Contents

Executive summary

As part of its obligation under Art. 8(3)(f) of Regulation (EC) 715/2009, ENTSOG has undertaken an assessment of the European gas network for the upcoming Winter (October 2022 to March 2023). Additionally, as part of its obligation under Art. 7(1) of Regulation (EC) 2017/1938, ENTSOG has undertaken an assessment Union-wide simulation of gas supply and infrastructure disruption scenarios, including scenarios of a prolonged disruption of a single supply source. 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 system is able to handle the Winter under different demand conditions: Reference Winter and Cold Winter[1].Additionally, ENTSOG investigated the full Russian supply disruption case.

The **main findings of the Winter Supply Outlook** are:

- **The gas storages significantly contribute to security of gas supply. On 1 October 2022, the EU storage level (89%) is one of the highest on record (985TWh), with different situations among countries.** This level is higher than the objective set for Member States to inject during the summer 2022 a minimum of 80% their capacity of storages, or 35% of their annual gas demand (when the storages Working Gas Volume allows it).

- **The gas infrastructure**, including projects to be commissioned over the upcoming winter, **allows for efficient cooperation** among the different Member States. **However,** under specific circumstances, **some possible supply limitations are identified.**

- **Reference case** (reflects the currently reduced Russian imports via Ukraine and Turk stream)

  In case of a normal winter (1-in-2 years) the gas system can ensure demand and supply adequacy. However, due to supply constraints, in case of a peak day most Member States are exposed to a limited risk of demand curtailment (6%). **In case of a cold winter (1-in-20 years) all European countries are exposed to a risk of 10% demand curtailment for the entire winter season** and of 10% to 27% in case of a peak day.

- **Russian supply disruption during a cold winter**

  In case of Russian supply disruption, **cooperation among all European countries can partially mitigate the risk of demand curtailment. Demand curtailment is limited to 13% on a daily basis.** Furthermore, in case of a peak day, the level of demand curtailment could be in a 12% - 27% range across Europe.

[1] The Reference Winter and the Cold Winter are defined on the document.

- **Additional LNG supply sensitivity**

In case of high demand situations and in a cold winter period, **provided that LNG is available on the global market, LNG imports could be increased up to 100 bcm (1150 TWh) over the winter**, significantly higher than the maximum volumes ever observed in winter (63 bcm / 700 TWh in winter 2019/2020)**.** In case of Russian supply disruption, this additional supply could reduce the risk of demand curtailment from 13% down to 6% across Europe during a cold winter. In case of a normal winter demand, **LNG import could increase up to 90bcm (1000 TWh] in case of total Russian supply disruption, even considering -15% demand reduction.**

- **Demand reduction assessment**

Demand reduction of ca. -15% (as a result of organic reduction due to high prices or policy-based demand measures) **and Member States cooperation would efficiently mitigate the risk demand curtailment in EU countries during winter season, including during a Russian supply disruption**. With -15% demand reduction, Europe would be exposed to 4% - 13% demand curtailment only during a peak day under Russian supply disruption.

Conclusions

- **With the current high storage levels, the gas infrastructure, including new projects to be commissioned in the upcoming winter, can efficiently reduce the dependence on Russian supply thanks to enhanced cooperation and additional LNG import capacities.**
- In case of Russian supply disruption, **cooperation among all European countries can partially mitigate the risk of demand curtailment. However, without demand reduction most countries would be exposed to significant risk of demand curtailment in case of a cold winter.**
- **An early and significant storage withdrawal** will result in low storage levels at the end of the winter season. This **will have a negative impact on the flexibility of the gas system** - and may increase exposure to demand curtailment in the second half of the winter season especially in case of cold and high demand events. Therefore, **it is important that all European storages continue to inject gas to the extent possible and that the European gas system continues to use imports to prepare for high demand situations as well as to ensure security of supply also in the following periods.**
- **Reminder from the Yearly Outlook 2022-2023 report:** Storages play an essential role to ensure security of supply. However, **without preparedness for Winter 2023/2024**, **the situation could deteriorate over the next gas year**: storages would be depleted in April 2023 and sites located in Central and South-Eastern Europe would be filled less than 15% on 1 October 2023, leaving the EU more exposed to risks of SoS for the winter 2023/2024.

