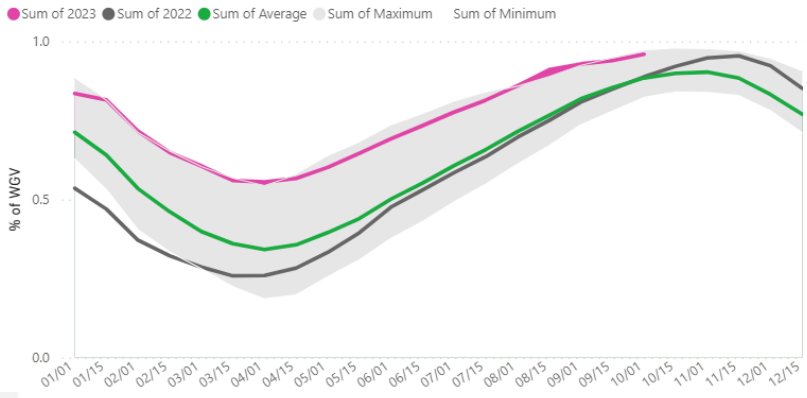
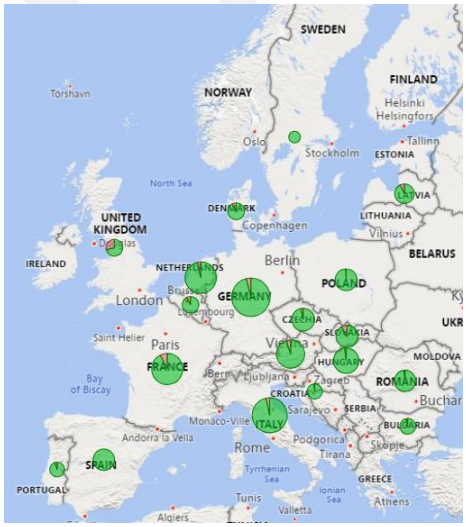


Figure 8. - Gas storage evolution compared to the storage evolution 2015-2023, % of WGV (Source: AGSI+)

For the modelling of the different scenarios, the Winter Supply Outlook 2023/24 considers the storage inventory level per country on 1 October 2023 as the initial situation as shown in Figure 9.

In absolute terms, the largest gas volumes on 1 October 2023 are stored in Italy and Germany. In relative terms, the storage level of all EU countries is higher than 90%. The highest filling levels (100%) are observed in Poland and Spain. These storage levels per country have been used as a starting point for the Winter Supply Outlook 2023/24.



Country	WGV, GWh	Gas in storage, GWh	Full, %
Austria	97,644	92,624	95%
Belgium	9,130	8,428	92%
Bulgaria	5,890	5,667	96%
Czechia	44,673	43,207	97%
Germany	256,128	246,312	96%
Denmark	9,845	9,043	92%
Spain	34,233	34,233	100%
France	136,346	126,244	93%
Croatia	4,773	4,630	97%
Hungary	68,133	66,674	98%
Italy	195,312	188,682	97%
Latvia	22,600	20,859	92%
Netherlands	139,908	134,869	96%
Poland	37,543	37,382	100%
Portugal	3,670	3,475	95%
Romania	33,864	33,127	98%
Serbia	4,532	4,079	90%
Sweden	102	97	95%
Slovakia	38,897	35,741	92%
United Kingdom	9,864	7,042	71%

Figure 9. - Actual storage inventory levels on 1 October 2023 (the initial level includes strategic stocks for some countries).[21]

[21] The gas in storage on 1 October 2023 for each country is based on the AGSI+ platform. For Serbia, the initial storage is considered 90% due to non-availability of data. The relative filling level has been calculated using the Working Gas Volume and gas in the storage from the AGSI+ platform.

3. MODELLING RESULTS FOR THE WINTER SUPPLY OUTLOOK 2023/24

The following table shows the most relevant information concerning the Winter Supply Outlook 2023/24 results in the different demand scenarios in combination with the main assumptions possible configurations. The simulation results are explained onwards in this chapter.

Winter Demand	RU supply	Storage Target	LNG Scenario	Demand curtailment	Final UGS filling level
Reference	Minimised	30%	Ref	No	32%
		30%	Low	No	23%
		Maximum	Ref	No	56%
	Disrupted	30%	Ref	No	32%
		30%	Low	No	12%
		Maximum	Ref	No	47%
Cold Winter	Minimised	30%	Ref	7%	9%
		30%	Low	17%	9%
		30%	Max	No	13%
	Disrupted	30%	Ref	9%	9%
		30%	Low	21%	9%
		30%	Max	3%	9%
Cold - 15%	Minimised	30%	Ref	No	32%
		30%	Low	3%	9%
		Maximum	Ref	No	38%
		Maximum	Max	No	58%
	Disrupted	30%	Ref	No	27%
		30%	Low	7%	9%
		30%	Max	No	32%
		Maximum	Max	No	47%

Table 3 . – WSO Results Summary

3.1. Reference Winter scenario with 30% storage target for 31 March 2024

For the Reference Winter 2023/24 scenario, the overall winter season withdrawal is defined as the amount of gas necessary to meet demand and reach 30% of the stock level in each European storage facility on 31 March 2024 starting with total European stock level of 96% on 1 October 2023 (see Figure 9).

The distribution of withdrawal and supply over the winter months results from the modelling and the following assumptions:

- The monthly gas demand estimated by TSOs in **Annex B**
- The monthly national gas production estimated by TSOs in **Annex B**
- The monthly capacity provided by TSOs
- The storage withdrawal curves as defined in **Annex A**
- The flexibility given to the model for the definition of the supply potentials derived from the historical supply mix (see **Table 2**)

Based on these assumptions, the modelling has been used to check if any physical congestion or dependence on an import source may limit the satisfaction of gas demand during the withdrawal period. As no risk group is defined in Regulation 1938/2017[22], all European countries cooperate as if they were part of a single European risk group.

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves. This means that strategic reserves remain available to reduce or even avoid demand curtailment in some countries. Availability of strategic storage reserves is depending on the country's specific regulation.

The main finding of the Winter Supply Outlook 2023/24 for the Reference Winter scenario in combination with the Reference LNG supply potential is that the European gas network is capable of enabling market participants to satisfy the demand and reach at least a 30%[23] stock level in all UGS facilities by the end of the winter season 2023/24. A sensitivity simulation with the same input data but aiming at a maximisation of the storage filling level at the end of the winter was run. This sensitivity shows that there is sufficient flexibility of the gas system infrastructure to achieve a higher storage filling level of over 50% at the end of the withdrawal period.

In case of Low LNG supply potential the UGS facilities are used to meet demand at such extent that they cannot reach the 30% target. At the end of the winter, the storage volume at the European level is 23%. This risk has to be mitigated if the EU countries are aiming at reaching the 30% target by the end of winter 2023/24[24].

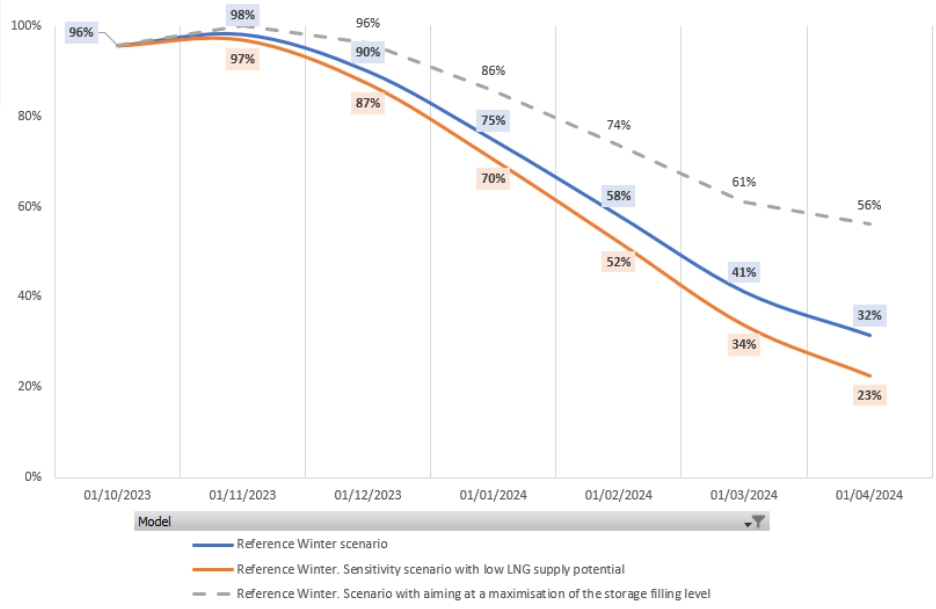


Figure 10. – Reference Winter scenario. Evolution of the aggregated European UGS stock level, %

[22] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.
[23] The storage filling level is above 30% due to national strategic reserves in some countries.
[24] The shortfall is about 104 TWh according to the simulation results.

Figures 11 and **12** show the stock level per country on 31 March 2024 as a result of the model for the Reference Winter.

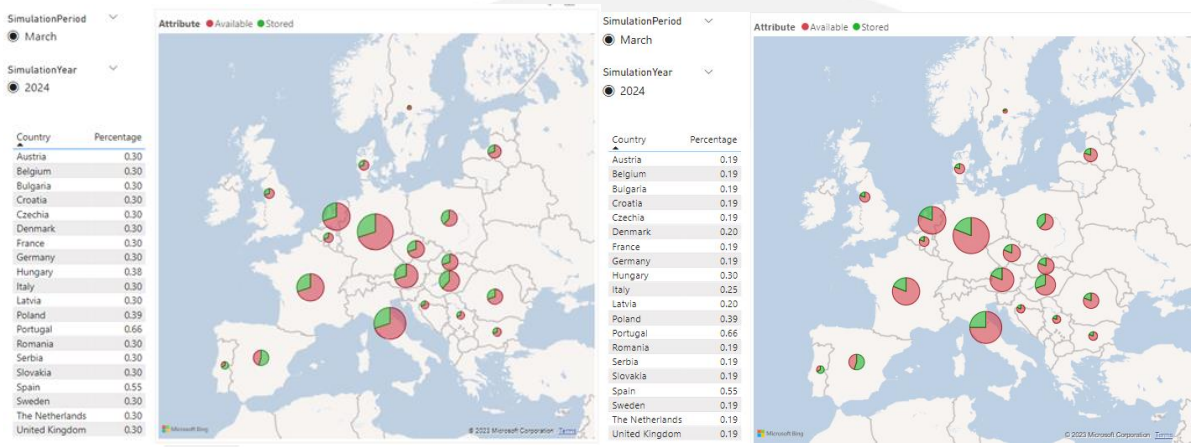


Figure 11 and Figure 12. - Reference Winter scenario and sensitivity scenario with low LNG supply potential. UGS stock level per country, %[25]

Figures 13, 14, 15 and 16 show the level and composition of the supply mix in the Reference Winter scenario and sensitivity scenario with Low LNG supply potential. The storage filling level at the end of March 2024 is 32%[26] and 23% respectively.[27]

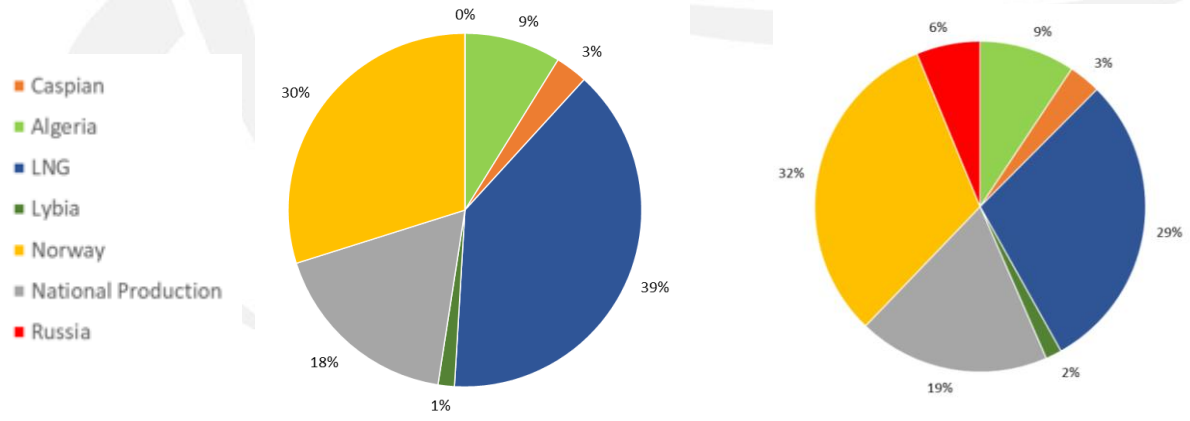


Figure 13 and Figure 14. - Reference Winter scenario and sensitivity scenario with Low LNG supply potential. Supply mix, %

[25] Values for Czech Republic include Slovakian storages located on the Czech Republic territory.

[26] The storage filling level is above 30% due to national strategic reserves in some countries.

[27] The import levels shown represent one possible supply option, where LNG is providing the required import flexibility in this example, and modelling was with highest priority minimizing Russian pipeline supply.

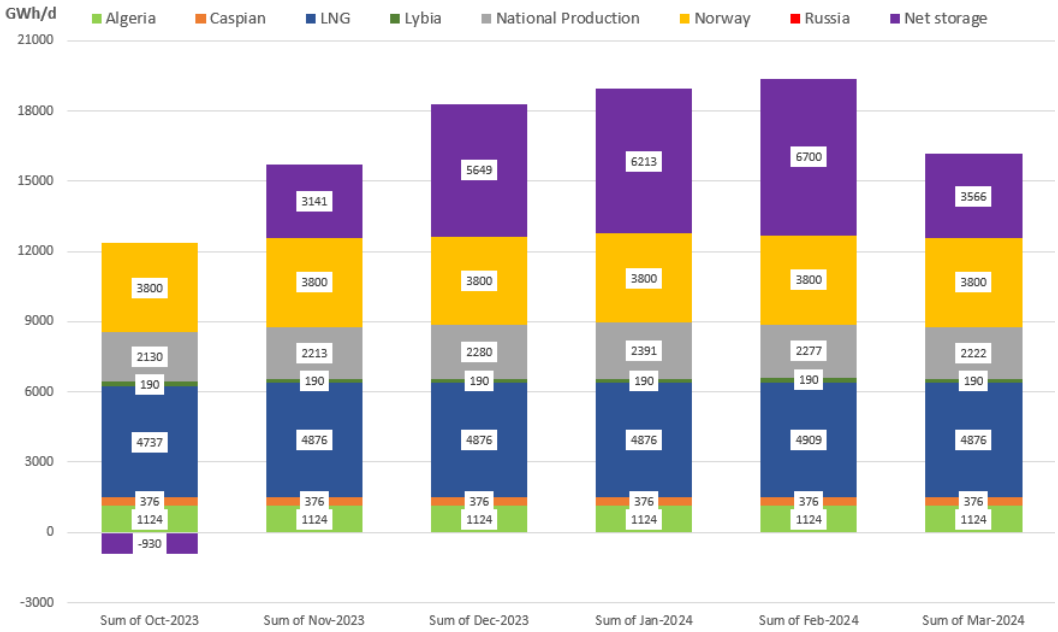


Figure 15. – Reference Winter scenario. Monthly supply mix, GWh/d

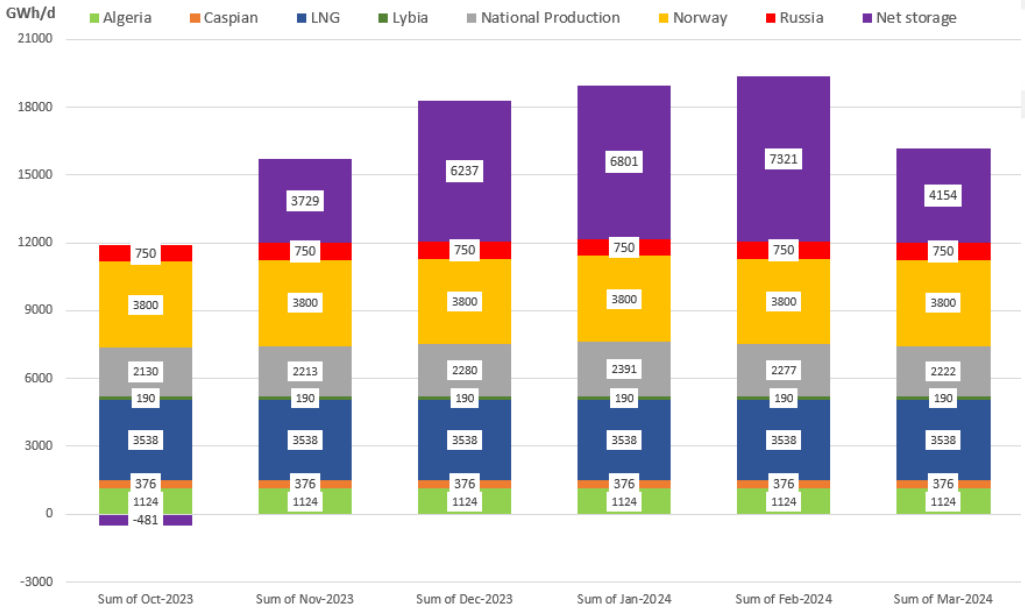


Figure 16. – Reference Winter. Sensitivity scenario with low LNG supply potential. Monthly supply mix, GWh/d

The monthly supply mix is stable over the winter season 2023/24 period for the Low LNG supply case, maximising the usage of all available supply sources up to their maximum potentials. This shows that no capacity restrictions are limiting imports in this case. LNG supply and supply from Norway represent 29% and 32% respectively, while Russian pipeline gas accounts for 6% of the total gas supply.