- **The European gas system is also capable of cooperating with Energy Community Contracting Parties and other EU neighbouring countries** to mitigate the exposure to demand curtailment to the minimum possible extent,
- ENTSOG will monitor the evolution of the storage levels and import volumes throughout the Winter and report on the situation on regular basis.

Important:

ENTSOG Winter Supply Outlook 2022/2023 is an assessment of the readiness of the gas infrastructure to cope with the upcoming winter under different scenarios, but this assessment is not a forecast of the expected gas supply situation. The model assumes cooperative behaviour among Member States as well as LNG distribution to terminals and storage utilisation according to security of supply needs. The actual utilisation of the gas infrastructure, including the development of the gas storage levels, will be determined by availability of supply sources, the decisions of the market participants (e.g. price driven instead of security of supply) and influenced by external factors such as policy decisions.
Given the uncertainty of the situation, TSOs identified and estimated possible enhancements of capacity that could further increase and maximise gas flow from west to east.

1. Introduction

This edition builds on previous Winter Supply Outlooks as well as on the supply assumptions of the Security of Supply Simulation Report 2021 and demand data updated for the purpose of 2021 edition. It aims to assess the ability of the European gas network to provide enough flexibility to meet different demand situations and specially to face high demand situations. Likewise, it aims to verify the consistency is ensured between "Cold Winter" and the SoS simulation report assumptions.

Recent events in Ukraine are affecting the market and TSOs were encouraged to include this context in their estimations regarding the demand forecast and capacity assumptions (including possible maintenance) provided for simulations.

Two different cases: winter period and high demand situations

As for previous reports, Winter Supply Outlook 2022/23 captures two different aspects of the season. The first one is an outlook of demand and supply and the resulting evolution of the UGS inventory along a Reference Winter and a Cold Winter demand scenarios. The second one is the analysis of specific high demand situations (1-day Design Case and 2-Week Cold Spell), under the framework of both reference and cold winters scenarios and with different storage levels values. Additionally, a demand reduction of -15% for Reference and Cold Winter demand scenarios (Monthly and high demand situations) is considered to be consistent with European Commission request to member states.

In both cases, the impacts of the additional LNG imports in combination with the enhanced[2] capacities (exceeding historically observed LNG flow to EU) if they are available on the global market has been studied. The scenarios with limited LNG correspond to a modelling situation based on LNG historic supplies to Europe which might not correspond to the actual supply available on the global LNG market. However, Europe may be able to attract additional LNG cargos above the historical volumes.

Observations of the supply situations in the past show that the underground gas storages are the most important flexibility assets to cope with the high demand variations during the winter season. Therefore, this report pays special attention to the storages. The winter months require storage withdrawal to cover both short high demand periods and the overall winter demand. The actual level of withdrawal by shippers varies from one country to the other and with climatic, price and regulatory parameters.

Currently, the European aggregate inventory level of underground gas stocks as of October 1 2022 is 985 TWh, which is a level lower to the storage levels of the winter 2019 and 2020 and much higher than that of the previous winter 2021 winter (831TWh) following the measures

[2] Conditional firm technical capacities as provided by TSOs to allow for more gas to be transported from Western to Eastern Europe.

implemented by MSs in order to support storage injection and be aligned with the targets defined by European Commission.

Winter Supply Outlook relation to SoS simulation report:
Consistency with SoS simulation report 2021: The results obtained in the Union-wide Security of Supply Simulation Report 2021 are verified in the Winter Supply Outlook simulations considering an updated projection of the "Cold Winter" demand. Supplies assumed in that report are based on historical values with a methodology in line with the Union-wide SoS simulation and explained further in this report. The transmission capacities are updated by TSOs for the upcoming winter 2022/2023.
Assessment of supply disruptions: The WSO assesses the impact of supply disruptions occurring during Winter period, a Peak Day or a 2-Week Cold Spell.

2. Assumptions

2.1. Demand

The simulations consider the European gas infrastructure from October to March 2022/2023 and gas storage level at the beginning of October 2022.

Given the exceptional situation, the following assumptions has been done about the infrastructure:

- The Belarus import route and the Russian import route to Finland, Estonia and Germany (Nord Stream) are no longer available. Import route from Russia to Latvia is considered as available from October to December. Additionally, supply from Russia via imports through Ukrainian transit route and Turk Stream is limited in order to be aligned with the structural reduction observed in last months. Gas flows are only possible from Ukraine to Slovakia and from Russia to Bulgaria.
- Interconnection capacity development in 2022:
    - Baltic Pipe import route from Norway to Denmark and to Poland is available
    - FSRU terminals in Germany, the Netherlands and Finland are available
    - Interconnection between Poland and Lithuania is now available
- The disruption case studied in this report is the full Russian Supply disruption case. Nevertheless, the following assumptions have been done: Serbia and North Macedonia will, in all cases, satisfy their demand using Turk stream flows. As a consequence, Turk Stream maximal flows have been updated to correspond to the demand values in Serbia and in North Macedonia. Serbia and North Macedonia won't cooperate in case of full Russia supply disruption. The EU infrastructure capacities have been upgraded to reflect the situation. Conditional firm technical capacities have been provided by TSOs to allow for more gas to be transported e.g. from Western to Eastern Europe (enhanced capacities).

The modelling tool (Plexos) for the Winter Supply Outlook is the same as the one used in the TYNDP 2022 and the Summer Supply Outlook 2022 (and any later). It considers the existing gas infrastructure as of September 2022 and the technical capacities updated by TSO with every WSO exercise.

The Winter Supply Outlook 2022/23 is developed based on assumptions specific to the upcoming winter season as detailed in the annexes and short-term trends. In any case actual withdrawal and supply mix will result from market behaviour and other external factors.

Storage behaviour is defined as following:

- A target level of 30% is define for each storage. This target is not mandatory. That mean that storage go below the 30% if other supply can't satisfy demand.
- The storage use is proportional in all countries. That mean that without any hard constraints, (demand curtailment), storages will be use at the same level.

The model does not anticipate the need to save some gas in the storages to prepare for the next winter. Some European countries could be reserving part of their own gas stock constituted as strategic reserves to be used only for the purpose of satisfying their own demand. However, following a cooperative behaviour, the model assumes that countries could help themselves by fully sharing gas in the storages not considering actual constraints on the utilization of the strategic reserve[3]. Therefore, storages can be depleted to avoid/reduce demand curtailment

Demand Curtailment

For each high 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 behavior 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.

[3] Strategic storages could be withdrawn according to timeframes and amounts that are compliant with the technical constraints, in order to preserve the integrity of the fields and considering their deterioration profile of withdrawal capacity.

2.1.1. Seasonal demand

A Reference Winter represents average climatic conditions with a 1-in-2 year probability of occurrence. The demand data has been provided by TSOs on a monthly level. An average daily demand has been considered for each month.

The demand for the Cold Winter is based on demand assumptions considered in SoS simulations report4 and represents a historical 1-in-20 high demand winter (with a probability of occurrence 1 in 20 years, see Annex B for country detail). Cold Winter demand values have been updated in view of the publication of the updated Union-wide SoS Simulation Report 2021. Cold Winter demand values have also been updated for the simulations in this report to consider infrastructure and market changes (example: market conversion from L-Gas to H-Gas).

For comparison purpose, Figure 1 shows the European aggregated demand for the Reference Winter and Cold Winter for Winter 2022/2023 compared to the historical demand over the last 10 winters. The aggregated reduced demand values with -15% reduction (Reference and Cold Winter) are also compared with historical values.