In the Reference LNG supply scenario, LNG and Norway constitute 39% and 30% of the total supply, respectively. For this case, the LNG supply is not used to its maximum potential since this is not needed to reach the storage target. Therefore, also no Russian pipeline gas is required in this case.

3.1.1. Reference Winter supply dependence assessment – RU supply disruption

This section investigates the potential impact on a scenario described in section 3.1 but with a condition of full disruption of the Russian pipeline supply during the withdrawal period[28]. The enhanced capacity provided by TSOs was applied in this case.

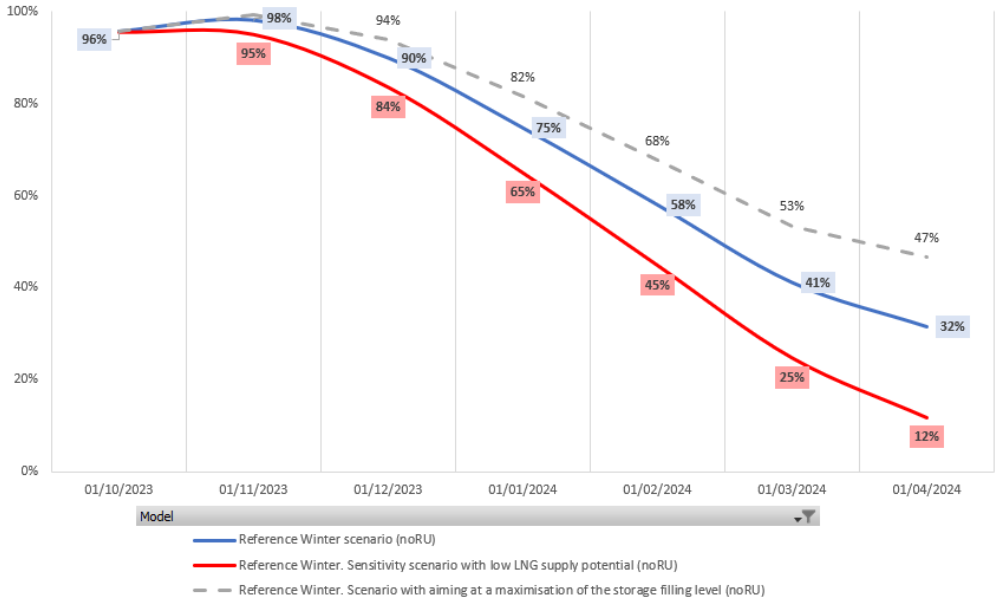


Figure 17. – Winter RU supply dependence assessment. Evolution of the aggregated European UGS stock level, %

Figures 18 and **19** show the stock level per country on 31 March 2024 as a result of the model for the winter supply dependence assessment of a Reference Winter.

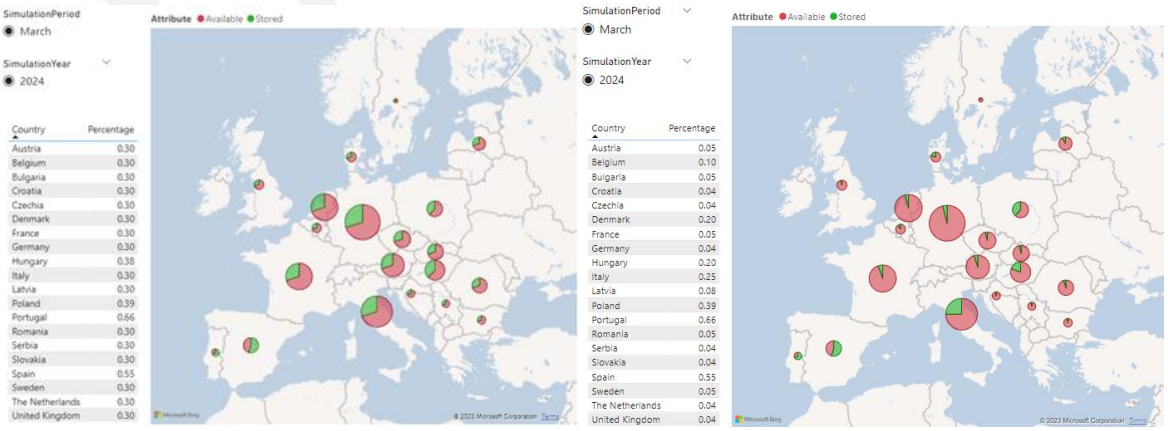


Figure 18 and Figure 19. - Winter RU supply dependence assessment. Reference Winter scenario and sensitivity scenario with low LNG supply potential. UGS stock level per country, %[29]

For the Reference Winter demand in combination with the Reference LNG supply potential, the European gas network is capable of enabling market participants to satisfy the demand

[28] Serbia and North Macedonia won't cooperate in case of full Russia supply disruption.

[29] Values for Czech Republic include Slovakian storages located on the Czech Republic territory.

and reach at least a 30%[30] filling level in all UGS facilities by the end of the winter season 2023/24. The outcomes of a sensitivity analysis aiming at a maximum storage filling level at the end of the winter further indicate that the gas system infrastructure exhibits sufficient flexibility to achieve storage filling levels over 40% at the end of the withdrawal period.

In the Low LNG supply potential sensitivity analysis, it is observed that UGS facilities are fully utilized to meet demand, resulting in an inability to replenish the storage volumes. By the end of the winter season, the storage volume at the European level remains at a mere 12% of the working gas volume. This figure encompasses almost only the strategic reserves of individual countries (strategic reserve gas in storage which is not freely available on the market under normal conditions and represents 9% of the total European storage working gas volume in average). This situation underscores a noteworthy risk that must be preemptively addressed, particularly if the EU Member States aim to achieve the targeted 30% storage filling level at the end of the winter season of 2023/24[31].

In the event of short-term coordinated preparedness, achieved by increasing capacities in specific interconnections, European countries can enhance cooperation to optimise the filling of storage facilities in Central and Eastern Europe. This approach facilitates a more equitable distribution of gas across various UGS facilities. Nevertheless, it is crucial to acknowledge that certain countries face constraints due to limitations in import or internal capacity, restricting their ability to contribute more gas.

One possible solution to address the gas supply needs of Eastern European countries is to establish a supply route from Poland, Slovakia, or Hungary through Ukraine to Romania.

Figures 20, 21, 22 and 23 show the level and composition of the supply mix in the supply dependence assessment of the Reference Winter scenario and the sensitivity scenario with Low LNG supply potential – pipeline supply disruption from Russia. The storage filling level at the end of March 2024 is 32% and 12% respectively.[32]

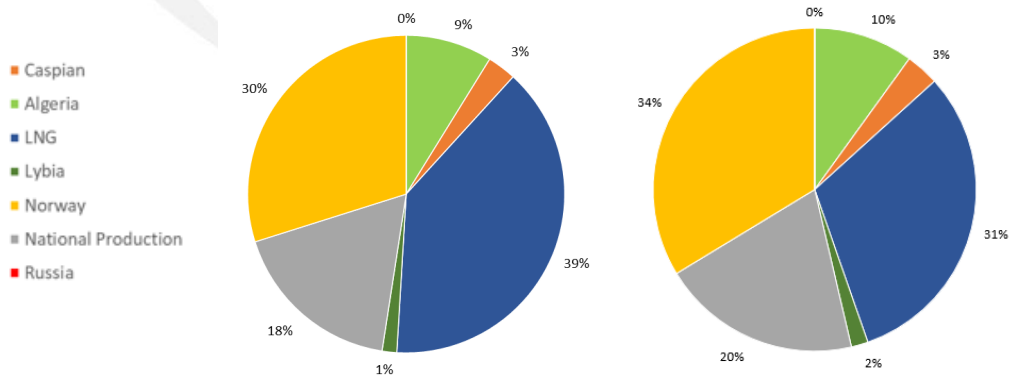


Figure 20 and Figure 21. - Winter RU supply dependence assessment. Reference Winter scenario and sensitivity scenario with low LNG supply potential. Supply mix, %

[30] The storage filling level is above 30% due to national strategic reserves in some countries.

[31] The shortfall is about 228 TWh according to the simulation results.

[32] The import levels shown represent one possible supply option, where LNG is providing the required import flexibility in this example, and modelling was with highest priority minimizing Russian pipeline supply.

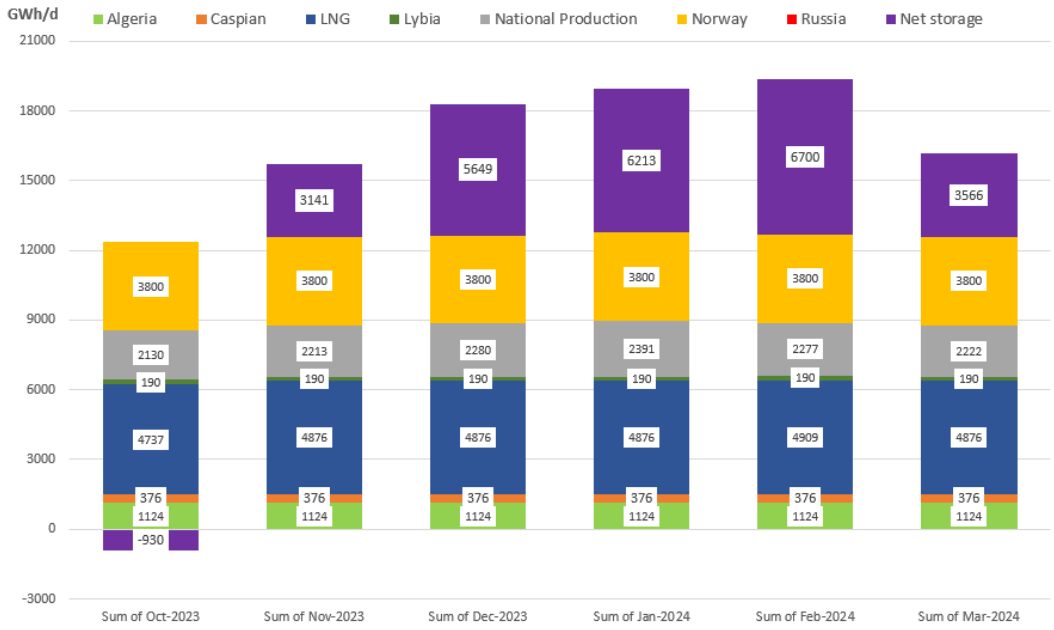


Figure 22. - Winter RU supply dependence assessment. Reference Winter scenario. Monthly supply mix, GWh/d

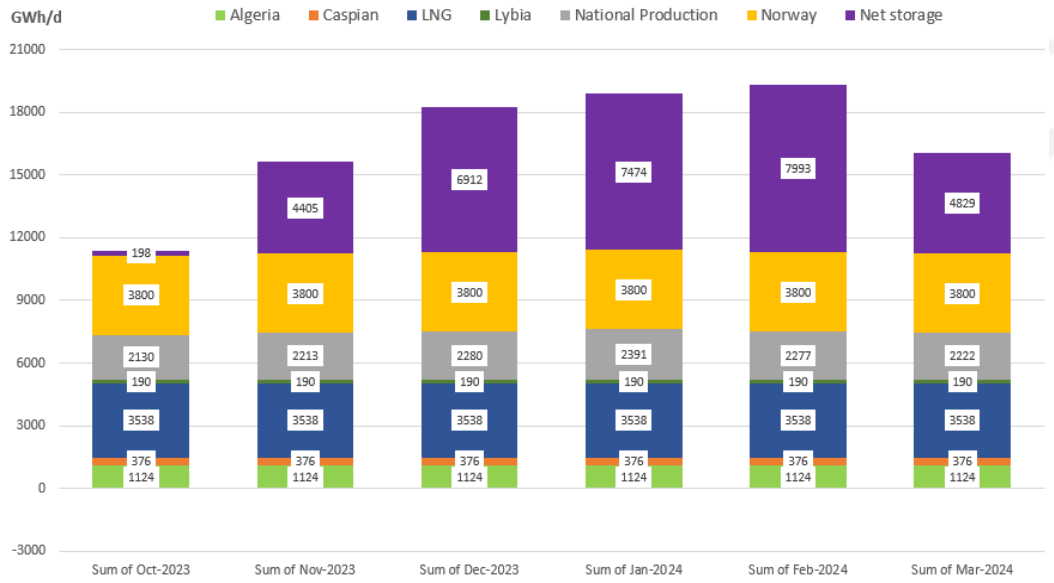


Figure 23. - Winter RU supply dependence assessment. Reference Winter. Sensitivity scenario with low LNG supply potential. Monthly supply mix, GWh/d

The monthly supply mix is stable over the winter season 2023/24 period. LNG supply and supply from NO represent the largest sources of supply. In the Reference Winter scenario, they constitute 39% and 30% of the total supply, respectively. The simulation results reveal that LNG supply falls short of reaching its maximum potential based on the assumptions made for this scenario. This observation underscores the flexibility in LNG imports.

In the low LNG supply potential sensitivity scenario, LNG supply and supply from NO represent 31% and 34% respectively.

Enhanced capacities, provided by TSOs in the case of full supply disruption from Russia, increase interconnection capacities between Germany and Austria, Belgium, the Czech

Republic, and the Netherlands, as well as between Spain and France, contributing to the flexibility of LNG imports to the central part of Europe.

3.2. Cold winter scenario - 30% storage target by 31 March 2024

For the Cold winter 2023/24 scenario, the overall winter season withdrawal is defined as the amount of gas necessary to meet demand and reach 30% of the stock level in each European storage facility on 31 March 2024, starting with total European stock level of 96% on 1 October 2023 (see Figure 9). In this scenario, the cold winter demand values and cold winter demand values with 15% reduction for each country during the withdrawal period were assumed.

The distribution of withdrawal, demand and supply during the winter months results from the modelling and the following assumptions:

- The cold winter monthly gas demand and cold winter monthly gas demand with 15% reduction in **Annex B**
- The monthly national gas production estimated by TSOs in **Annex B**
- The monthly capacity provided by TSOs
- The storage withdrawal curves as defined in **Annex A**
- The flexibility given to the model for the definition of the supply potentials derives from the historical supply mix (see **Table 2**)

Based on these assumptions, the modelling has been used to check if any physical congestion or dependence on an import source may limit the fulfilment of gas demand during the Cold Winter withdrawal period. As no risk group is defined in regulation 1938/2017[33], all European countries cooperate as if they were part of a single European risk group.