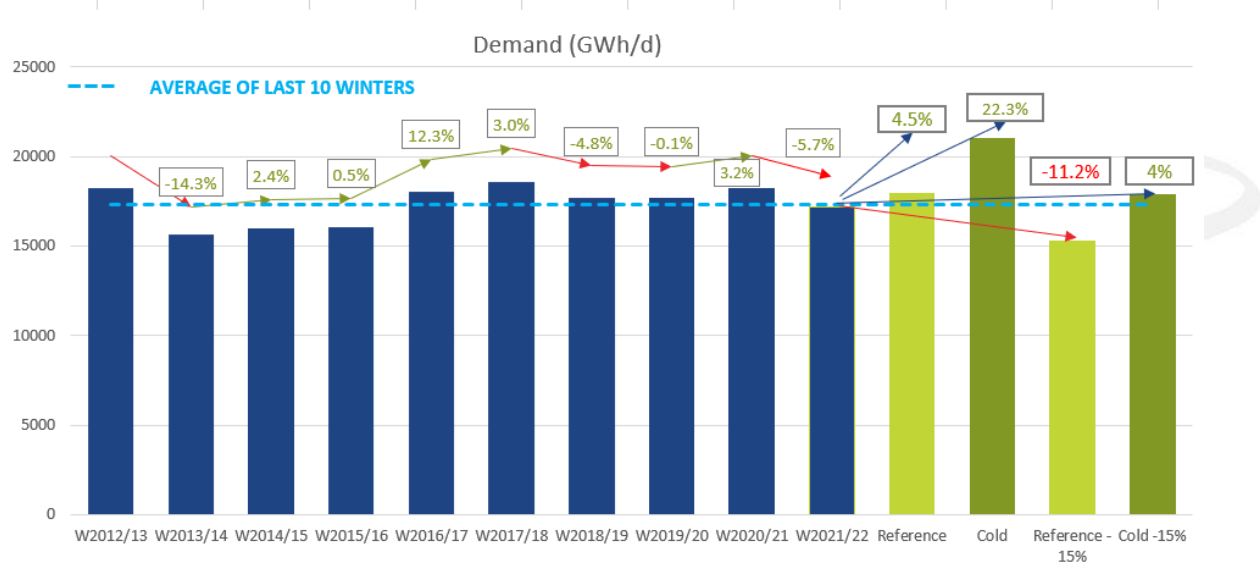


Figure 1. - European seasonal demand in the last 10 winters compared with the two cases.

The Reference Winter demand is slightly higher than the one observed during the last winter (+4.5%) which was considered a mild winter. As the difference is between two winters that are not assumed cold (reference winter 2022/2023 and previous winter). The Cold Winter demand is higher than the last ten winters (since it is 1-in-20) and shows an overall demand of 22.3% higher than the total demand of winter 2021/22. In case of 15% reduction, Reference

[4] The methodology and assumptions performed to obtain the Cold Winter Demand in the three cases (whole winter, 2 weeks and Peak Day) are explained in SoS simulations report, point 3.1. (Pages 8-9).
https://www.entsog.eu/public/uploads/files/publications/sos/ENTSOG%20Union%20wide%20SoS%20simulation%20report_INV0262-171121.pdf

Winter and Cold Winter demands are respectively lower (-11.2%) and higher (+4%) than the one observed during last winter.
Furthermore, Reference and Cold Winter are higher compared with average demand of last 10 winters, 3.6% and 21.3% respectively. In case of 15% reduction, Reference Winter and Cold Winter demands are respectively lower (-11.9%) and higher (+3.1%) than the average demand of last 10 winters.

2.1.2. Peak demand

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

Period	Occurrence of the demand provided by each TSO
1-in-20 Peak Day	National design standard for gas demand, assume to occur on 15 February
1-in-20 2-Week Cold Spell	High demand during a 14-day period in February (Cold Spell), assumed to occur between 15 -28 February.

The Peak Day and 2-weeks demand are used to check if the withdraw capacity in the UGS is enough to cope with a Peak Day or Cold Spell events at the end of February when the storages are not at their maximum level (therefore, they are not at their maximum withdraw capacity). **Figure 2** shows the European aggregated 2-Week average demand for the Reference Winter and Cold Winter compared to the historical demand over the last ten winters, and **Figure 3** shows the European aggregated Peak Day demand. Reference and Cold winter demand values with -15% are also compared with previous winter values in both figures.

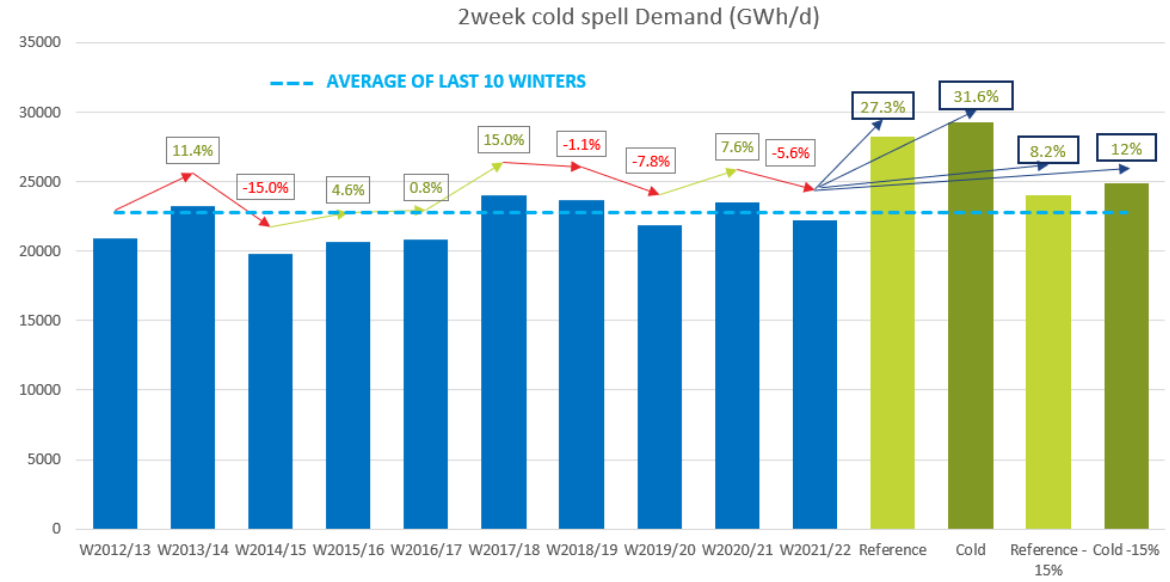


Figure 2.- European 2-week demand history (2011 – 2021) compared with Reference and Cold winter 2-week demand.

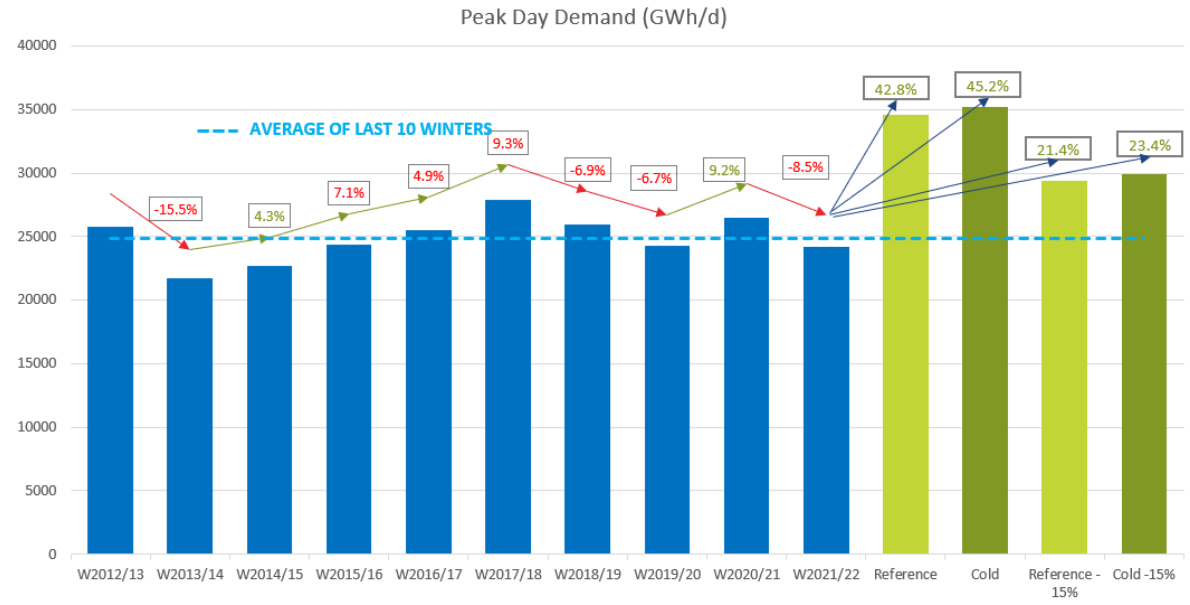


Figure 3.- European Peak Day demand history (2011 – 2021) compared with Reference and Cold winter peak demand.