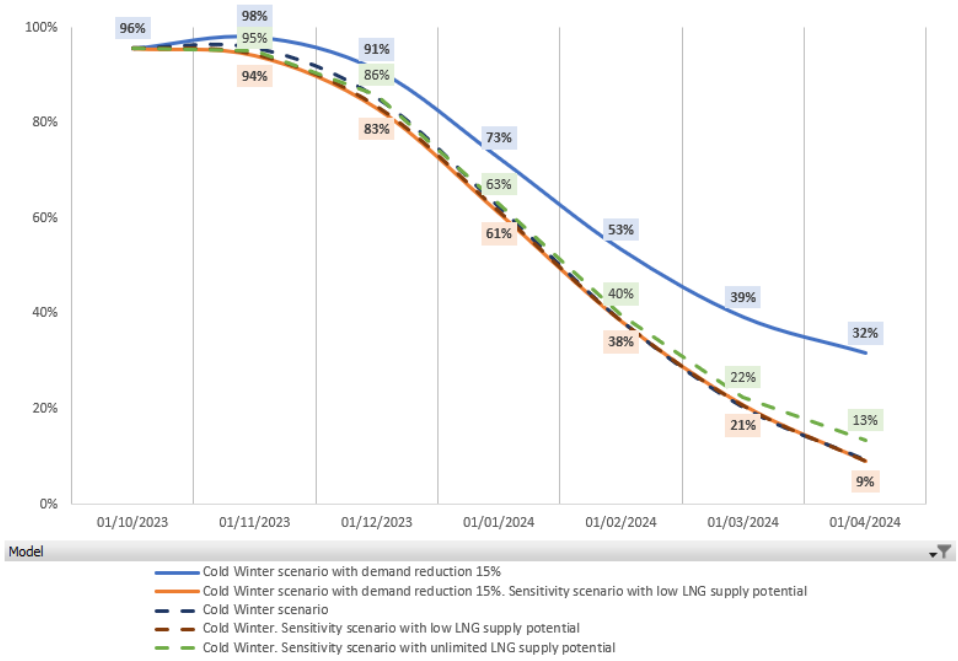


Figure 24. – Cold Winter scenario. Evolution of the aggregated European UGS stock level, %

[33] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.

The Cold winter 2023/24 scenario simulation results show that withdrawal capacities of the gas storage facilities combined with the supply flexibility of imports is no sufficient to cover the demand and reach an inventory target level 30%.

European countries are facing of demand curtailment on average during whole winter season, the scenario influenced by the dynamics of LNG import as shown in **Figure 25.** By the end of the winter season, the storage volume at the European level remains at a mere 9% of the working gas volume and 13% in the scenario with unlimited supply potential (limited by the European LNG terminal regasification capacities and TSO network capacities). This figure covers only the strategic reserves of select countries (strategic reserve gas in storage which is not freely available on the market under normal conditions and represents 9% of the total European storage working gas volume in average). This situation underscores a noteworthy risk that must be preemptively addressed, particularly if EU countries aim to achieve the targeted 30% storage capacity by the end of the winter season of 2023/24 during the withdrawal period[34].

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

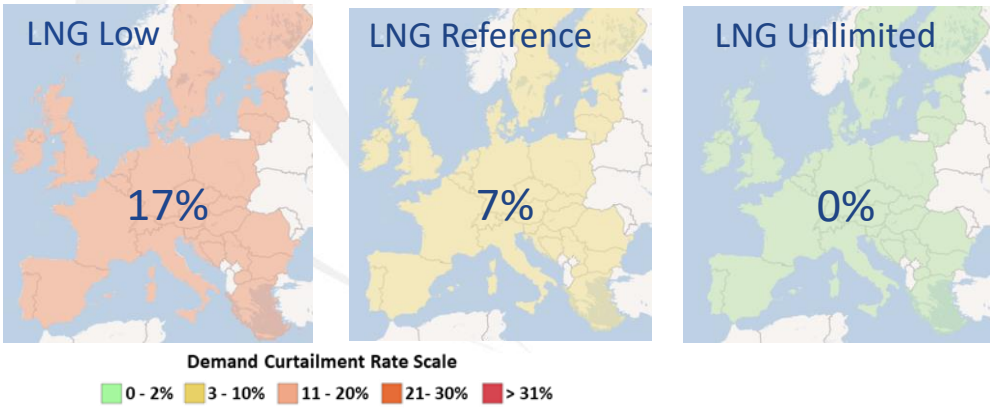


Figure 25. – Cold Winter scenario. Demand Curtailment (average), %

➢ **In case of 15% demand reduction**, European gas network is capable of enabling market participants to satisfy the demand and reach at least a 30% stock level in all underground gas storage facilities by the end of the winter season 2023/24. The results of the sensitivity analysis further confirm that the gas system infrastructure has sufficient flexibility to achieve storage fill levels in excess of 30% during the withdrawal period.

In the low LNG supply potential sensitivity analysis, withdrawal capacities of the gas storage facilities combined with the supply flexibility of imports are no sufficient to cover the demand

[34] Shortfall is about 921 TWh for LNG low, 498 TWh for LNG reference and 210 TWh for LNG unlimited (limited by LNG regasification capacity) sensitivity analyses according to the simulation results.

and reach an inventory target level 30%. By the end of the winter season, the storage volume at the European level remains at a mere 9% (strategic reserve gas in storage which is not freely available on the market under normal conditions and represents 9% of the total European storage working gas volume in average) of the working gas volume and European countries are facing of demand curtailment 3% on average during whole winter season. This situation underscores a noteworthy risk that must be preemptively addressed, particularly if EU countries aim to achieve the targeted 30% storage capacity by the end of the winter season of 2023/24 during the withdrawal period[35].

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

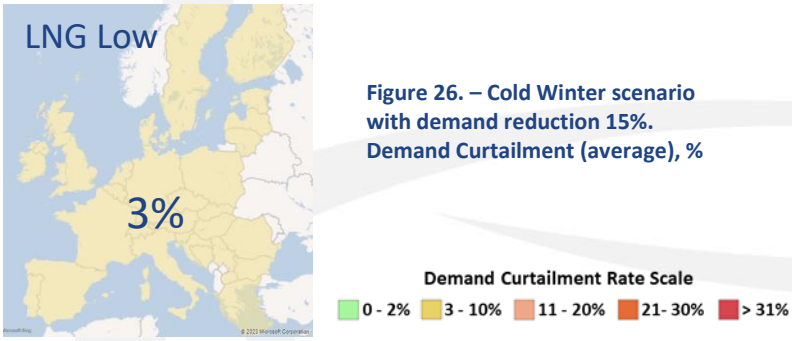


Figure 26. – Cold Winter scenario with demand reduction 15%. Demand Curtailment (average), %

Figures 27 and **28** show the stock level per country on 31 March 2024 as a result of the model for the Cold Winter with demand reduction 15%.

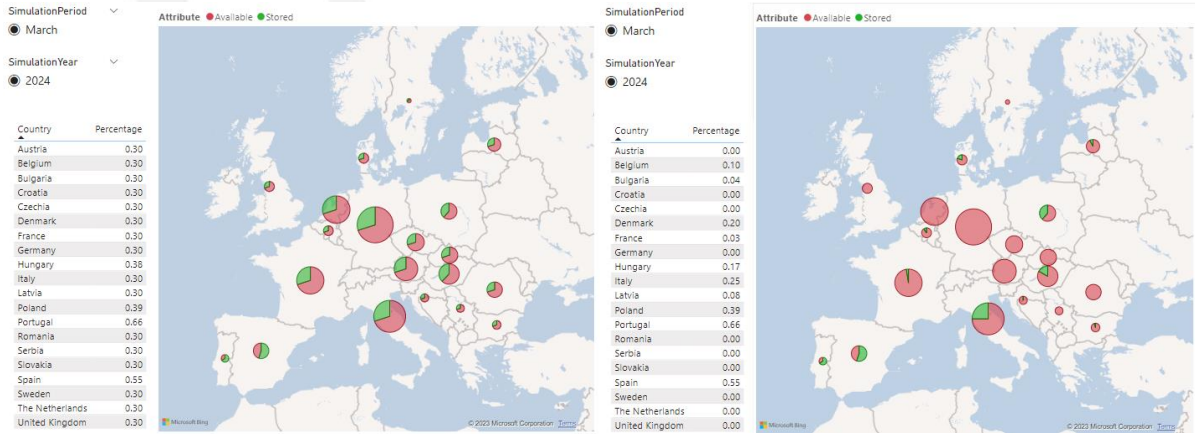


Figure 27 and Figure 28. - Cold Winter with demand reduction 15% scenario and sensitivity scenario with low LNG supply potential. UGS stock level per country, %[36]

[35] Shortfall is about 343 TWh according to the simulation results.

[36] Values for Czech Republic include Slovakian storages located on the Czech Republic territory.

Figures 29, 30, 31 and 32 show the level and composition of the supply mix in the Cold Winter with demand reduction 15% scenario and sensitivity scenario with low LNG supply potential. The storage filling level at the end of March 2024 is 32% and 9% respectively.[37]

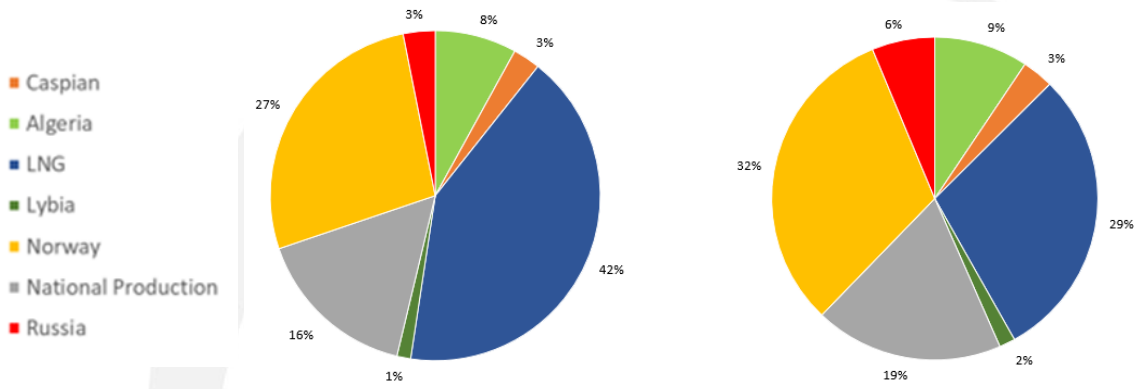


Figure 29 and Figure 30.- Cold Winter with demand reduction 15% scenario and sensitivity scenario with low LNG supply potential. Supply mix, %

The monthly supply mix is stable over the winter season 2023/24 period. LNG supply and supply from NO represent the largest sources of supply. In the Cold Winter with demand reduction 15% scenario, they constitute 42% and 27% of the total supply, respectively. Gas supply from RU accounts for 3% of the total gas supply while other sources are maximised but limited by the firm capacity of the gas network or LNG supply potential.

In the low LNG supply potential sensitivity scenario, LNG supply and supply from NO represent 29% and 32% respectively. Gas supply from RU accounts for 6% of the total gas supply while other sources are maximised but limited by the firm capacity of the gas network or LNG supply potential.

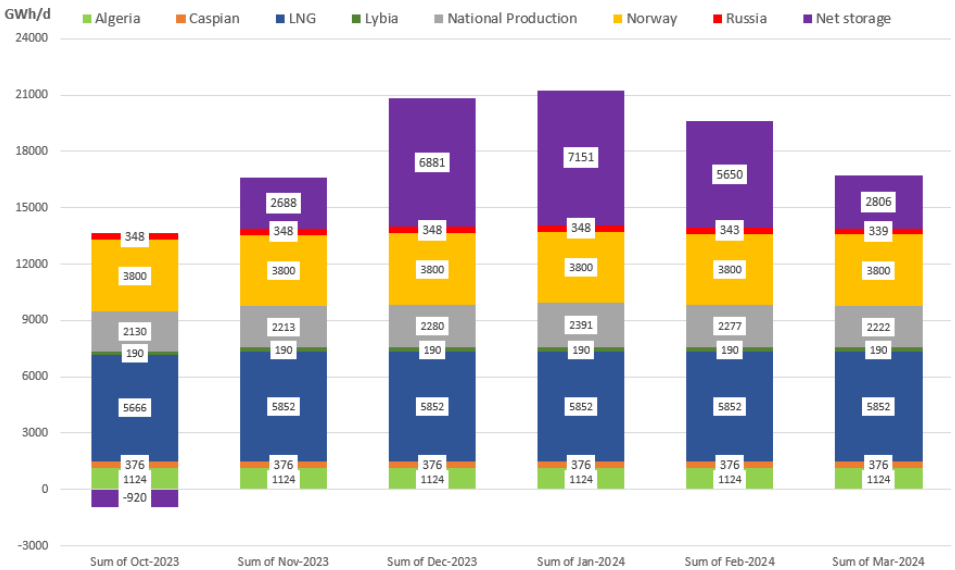


Figure 31. – Cold Winter with demand reduction 15% scenario. Monthly supply mix, GWh/d

[37] The import levels shown represent one possible supply option, with LNG providing import flexibility in this example, and modelling was done while minimizing Russia supply.

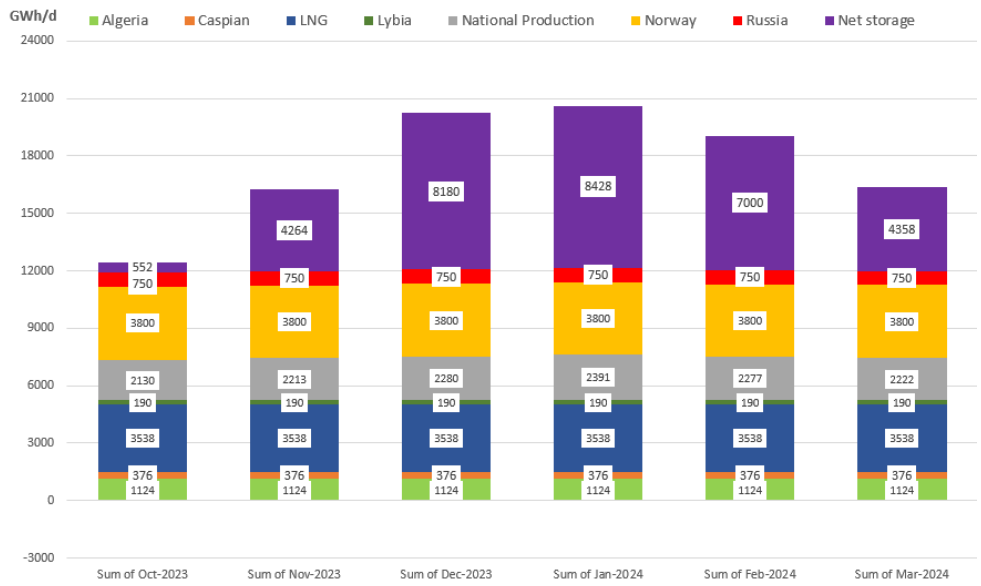


Figure 32. – Cold Winter with demand reduction 15%. Sensitivity scenario with low LNG supply potential. Monthly supply mix, GWh/d

3.2.1. Cold Winter supply dependence assessment – RU supply disruption

This section investigates the potential impact on a scenario described in section 3.1 but with a condition of full disruption of the Russian pipeline supply during the withdrawal period[38]. The enhanced capacity provided by TSOs was applied in this case.