The 2-Week Cold Spell demand for Reference Winter is significantly higher than the one observed during the last winter (+27.3%) or the average of the last ten winters (+24.1%), but comparable to the 2-week demand of 2012/2013. In case of a 2-Week Cold Spell[5] in Cold Winter the demand could be 31.6% higher than in winter 2021/22. In case of -15%, 2-Week Cold Spell demand for Reference and Cold Winter could be higher the one observed during the last winter with respectively +8.2% and +12%.

Due to mild last winter, the Peak Day demand for Reference Winter is higher than the one observed during the last winter (42.8%) and higher than the average of the last ten winters (+39%). In case of a Peak Day[6] in a Cold winter the demand could be 45.2% than in winter 2021/22. In case of -15%, Peak demand for Reference and Cold Winter could be higher the one observed during the last winter with respectively +21.4% and +23.4%.

[5] 2-Week Cold Spell for Cold Winter: A period of 2 weeks of exceptionally high demand, occurring with a statistical probability of once in 20 years.

[6] Peak Day for Cold Winter: One day of exceptionally high demand, occurring with statistical probability of once in 20 years.

2.2. Supply

The maximum supply potentials of the different sources providing gas to the EU are based on a 10-year history for Winter Season and on eight-year available history for 2-Week Cold Spell and 1-day Design Case (Peak Day). The maximum supply potential of the new source of gas for Europe from Caspian aera with Greece and Italy available since November 2020 has been assessed to take into consideration the market development.

Supply limitations are set for different time scales or profiles (winter season, month, 2 weeks and day) so that the maximum flow of each source cannot exceed reasonable levels based on historical observations[7]. The detailed data is provided in the annexes. For each of the winter demand profile and high demand situation, specific gas supply maximum availability has been defined in **Table 1**:

<table>
<tr><th></th><th>National Production</th><th>UGS[8]</th><th>LNG</th><th>Algeria, Norway, Libya, Russia</th></tr>
<tr><td>Winter Season</td><td>TSO forecast for winter.</td><td rowspan="4">Limited for each country (or zone) by the stored volumes and the deliverability associated with the inventory level.</td><td colspan="2">Limited for the whole winter period to the highest winter average supply observed during the last 10 winters and at monthly level to the maximum 30 days rolling average of the last 10 winters.</td></tr>
<tr><td rowspan="3">2-Week Cold Spell</td><td rowspan="3">TSO forecast for high demand situations.</td><td>Week 1</td><td rowspan="3">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
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>1-day Design Case</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>
</table>

Table 1.- Gas supply maximum availability definitions.

Figure 4 shows historical seasonal supply for the last ten winters for pipeline imports and LNG imports. Russian supply is decreasing and compensated by Norwegian and LNG increased. Algerian supply is decreasing with Tarifa import route closed and Libyan supply is reaching its lowest value from the last 10 years. Caspian supply with a full winter season, is compensated the decrease in the south area.

[7] The methodology and an example of the supply assumptions calculations can be found in SoS simulations report, point 3.4. (page13).https://www.entsog.eu/public/uploads/files/publications/sos/ENTSOG%20Union%20wide%20SoS%20simulation%20report_INV0262-171121.pdf

[8] UGS inventory on withdrawal deliverability has been considered using deliverability curves provided by GSE (see Annex A).