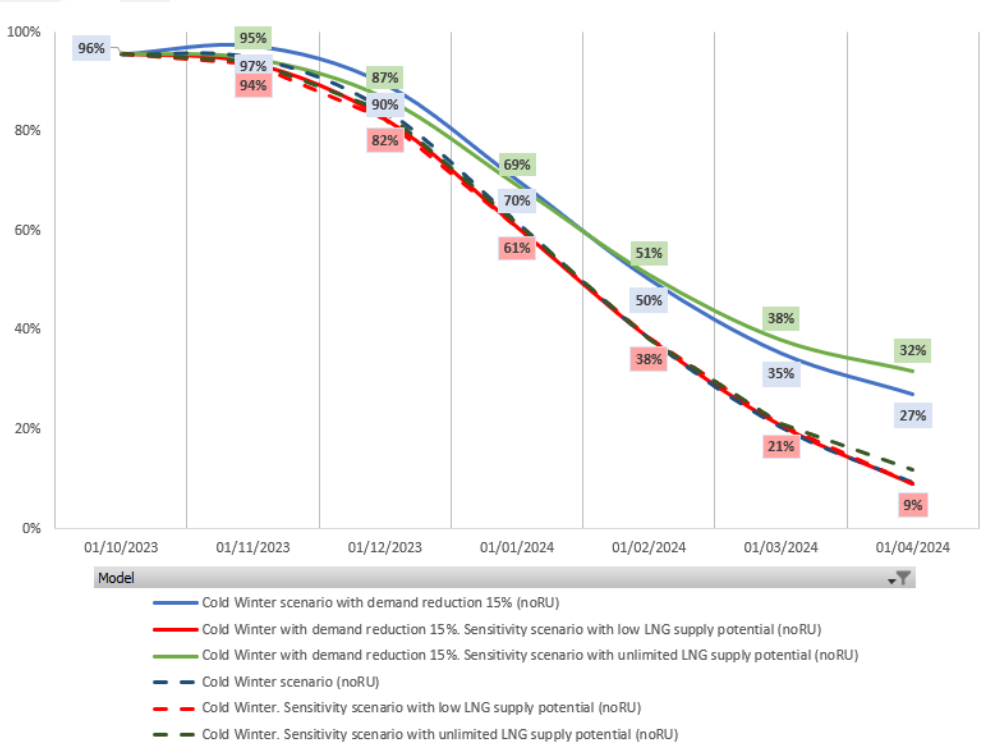


Figure 33. – Cold Winter RU supply dependence assessment. Evolution of the aggregated European UGS stock level, %

[38] Serbia and North Macedonia won't cooperate in case of full Russia supply disruption.

The Cold Winter 2023/24 in case of full Russia disruption scenario simulation results show that withdrawal capacities of the gas storage facilities combined with the supply flexibility of imports is no sufficient to cover the demand and reach an inventory target level 30%. European countries are facing of demand curtailment on average during whole winter season, the scenario influenced by the dynamics of LNG import as shown in **Figure 34**. The simulation results reveal the presence of insufficient LNG capacity and internal bottlenecks in the gas supply from Southern Europe to Central and Eastern Europe.

By the end of the winter season, the storage volume at the European level remains at a mere 9% of the working gas volume (**Figure 33**). This figure encompasses only the strategic reserves of select countries which is not freely available on the market under normal conditions. This situation underscores a noteworthy risk that must be preemptively addressed, particularly if EU countries aim to achieve the targeted 30% storage capacity by the end of the winter season of 2023/24 during the withdrawal period[39].

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

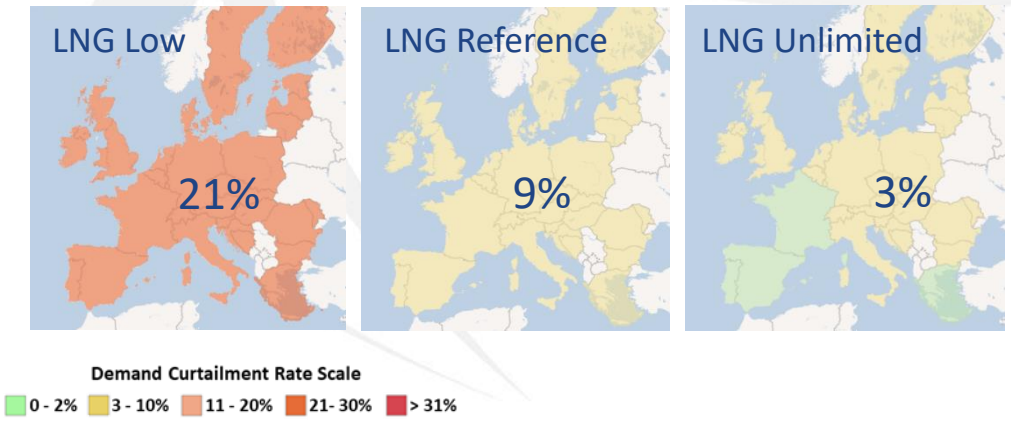


Figure 34. – Cold Winter RU supply dependence assessment. Demand Curtailment (average), %

➢ **In case of 15% demand reduction**, European gas network is capable of enabling market participants to satisfy the demand and achieve only 27% stock level by the end of the winter season 2023/24 (**Figure 33**). The results of the sensitivity analysis shows that the gas system infrastructure has sufficient flexibility to achieve storage fill levels 30% or even more than 40% during the withdrawal period with increased LNG supply. However, limitations arise in Bulgaria, Hungary, and Romania due to restricted capacity between Croatia to Hungary and Greece to Bulgaria. This capacity is fully utilized to supplying gas imported to LNG terminals, and preventing the storage filling level from surpassing 37% in these specific regions.

[39] Shortfall is about 1045 TWh for LNG low, 621 TWh for LNG reference and 328 TWh for LNG unlimited (limited by LNG regasification capacity) sensitivity analyses according to the simulation results.

In the low LNG supply potential sensitivity analysis, withdrawal capacities of the gas storage facilities combined with the supply flexibility of imports is no sufficient to cover the demand and reach an inventory target level 30%. By the end of the winter season, the storage volume at the European level remains at a mere 9% (strategic reserve gas in storage which is not freely available on the market under normal conditions and represents 9% of the total European storage working gas volume in average) and European countries are facing of demand curtailment 7% on average during whole winter season (**Figure 35**). This situation underscores a noteworthy risk that must be preemptively addressed, particularly if EU countries aim to achieve the targeted 30% storage capacity by the end of the winter season of 2023/24 during the withdrawal period[40].

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

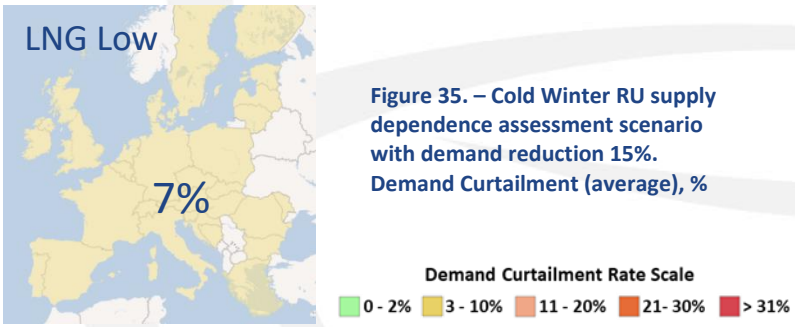


Figure 35. – Cold Winter RU supply dependence assessment scenario with demand reduction 15%. Demand Curtailment (average), %

Figures 36 and **37** show the stock level per country on 31 March 2024 as a result of the model for the Cold Winter supply dependence assessment scenario with demand reduction 15%.

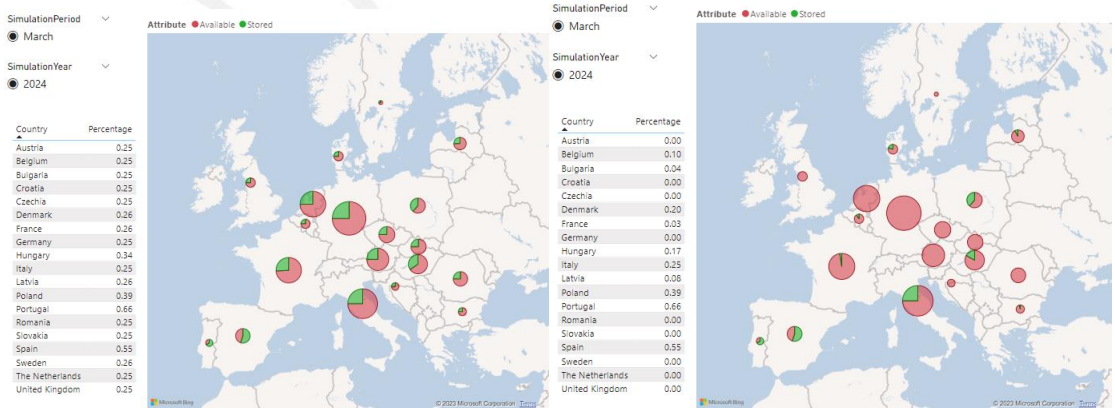


Figure 36 and Figure 37. - Cold Winter RU supply dependence assessment scenario with demand reduction 15% and sensitivity scenario with low LNG supply potential. UGS stock level per country, %[41]

[40] Shortfall is about 469 TWh for LNG low and 52 TWh for LNG reference sensitivity analyses according to the simulation results.

[41] Values for Czech Republic include Slovakian storages located on the Czech Republic territory.

Figures 38, 39, 40 and 41 show the level and composition of the supply mix in the Cold Winter supply dependence assessment scenario with demand reduction 15% and sensitivity scenario with low LNG supply potential. The storage filling level at the end of March 2024 is 27% and 9% respectively.[42]

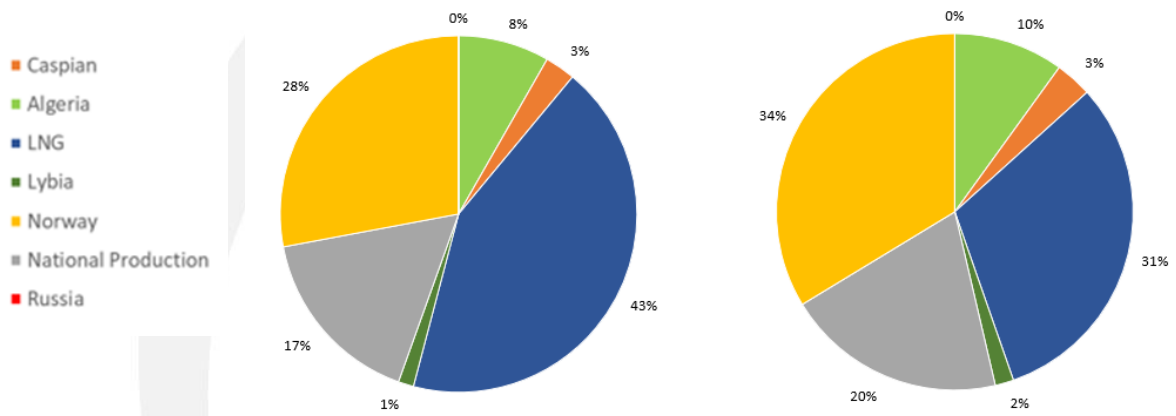


Figure 38 and Figure 39.- Cold Winter RU supply dependence assessment scenario with demand reduction 15% and sensitivity scenario with low LNG supply potential. Supply mix, %

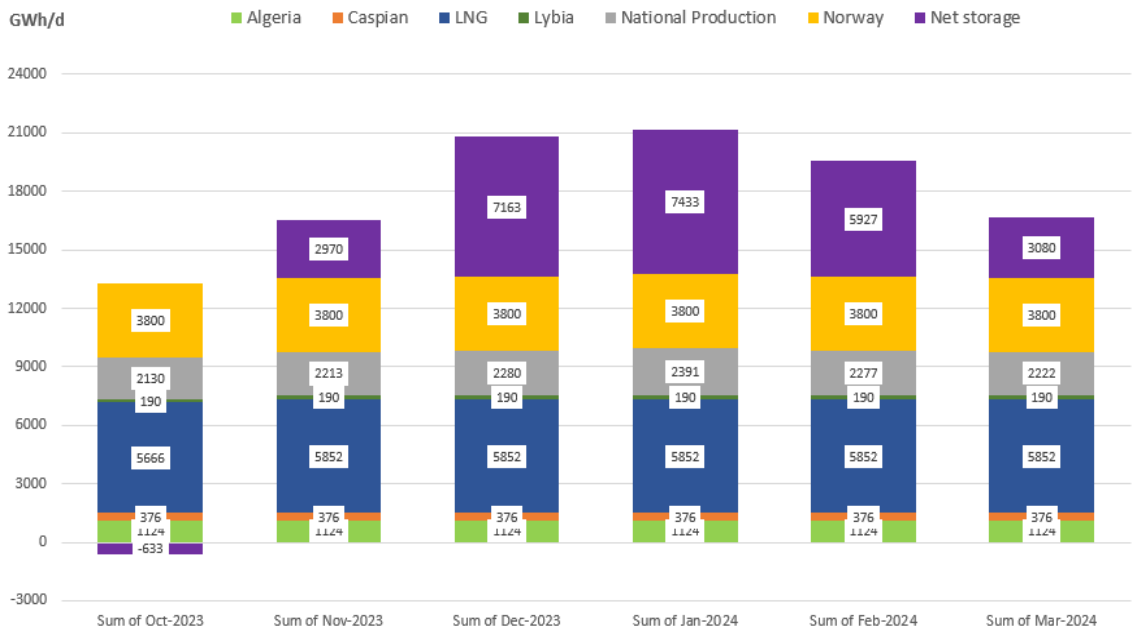


Figure 40. – Cold Winter RU supply dependence assessment. Cold Winter scenario with demand reduction 15%. Monthly supply mix, GWh/d

[42] The import levels shown represent one possible supply option, with LNG providing import flexibility in this example, and modelling was done while minimizing Russia supply.

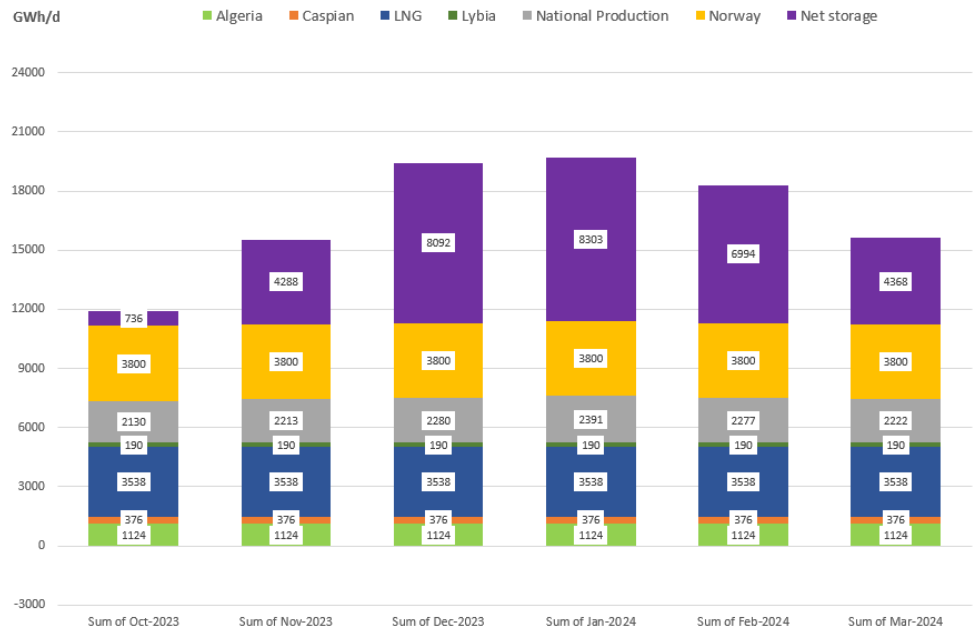


Figure 41. – Cold Winter RU supply dependence assessment. Cold Winter with demand reduction 15%. Sensitivity scenario with low LNG supply potential. Monthly supply mix, GWh/d

The monthly supply mix is stable over the winter season 2023/24 period. LNG supply and supply from NO represent the largest sources of supply. In the Cold Winter scenario with demand reduction 15%, they constitute 43% and 28% of the total supply, respectively.

In the low LNG supply potential sensitivity scenario, LNG supply and supply from NO represent 31% and 34% respectively.

Enhanced capacities, provided by TSOs in the case of full supply disruption from Russia, increase interconnection capacities between Germany and Austria, Belgium, the Czech Republic, and the Netherlands, as well as between Spain and France, contributing to the flexibility of LNG imports to the central part of Europe.

3.3. High Demand Situations – initial storage level 50%

For the High Demand Situations scenario, meeting the demand for Peak Day and 2-week Cold Spell is defined as availability of peak supply potential and sufficient withdrawal capacity, starting from an initial European stock level of 50%.

High demand cases, such as Peak Day and 2-Week Cold Spell, are simulated as independent analyses. However, these high demand events are typically expected to occur late in winter, usually during the month of February when storage are no longer at their maximum level (therefore, they are not at their maximum withdraw capacity). At this stage, seasonal simulation results show that maintaining a 50% storage stock level, when high demand situations may arise, would enable an effective response to increased demand through efficient withdrawals from storages. A lower stock level leads to a decrease in withdrawal capacity, primarily due to reduced pressure in the underground storage facilities.

The distribution of withdrawal and supply during the high demand situation results from the modelling and the following assumptions:

- The Peak Day and 2-week Cold Spell gas demand estimated by TSOs for the Reference Winter in **Annex B**
- The Cold Peak Day and Cold 2-week Cold Spell gas demand for the Cold Winter and Cold Winter with 15% reduction in **Annex B**
- The peak national gas production estimated by TSOs in **Annex B**
- The peak capacity provided by TSOs
- The storage withdrawal curves as defined in **Annex A**
- The flexibility given to the model for the definition of the supply potentials derives from the historical supply mix (see **Table 2**) and plus additional LNG that can be taken from the tanks (see **Annex A**)

Based on these assumptions, the modelling has been used to evaluate the ability of the gas system to cope with high demand situations such as a 1-in-20 years Peak Day and a 1-in-20 years 2-week Cold Spell during the winter period. As no risk group is defined in regulation 1938/2017[43], all European countries cooperate as if they were part of a single European risk group.

➢ **In the case of Reference Winter (see Figures 42** and **43)**, the European gas network is capable of fully meeting the demand during a 2-week Cold Spell. However, in the sensitivity scenario with low LNG supply potential, European countries face a demand curtailment of 2%.

During a Peak Day situation, countries experience a demand curtailment of 11%, except for the Baltic countries and Finland -9%. This discrepancy is due to a bottleneck between Lithuania and Poland. Additionally, Spain and Portugal have no demand curtailment owing (bottlenecks between Spain and France).

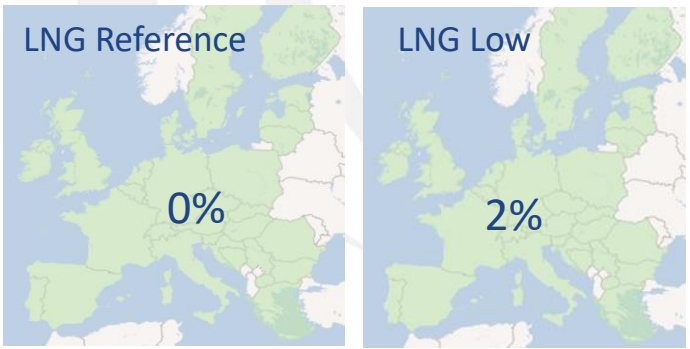


Figure 42. – Reference Winter. 2-week Cold Spell. Demand Curtailment, %

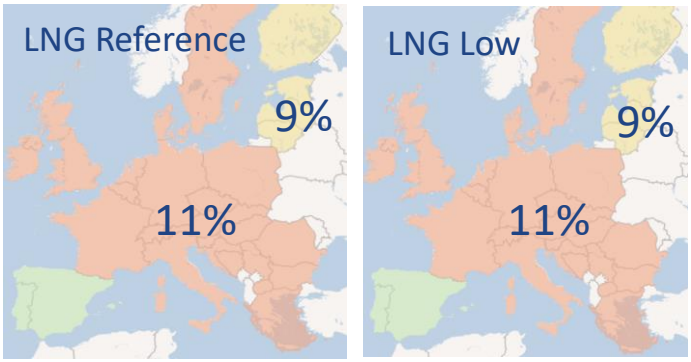


Figure 43. – Reference Winter. Peak Day. Demand Curtailment, %

[43] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

➢ **In the case of Cold Winter (see Figures 44** and **45)**, most of the European countries are exposed 3% of demand curtailment, except Portugal and Spain, during a 2-week Cold Spell. Baltic countries and Finland face a demand curtailment of 11%. The bottlenecks between Southern European countries and the north do not allow for gas supply. In the sensitivity scenario with low LNG supply potential, all European countries face a demand curtailment of 9% to 11%.

During a Peak Day situation, countries experience a demand curtailment ranging from 16% to 17%, except for the Baltic countries and Finland (23%). This discrepancy is due to a bottleneck between Lithuania and Poland. Spain and Portugal have no demand curtailment owing (bottlenecks between Spain and France).

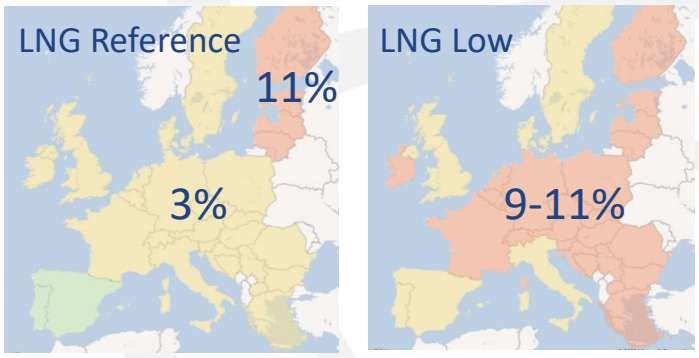


Figure 44. – Cold Winter. 2-week Cold Spell. Demand Curtailment, %

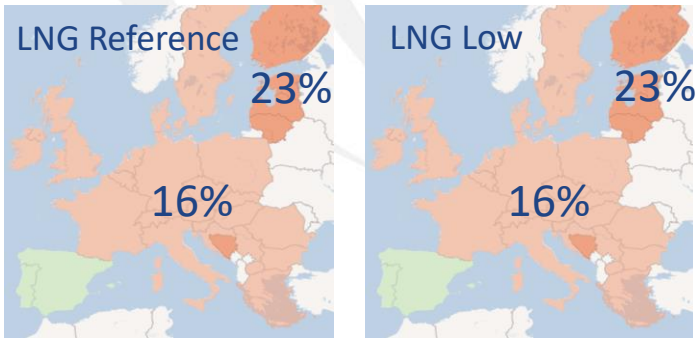


Figure 45. – Cold Winter. Peak Day. Demand Curtailment, %

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

➢ **In the case of Cold Winter with 15% demand reduction (see Figures 46** and **47)**, the European gas network is capable of fully meeting the demand during a 2-week Cold Spell.

During a Peak Day situation, countries experience a demand curtailment of 1%, except for the Baltic countries and Finland (9%). This discrepancy is due to a bottleneck between Lithuania and Poland.

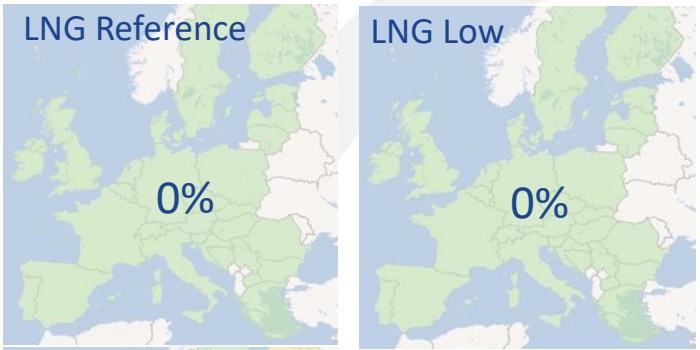


Figure 46. – Cold Winter with 15% demand reduction. 2-week Cold Spell. Demand Curtailment, %

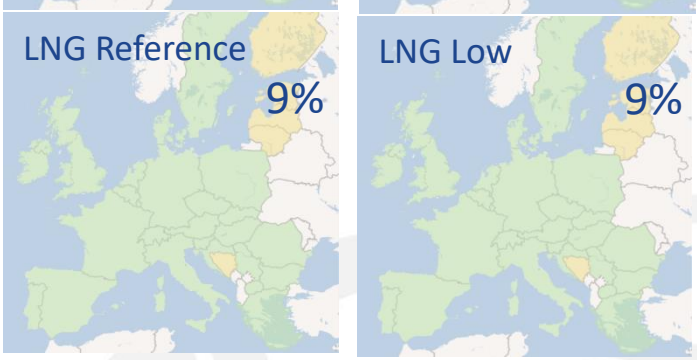


Figure 47. – Cold Winter with 15% demand reduction. Peak Day. Demand Curtailment, %

3.3.1. High Demand situation supply dependence assessment – RU supply disruption

This section investigates the potential impact of full disruption along the Russian supply routes during the High Demand Situations scenario - meeting the demand for Peak Day and 2-week Cold Spell is defined as availability of peak supply potential and sufficient withdrawal capacity, starting from an initial European stock level of 50%. The enhanced peak capacity provided by TSOs was applied in this case.

High demand cases, such as Peak Day and 2-Week Cold Spell, are simulated as independent analyses. However, these high demand events are typically expected to occur late in winter, usually during the month of February when storage are no longer at their maximum level (therefore, they are not at their maximum withdraw capacity). At this stage, seasonal simulation results show that maintaining a 50% storage stock level, when high demand situations may arise, would enable an effective response to increased demand through efficient withdrawals from storages. A lower stock level leads to a decrease in withdrawal capacity, primarily due to reduced pressure in the underground storage facilities.

➢ **In the case of Reference Winter (see Figures 48** and **49)**, the European gas network is capable of fully meeting the demand during a 2-week Cold Spell. However, in the sensitivity scenario with low LNG supply potential, all European countries face a demand curtailment of 5% to 6%.

During a Peak Day situation, countries experience a demand curtailment of 14%, except for the Baltic countries and Finland (9%) – bottleneck between Poland and Lithuania; and Spain and Portugal (0%) - bottlenecks between Spain and France.

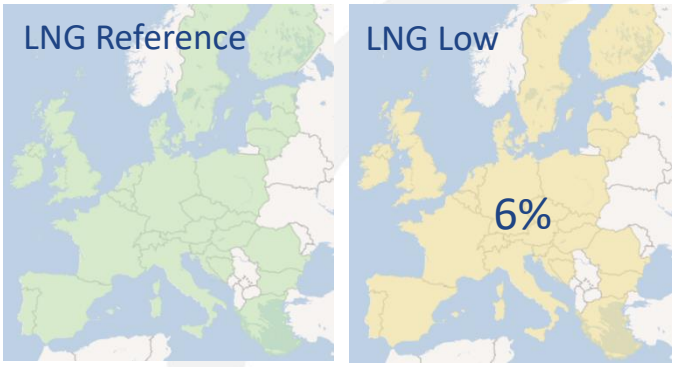


Figure 48. – Reference Winter RU supply dependence assessment. 2-week Cold Spell. Demand Curtailment, %

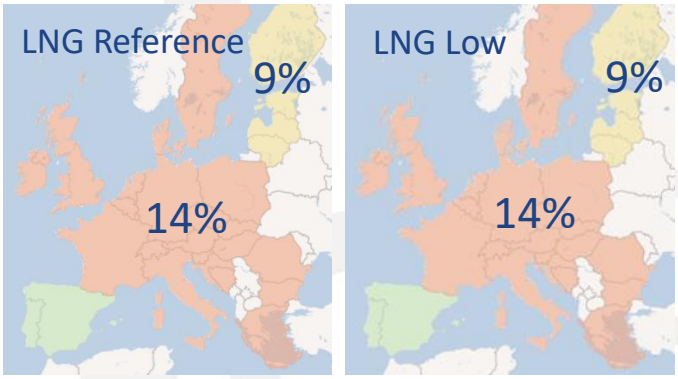


Figure 49. – Reference Winter RU supply dependence assessment. Peak Day. Demand Curtailment, %

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

➢ **In the case of Cold Winter (see Figures 50** and **51)**, most of the European countries are exposed 5% of demand curtailment, except Portugal, Spain and Greece, during a 2-week Cold Spell. Baltic countries and Finland face a demand curtailment of 11%; Bulgaria, Romania, Hungary, Croatia – of 19%. The bottlenecks between Southern European countries and the north/east do not allow for gas supply. In the sensitivity scenario with low LNG supply potential, all European countries face a demand curtailment of 13%, except East countries – curtailment of 19%.

During a Peak Day situation, countries experience a demand curtailment ranging from 17% to 18%. Baltic countries and Finland face a demand curtailment of 23%; Bulgaria, Romania, Hungary, Croatia – of 24%. However, Portugal, Spain – 2% and Greece – 11%. The bottlenecks between Southern European countries and the north/east do not allow for gas supply.

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment.

Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

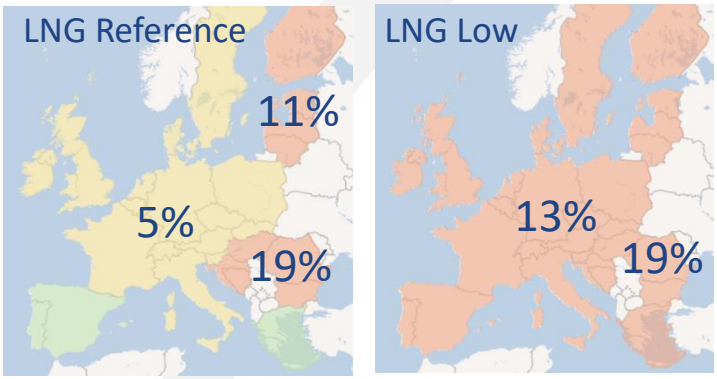


Figure 50. – Cold Winter RU supply dependence assessment. 2-week Cold Spell. Demand Curtailment, %

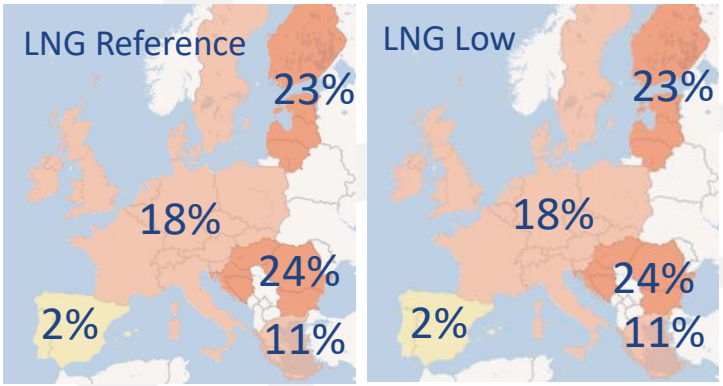


Figure 51. – Cold Winter RU supply dependence assessment. Peak Day. Demand Curtailment, %

➢ **In the case of Cold Winter with 15% demand reduction (see Figures 52** and **53)**, the European gas network is capable of fully meeting the demand during a 2-week Cold Spell, except Bulgaria, Romania, Hungary, Croatia – 5% of demand curtailment. The bottlenecks between Southern and Central European countries and the east do not allow for gas supply.

During a Peak Day situation, main countries experience a demand curtailment ranging from 4% to 9%, except East countries – 11%. However Portugal, Spain and Greece have no demand curtailment owing.

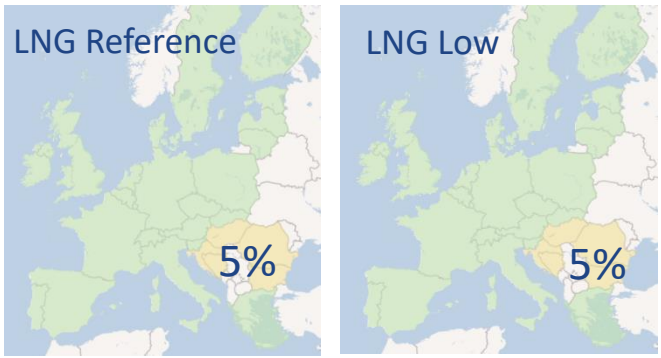


Figure 52. – Cold Winter with 15% demand reduction RU supply dependence assessment. 2-week Cold Spell. Demand Curtailment, %

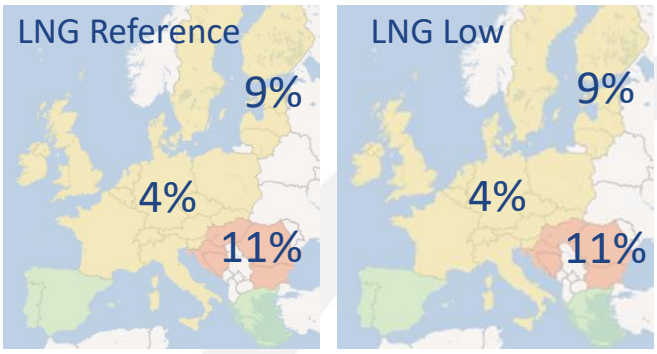


Figure 53. – Cold Winter with 15% demand reduction RU supply dependence assessment. Peak Day. Demand Curtailment, %

However, some European countries reserving a part of their own gas stock constituted as strategic reserves to be used only for the purpose of mitigating demand curtailment. Availability of strategic storage reserves depending of country specific regulation. The model assumes actual strategic storage facilities constraints but simulation results do not consider the utilization of strategic storage reserves - strategic reserves remain available to avoid/reduce demand curtailment in some countries.