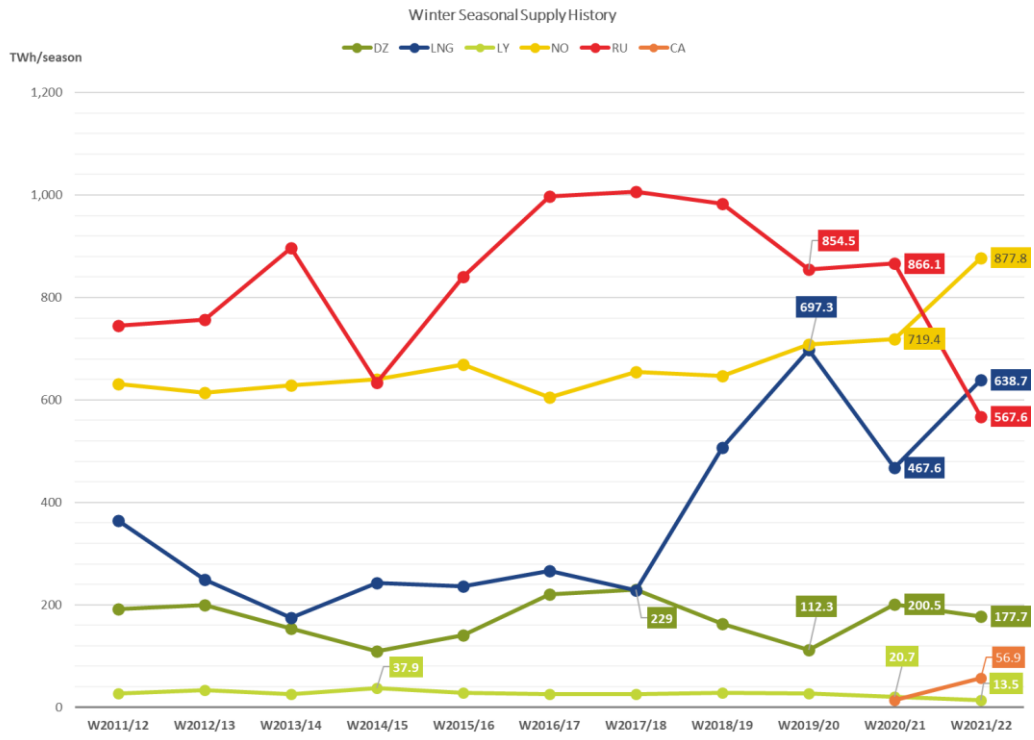


Figure 4.- Winter supply limitation.

Figure 5, 6 and 7 respectively show historical 30-day, 14-day and peak day supply for the last eight winters, with the most noticeable variations for LNG and Norwegian (increase) and Russian supply (decrease).