4. MODELLING RESULTS FOR THE SUMMER 2024 OVERVIEW

4.1. Reference summer scenario - 90% storage target by 30 September 2024

For the Reference Summer 2024 overview scenario two types of simulations were performed:

- Full year (12 months) simulations where model anticipates target to reach 90% at the end of this period (after these 12 months) already from the beginning of the gas year – 1 October 2023. In this scenario, the monthly average gas demand estimated by TSOs during the winter period (Reference Winter) and the 5-year average with 15% reduction monthly demand values for each country during the summer period were assumed.
- Summer season simulations investigating possibilities to reach target of 90% at the end of season but starting from 30% on average at the beginning of summer season – 1 April 2024. In this scenario 5 year average with 15% reduction monthly demand values for each country during the summer period were assumed.

The analysis investigates the possible evolution of the gas supply as well as the ability of the gas infrastructures to meet the demand, export and storage injection needs to reach 90% of the stock level in each European storage facility on 30 September 2024. In case of full year scenario during the gas year 2023/24 (from 1 October 2023 to 30 September 2024), the simulation starts with total European stock level of 96% on 1 October 2023 (see Figure 9).

ENTSOG has run additional sensitivity analyses to evaluate the impact of the initial storage level at the start of the injection period. This sensitivity analysis was done with a total European stock level of 30%[44] on 1 April 2024.

The distribution of withdrawal, injection, demand and supply during the winter and summer months results from the modelling and the following assumptions:

- The monthly gas demand estimated by TSOs during the winter period and the 5-year average with 15% reduction gas demand during the summer period in **Annex B**
- The monthly national gas production estimated by TSOs in **Annex B**
- The monthly capacity provided by TSOs
- The storage withdrawal and injection curves as defined in **Annex A**
- The flexibility given to the model for the definition of the supply potentials derives from the historical supply mix (see **Table 2**)

Full year (12 months) simulations demonstrate that the European gas network is capable to enable market participants to meet demand and achieve a minimum stock level of 90% in all underground gas storage facilities by the end of the summer season 2024. According to the simulation results, that at least a 46% level of working gas volume would be needed at the end of the winter to reach the 90% target by the end of summer 2024 during the injection period.
However, the outcomes of the sensitivity analysis further indicate that when the initial storage level in all countries is set at 30% at the beginning of the injection period, the gas system infrastructure is insufficient to achieve storage filling levels of 90%. In such cases, an increase

[44] The storage filling level is above 30% due to national strategic reserves in some countries.

in LNG supplies offers supply flexibility and the opportunity to reach the 90% target for all storage facilities.
In the sensitivity analysis for low LNG supply potential, the 90% target is not met. In such cases, a higher initial level at the beginning of the injection period can provide added flexibility to the gas network system.

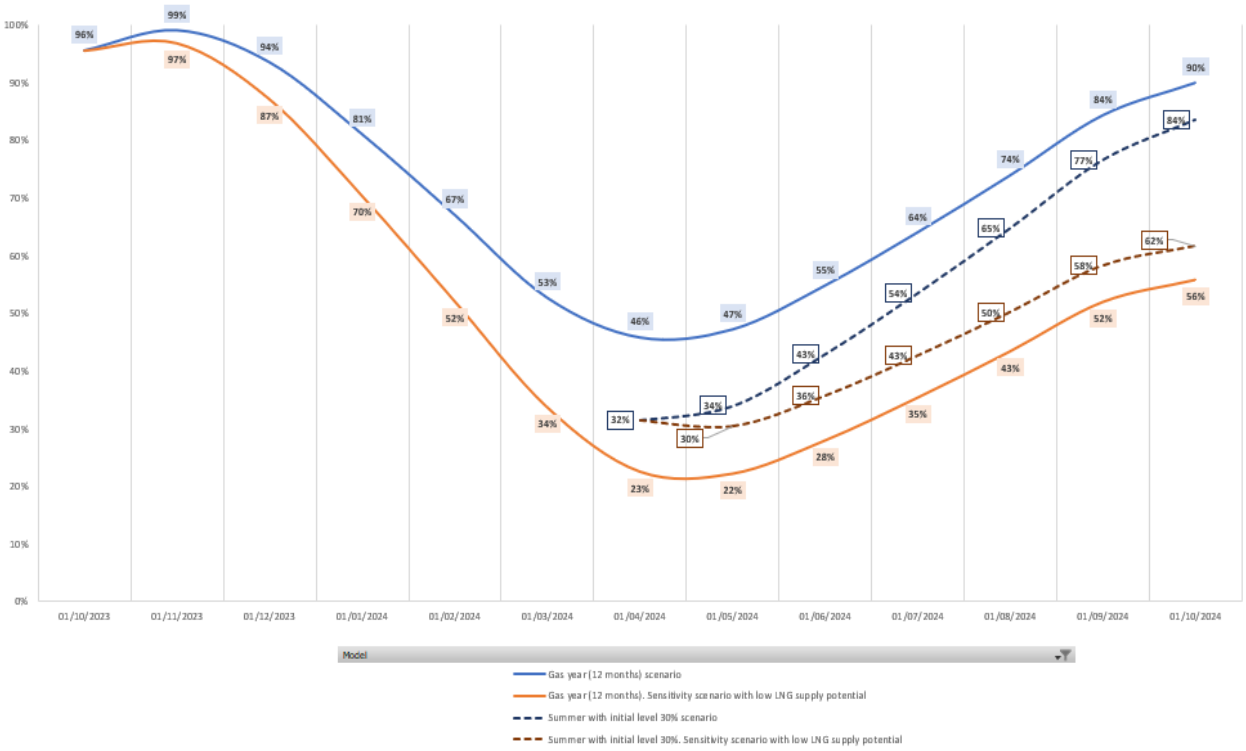
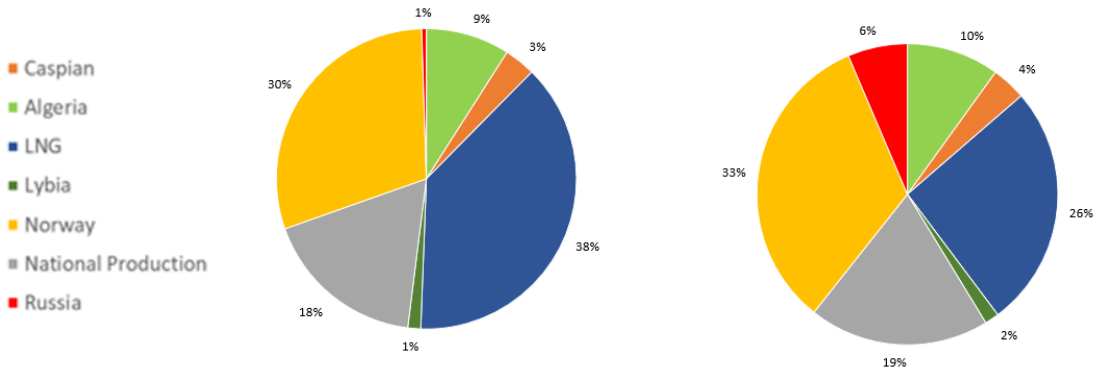


Figure 54. –Summer scenario. Evolution of the aggregated European UGS stock level, %

Figures 55, 56, 57 and 58 show the level and composition of the supply mix in the full year (12 months) simulation scenario and sensitivity scenario with low LNG supply potential. The storage filling level at the end of September 2024 is 90% and 56% respectively.[45]



Figures 55 and 56.- Reference Summer (full year) scenario and sensitivity scenario with low LNG supply potential. Supply mix, %

[45] The import levels shown represent one possible supply option, with LNG providing import flexibility in this example, and modelling was done while minimizing Russia supply.

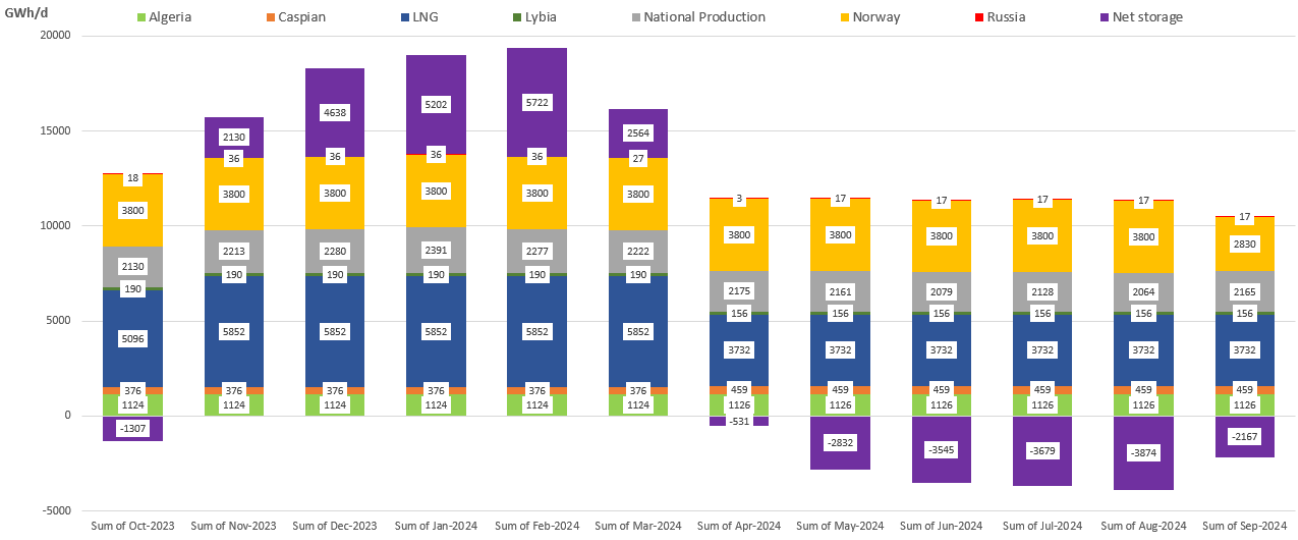


Figure 57. – Reference Summer (full year) scenario. Monthly supply mix, GWh/d

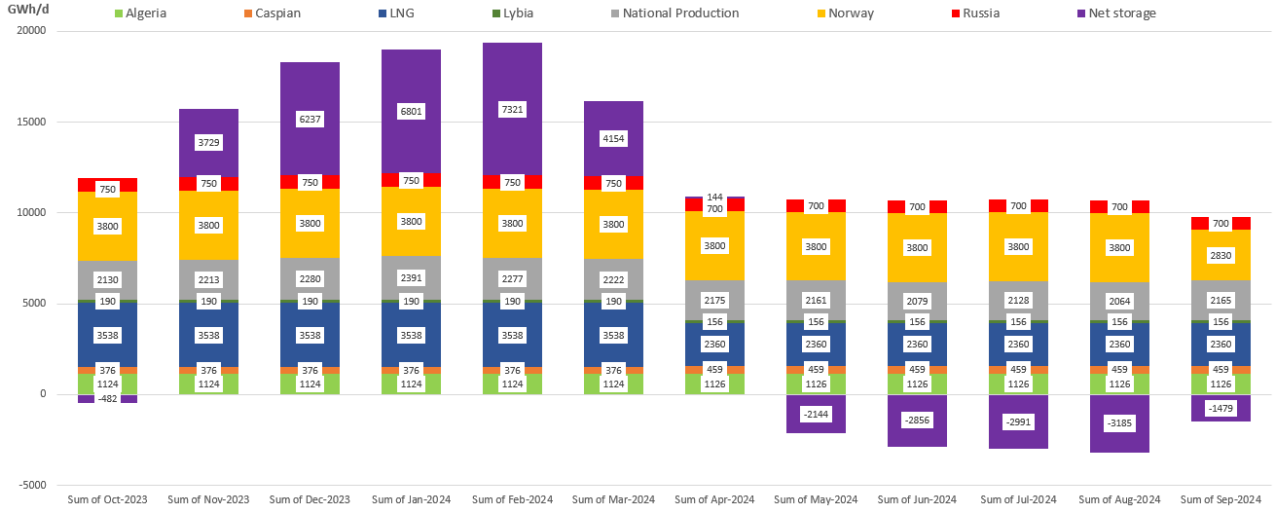


Figure 58. – Reference Summer (full year). Sensitivity scenario with low LNG supply potential. Monthly supply mix, GWh/d

LNG supply and supply from Norway represent the largest sources of supply. In the Reference Summer scenario, they constitute 38% and 30% of the total supply, respectively. The simulation results reveal that LNG supply used at its maximum potential based on the assumptions made for this scenario, to reach a target of 90% by the end of September 2024.

In the low LNG supply potential sensitivity scenario, LNG supply and supply from Norway represent 26% and 33% respectively. Gas supply from RU accounts for 6% of the total gas supply while other sources are maximised but limited by the firm capacity of the gas network or LNG supply potential.

The monthly supply mix remains stable throughout the winter season of 2023/24. However, during the summer season 2024, the supply is reduced due to extensive maintenance work on the Norway field in September, which anticipate will impact injection possibilities for that month. The European storage filling level could potentially increase in October 2024, as the injection season typically extends until November 1 in some countries.

4.1.1. Summer supply dependence assessment – RU supply disruption

This section investigates the potential impact of full disruption along the Russian supply pipeline routes during the withdrawal and injection period. The analysis investigates the possible evolution of the gas supply as well as the ability of the gas infrastructures to meet the demand, export and storage injection needs to reach 90% of the stock level in each European storage facility on 30 September 2024 starting with total European stock level of 96% on 1 October 2023 (see Figure 9) during the gas year 2023/2024 (from 1 October 2023 to 30 September 2024). In this scenario, the monthly gas demand estimated by TSOs (Reference Winter) during the winter period and the 5-year average with 15% reduction demand values for each country during the summer period were assumed.

ENTSOG has run additional sensitivity analyses to evaluate the impact of the initial storage level at the start of the injection period. This sensitivity analysis was done with a total European stock level of 30%[46] on 1 April 2024.

The distribution of withdrawal and supply during the winter months results from the modelling and the following assumptions:

- The monthly gas demand estimated by TSOs during the winter period and the 5-year average with 15% reduction gas demand during the summer period in **Annex B**
- The monthly national gas production estimated by TSOs in **Annex B**
- The monthly enhanced capacity provided by TSOs
- The storage withdrawal and injection curves as defined in **Annex A**
- The flexibility given to the model for the definition of the supply potentials derives from the historical supply mix (see **Table 2**)

Based on these assumptions, the modelling has been used to check if any physical congestion or dependence on an import source may limit the fulfilment of gas demand during the withdrawal period. As no risk group is defined in regulation 1938/2017[47], all European countries cooperate as if they were part of a single European risk group[48].

According to simulation results, the European gas network is capable to enable market participants to meet demand and achieved stock level 90% in all underground gas storage facilities by the end of the summer season 2024. According to the simulation results, the optimal storage level is determined to be 46% on 1 April 2024. The sensitivity analysis further indicates that when the initial storage level in all countries is set at 30% at the beginning of the injection period, the gas system infrastructure can achieve storage filling levels of 73%. Increase in LNG supplies offers supply flexibility and the opportunity to reach the 90% target for all storage facilities.
In the sensitivity analysis for low LNG supply potential, the 90% target is not met. In such cases, a higher initial level at the beginning of the injection period can provide added flexibility to the gas network system.

[46] The storage filling level is above 30% due to national strategic reserves in some countries.
[47] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.
[48] Serbia and North Macedonia won't cooperate in case of full Russia supply disruption.

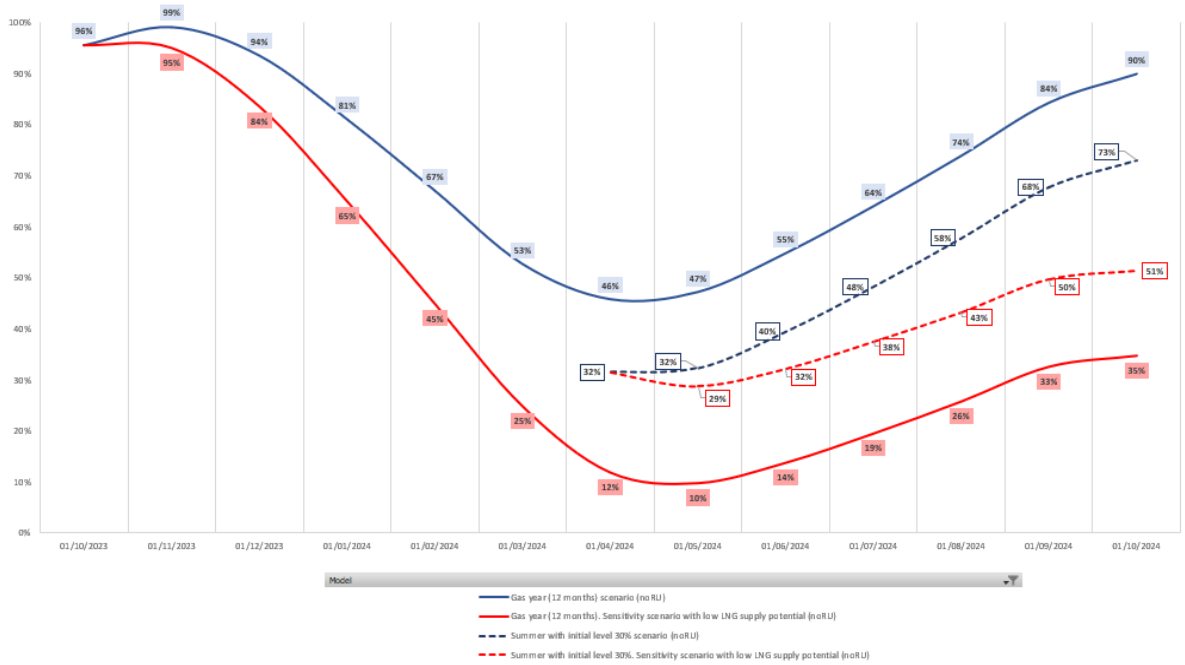


Figure 59. – Reference Summer (full year) RU supply dependence assessment. Evolution of the aggregated European UGS stock level, %

Figures 60, 61, 62 and 63 show the level and composition of the supply mix in the Reference Summer (yearly) scenario and sensitivity scenario with low LNG supply potential. The storage filling level at the end of September 2024 is 90% and 35% respectively.[49]

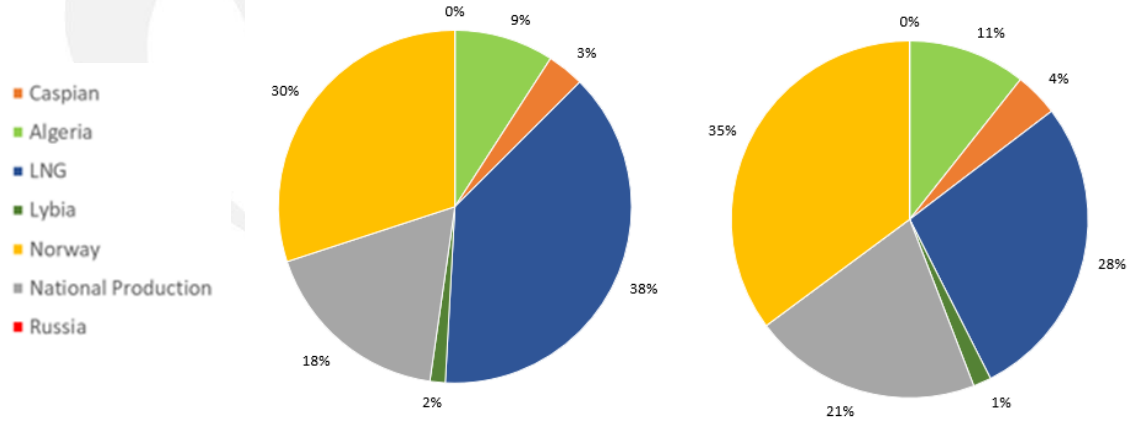


Figure 60 and Figure 61.- Reference Summer (full year) RU supply dependence assessment. Reference Summer (full year) scenario and sensitivity scenario with low LNG supply potential. Supply mix, %

LNG supply and supply from Norway represent the largest sources of supply. In the Reference Summer scenario, they constitute 38% and 30% of the total supply, respectively. The simulation results reveal that LNG supply used at its maximum potential based on the assumptions made for this scenario, to reach a target of 90% by the end of September 2024. In the low LNG supply potential sensitivity scenario, LNG supply and supply from NO represent 28% and 35% respectively.

[49] The import levels shown represent one possible supply option, with LNG providing import flexibility in this example, and modelling was done while minimizing Russia supply.

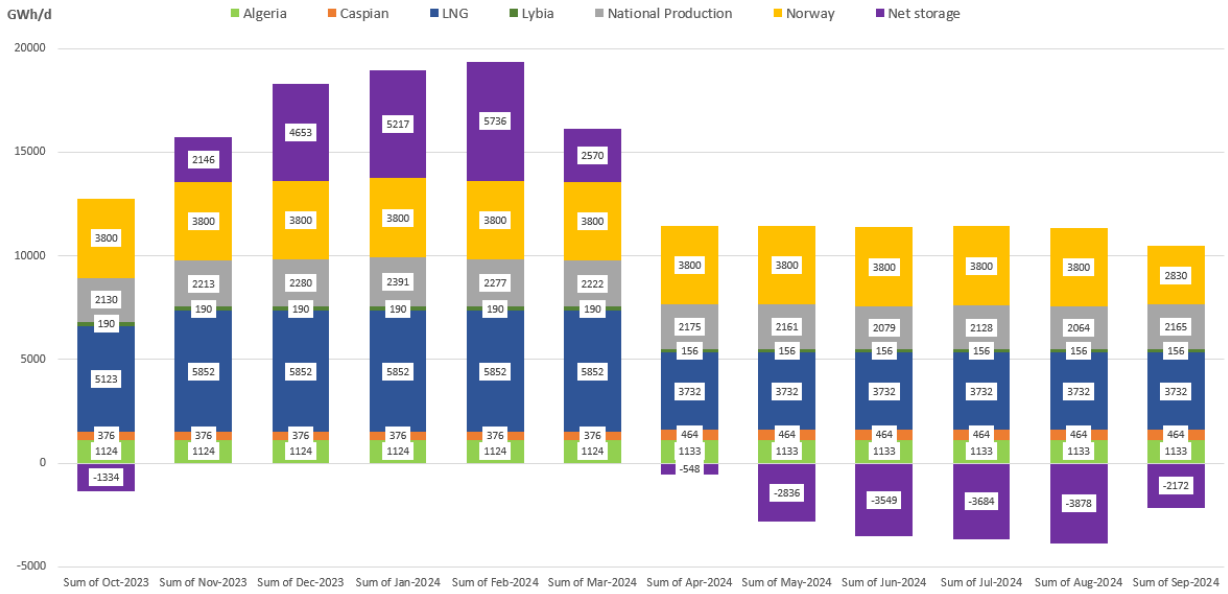


Figure 62. – Reference Summer (full year) RU supply dependence assessment. Monthly supply mix, GWh/d

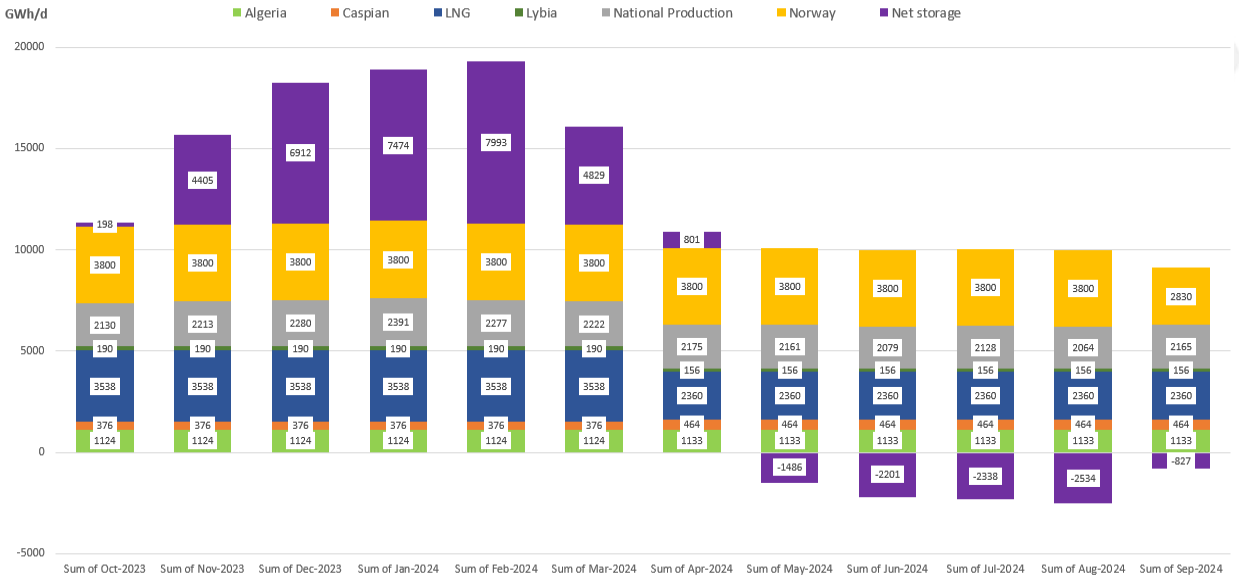


Figure 63. – Reference Summer (full year) RU supply dependence assessment. Sensitivity scenario with low LNG supply potential. Monthly supply mix, GWh/d

The monthly supply mix remains stable throughout the winter season of 2023/24. However, during the summer season 2024, the supply is reduced due to extensive maintenance work on the Norway field in September, which anticipate will impact injection possibilities for that month. The European storage filling level could potentially increase in October 2024, as the injection season typically extends until November 1 in some countries.

5. ENTSO-E INSIGHTS ON GAS CONSUMPTION FOR ELECTRICAL POWER SYSTEM

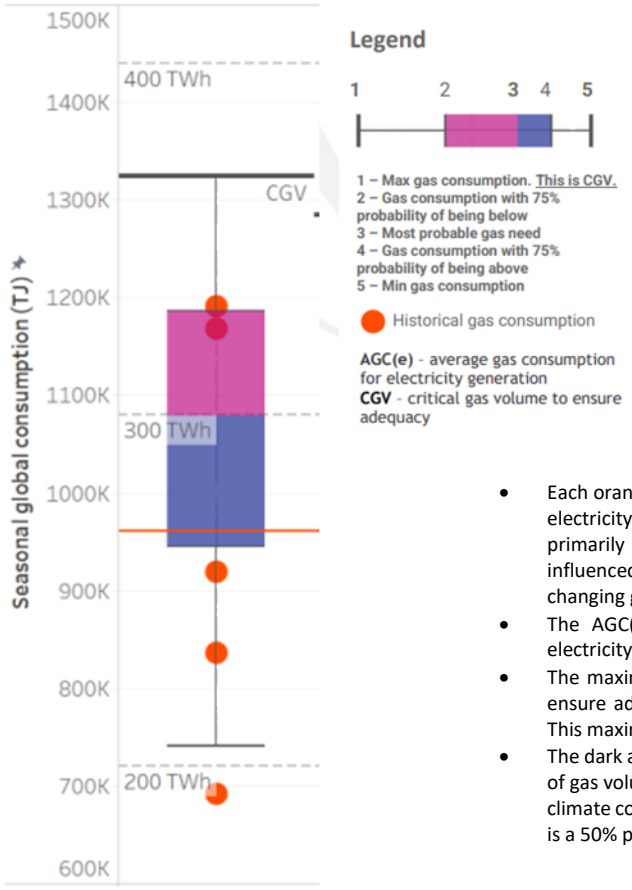
The operations of electricity and gas systems are historically interdependent. Gas-fired generators are key for covering the electricity demand during peak hours and during period of low renewable generation. This is especially true during the winter period and ENTSO-E remains alert and in close cooperation with ENTSOG, especially in case winter 2023-2024 will be cold.

For this reason, ENTSO-E will conduct this year again a critical gas volume (CGV) analysis to quantify the amount of gas needed to ensure adequacy on the electrical power system. (see figure here-under for more explanation and CGV results of winter 2022/2023). The CGV analysis will be part of ENTSO-E's Winter Outlook 2023-2024 publication.

Previous year, this CGV was estimated to be around a third of the European Working Gas volume.

For the coming winter, the electrical power system expects consumption and peak demand levels aligned with the average of the past 5 years showing a rebound after covid period and the start of the war in Ukraine (see figure here-under). On the generation side, we expect a higher nuclear availability in France, and lower power-unit planned outages.

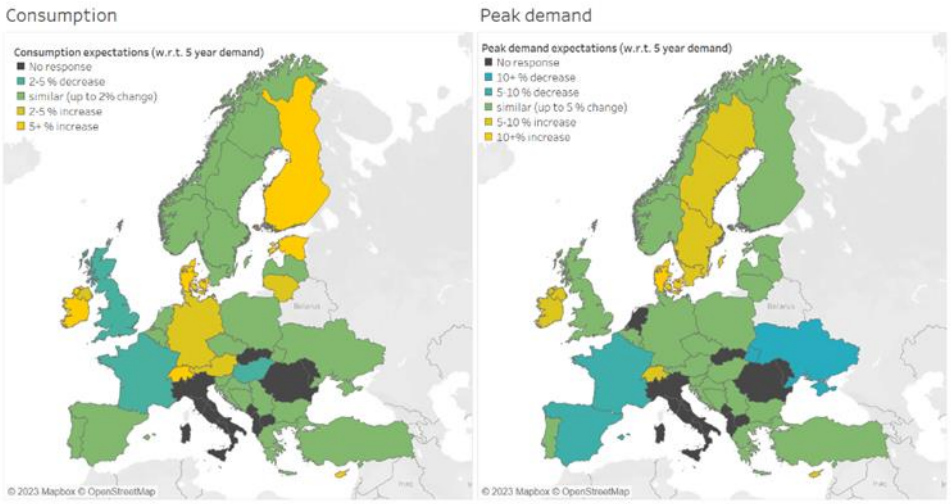
How these two effects will balance each other and which new CGV volumes are projected will come in the next ENTSO-E winter outlook, which will be released before December. Also, a sensitivity on reduced electrical demand will be conducted to estimate the potential of gas savings in power system in the event of reintroduction of the electricity saving measure similar to the measures taken in winter 2022-2023.



How to interpret the CGV chart:

- Each orange dot represents a historical winter period of gas consumption for electricity generation. The significant differences between periods are primarily related to temperature and climate conditions but can also be influenced by the situation in the electricity market (prices, planned outages, changing generation fleet, etc.);
- The AGC(e) (orange line) represents the average gas consumption for electricity generation for the 5 statistical years (orange dots);
- The maximum gas consumption corresponds to the gas volume needed to ensure adequacy in the worst- case simulated weather condition scenario. This maximum is indicated as the CGV to ensure adequacy, and
- The dark and light purple colours represent the range of simulation outcomes of gas volume needed to ensure adequacy for a given year, depending on the climate conditions (the simulation uses 34 climate condition scenarios). There is a 50% probability for a given year to be in this range.

ENTSO-E remains alert to the developments in the gas system and keeps a tight cooperation with ENTSO-G as the gas systems play a crucial role in delivering electricity to sensitive consumers and ensuring grid stability. It is anticipated that gas and electricity markets will ensure optimal allocation of resources during winter season. In the event of limited gas supplies, in some member states legislative framework would prioritize scarce gas resources for critical gas-fired power plants to ensure security of power system operations and supply of electricity to the sensitive electricity consumers.



6. BALTICCONNECTOR PIPELINE DISRUPTION

In light of the latest news regarding the complete shutdown of the Balticconnector pipeline due to physical damage, and considering the possibility that this gas connection between Finland and Estonia might remain out of operation for several months, ENTSOG has conducted a sensitivity analysis of the situation.

Simulations show that the disruption of the Balticconnector pipeline limits the possibility of Finland's cooperation with the Baltic States, but at the same time does not pose a significant risk to the security of gas supplies in the region. In most of the cases this disruption is not impacting the ability to satisfy demand and maintain target storage levels.

Impact of this disruption may be observed only in case of cold winter without any demand response and in case of high demand events.

Reference Winter Peak Day Demand situation – RU supply disruption

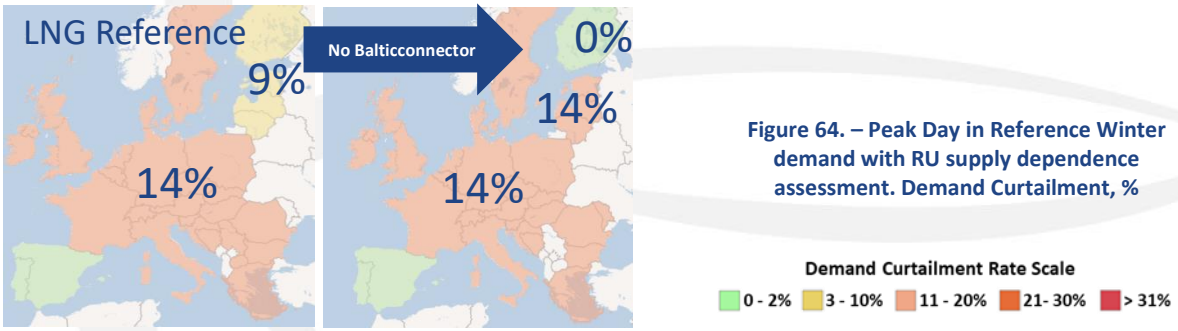


Figure 64. – Peak Day in Reference Winter demand with RU supply dependence assessment. Demand Curtailment, %

Results of this analysis shows that Finland cannot directly cooperate with Baltic States and contribute to more efficient reduction of the demand curtailment risk but does not change dramatically situation neither in the region nor in the rest of Europe. The Baltic States region can still cooperate with the rest of Europe through PL-LT interconnector and LNG terminal in Klaipeda. The same impact is observed in case of peak day in cold winter.

Cold Winter supply dependence assessment – RU supply disruption

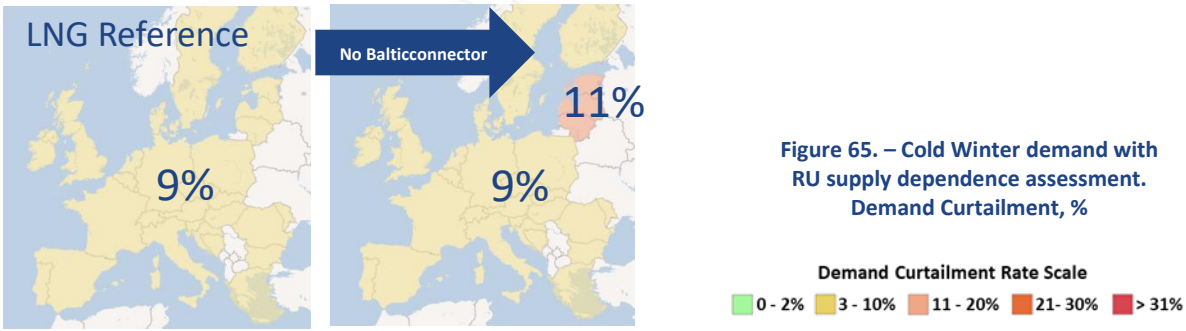


Figure 65. – Cold Winter demand with RU supply dependence assessment. Demand Curtailment, %

Winter season results considering the cold winter demand show how the Baltic region cannot benefit from the additional supplies from Finland but change in the risk of demand curtailment is very small and can be addressed easily with other measures.

Legal Notice

The current analysis is developed specifically for this Summer Supply Outlook 2023 with winter 2023/24 overview. It results from TSOs experience, ENTSOG modelling and supply assumptions and should not be considered as a forecast. The actual supply mix and storage level on 30 September 2023 and 31 March 2024 will depend on market behaviour and global factors.

ENTSOG has prepared this Summer Supply Outlook 2023 with winter 2023/24 overview in good faith and has endeavoured to prepare this document in a manner which is, as far as reasonably possible, objective, using information collected and compiled by ENTSOG from its members and from stakeholders together with its own assumptions on the usage of the gas transmission system. While ENTSOG has not sought to mislead any person as to the contents of this document, readers should rely on their own information (and not on the information contained in this document) when determining their respective commercial positions. ENTSOG accepts no liability for any loss or damage incurred as a result of relying upon or using the information contained in this document.

Annex A: UGS and LNG

The data for Winter Supply Outlook 2023/24 is available online as an annex of this report. The data available is specifically:

- Working Gas Volume and Gas in storage on 1 October 2023.

For the modelling of the different scenarios, the Winter Supply Outlook 2023/24 considers the storage inventory level per country on 1 October 2023 as the initial situation. The gas in storage on 1 October 2023 for each country is based on the AGSI+ platform. For Serbia, the initial storage is considered 90% due to non-availability of data. The relative filling level has been calculated using the Working Gas Volume and gas in the storage from the AGSI+ platform.

- Injection and withdrawal curves.

In order to capture the influence of UGS inventory level on the withdrawal capacity, ENTSOG has used the deliverability curves made available by GSE. These curves represent a weighted average of the facilities (salt caverns, aquifers or depleted fields) of each area.

- LNG Tank Volume and Flexibility.

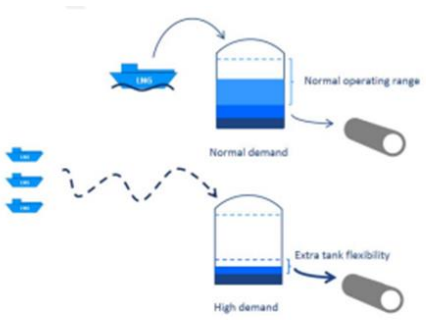
The send-outs from the terminals are modelled to represent the sum of both the off-loaded volumes of arriving cargos and gas from tanks. As for the previous Winter Outlook, the 2-Week Cold Spell is split in 2 periods to allow a differentiation of the LNG terminals behaviour between the first and the second week.

- *First week, the model will determine the LNG send-outs using the level of LNG supply reached in LNG terminals for February as a result from the whole winter simulation, plus additional LNG that can be taken from the tanks.*
- *Second week allows importers to access a relevant number of cargos, so that the LNG supply reaching the terminals can reach the February maximum supply potential. In addition, the LNG send-outs can use the remaining LNG stored in the tanks.*

LNG terminals tank flexibility:

LNG stocked in the tanks fluctuates within a normal operating range of LNG in the tanks following normal operation. Besides, there is a minimum amount of LNG that must be kept in the tanks for a safe operation.

However, in case of high demand events such as 2-week cold spells or peak demand days, this minimum amount can be lowered, and part of the tanks are therefore used as a buffer volume, waiting for more LNG carriers to unload.



ENTSOG models this tank flexibility based on figures provided by the LSOs via GLE.

Annex B: Demand, National Production, Supply Potential and Export

The data for Winter Supply Outlook 2023/24 is available online as an annex of this report. The data available is specifically:

- Average daily Reference Winter and Reference Summer demand forecast, GWh/d.

The Reference Winter demand (from 1 October 2023 to 31 March 2024) is based on TSOs' estimates.

The Reference Summer demand (from 1 April to 30 September 2024) based on 5-year average demand (with 15% demand reduction) 2017-2021.

- Average daily Cold Winter demand and Cold Winter with -15% demand response forecast, GWh/d.

The Cold Winter demand is based on demand assumptions considered in ENTSOG's Union-wide Security of Supply Simulation Report 2021, i.e., the historical highest winter demand since the winter 2009/10 on country level.

- Average daily National production forecast, GWh/d.

The national gas production estimated by TSOs

- Supply potential and exports to Ukraine and Moldova

For each of the winter and summer demand profiles and high demand situations in the winter season, specific maximum gas supply availabilities are used in the report. The maximum supply potentials of the different sources providing gas to the EU are based on the historical availability over the last five years (Caspian Sea, Algeria, Reference LNG) or based on TSO information (Libya, Norway) or the observed flows of the last year (Russia).

Supply limitations are set for different cases (monthly values for winter and summer seasons, weekly values for the 2-Week Cold Spell case, daily values for the Peak Day case) so that the maximum flows from each source cannot exceed reasonable levels based on historical observations.

Export to Ukraine and Moldova is based on the expected forecast provided by the Ukrainian TSO and the Energy Community Secretariat respectively.

Annex C: Modelling approach

The topology of the network model considers the existing European gas infrastructure, new upcoming projects, and the firm technical capacities provided by TSOs, which include maintenance plans known as of October 2023.

ENTSOG is using Plexos modelling tool since spring 2021. The gas topology at European level and the Entsog model is modelling the European gas infrastructure with the most relevant accuracy. This enables the national assessment of relevant risks affecting the security of gas supply to benefit from the Union wide simulation of supply and infrastructure disruption scenarios and further extend the local assessment with a higher granularity.

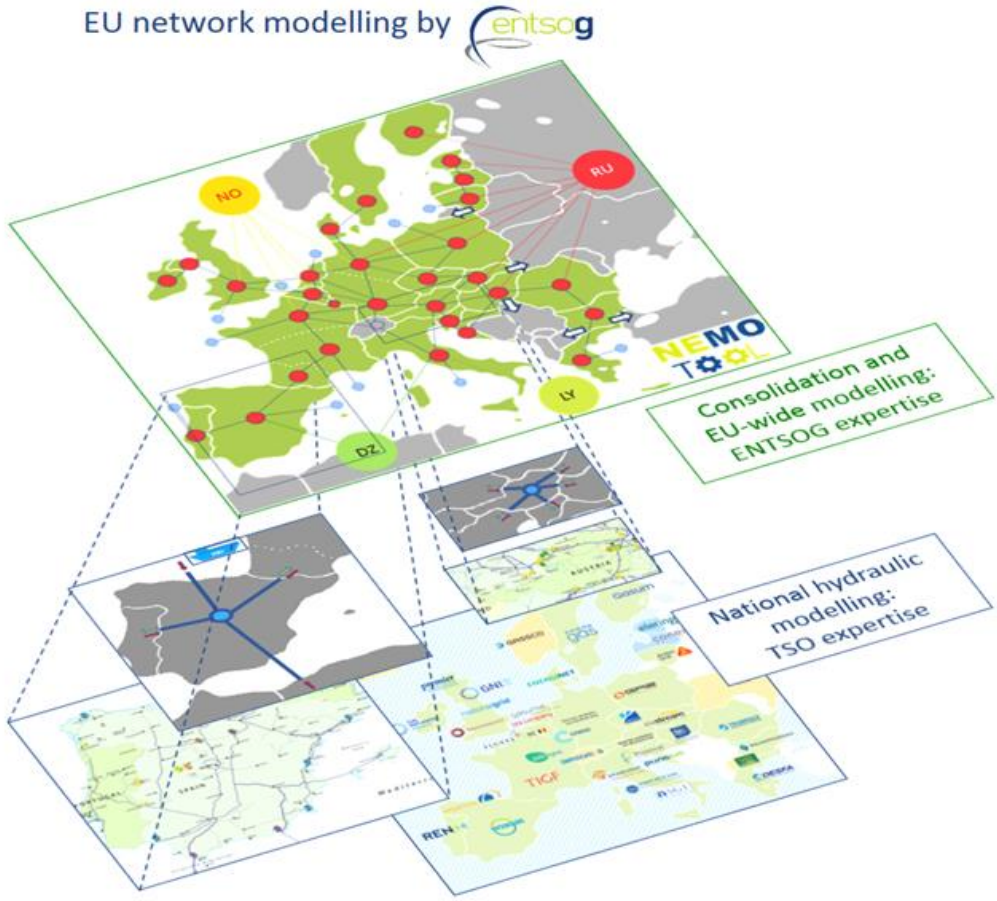


Illustration 1: Entsog model overview

The cooperative modelling is done on the basis of an optimal crisis management. That is, in case a country faces a demand curtailment, all the other countries will cooperate in order to share the same ratio of demand curtailment.

Annex D: *Curtailment Rate*

The data for Winter Supply Outlook 2023/24 is available online as an annex of this report. The data available is specifically:

- Curtailment Rate for Winter Outlook monthly simulations, %
- Curtailment Rate for High demand situation – 2-week Cold Spell and Peak day simulations, %

For each demand situation and each zone, modelling results consist in the calculation of Curtailment Rate which is the potential level of demand curtailment representing the share of the gas demand that cannot be satisfied (calculated as a daily volume). The level of demand curtailment is assessed considering a cooperative behaviour between European countries in order to mitigate its relative impact. This means that all countries try to reduce the curtailment rate of other countries by sharing it.

Note: to give a comparable picture of the situation and avoid any distortion in the cooperative behaviour of ENTSOG's model, all indicators consider the demand as it is defined in the assumptions. However, in practice, a reduction of demand is observed in case of risk of inadequacy between supply and demand, generally as a consequence of increasing prices. This demand response to high prices is considered in the results (-15% demand reduction) and should be given due attention when interpreting the risk exposure to demand curtailment in the different countries. This is why an exposure to a few percentiles of demand curtailment observed in a country is generally considered as a limited risk in this assessment.

Abbreviation

TSO	Transmission System Operator
UGS	Underground Storage
LNG	Liquified Natural Gas
WGV	Working Gas Volume
UAe	Export to Ukraine
MDe	Export to Moldova

Supplies

CA	Caspian Area
DZ	Algeria
LY	Libya
NO	Norway
NP	National Production
RU	Russia

Countries

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MK	North Macedonia
MT	Malta
NL	The Netherlands
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom
UKn	Northern Ireland

Other

BEl	Belgium L-gas
DEl	Germany L-gas
DEn	Germany THE South
DEg	Germany THE North
FRnL	French Nord L-gas
LNG_FRn	French LNG zone North
LNG_FRs	French LNG zone South
LNG_ITa	Italian LNG zone Adriatic
LNG_ESa	Spain LNG zone Atlantic
STcAT	Austrian storage zone
STcATm	Austrian multi-country storage zone
STcATn	Austrian storage zone connected to THE South
STcCZd	Czech storage zone connected to Slovakia
STcDE	Germany storage zone
STcDEd	Germany Dutch storage zone
STcDEdL	Germany Dutch storage zone L-gas
STcDEg	Germany storage zone connected to THE North
STcDEm	Germany multi-country storage zone
STcDEmL	Germany multi-country storage zone L-gas
STcDEn	Germany storage zone connected to THE South
STcFRa	TSO GRTGaz storage zone Atlantic
STcFRn	TSO GRTGaz storage zone North
STcFRnL	TSO GRTGaz storage zone North L-gas
STcFRs	TSO GRTGaz storage zone South
STcFRt	TSO Terega storage zone

Publisher ENTSOG AISBL
Avenue de Cortenbergh 100
1000 Brussels, Belgium

Co-Authors Thilo von der Grün, Kacper Zeromski, Arturo de Onis, Diana Fathelbajanova, Hubert Bolesta

Cover picture Courtesy of Elering

ENTSOG AISBL
Avenue de Cortenbergh 100 | 1000 Brussels, Belgium
Tel. +32 2 894 51 00

info@entsog.eu | www.entsog.eu