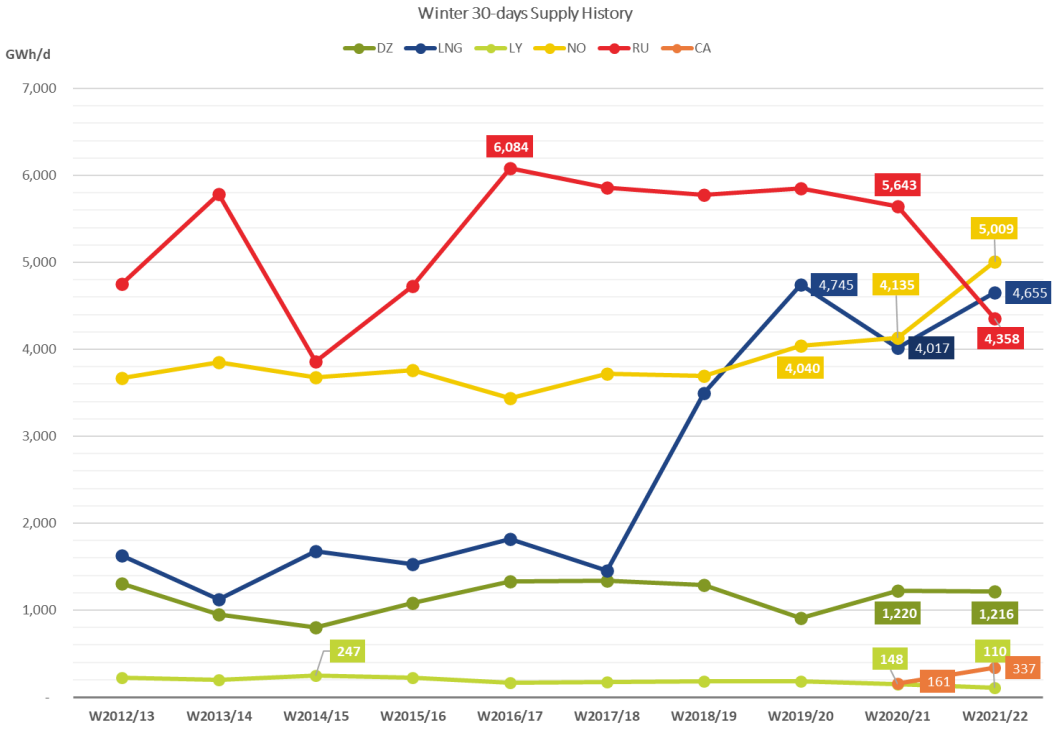


Figure 5.- 30-days supply limitation.

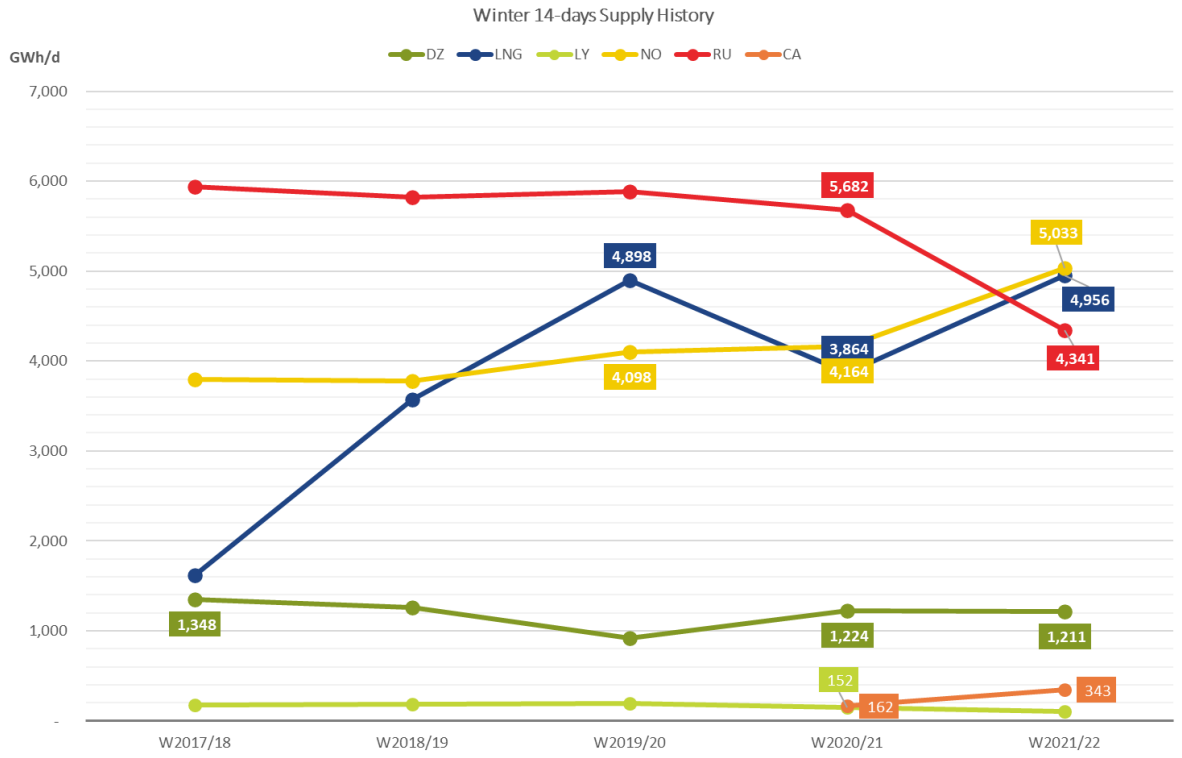


Figure 6.- 14 days supply limitation.

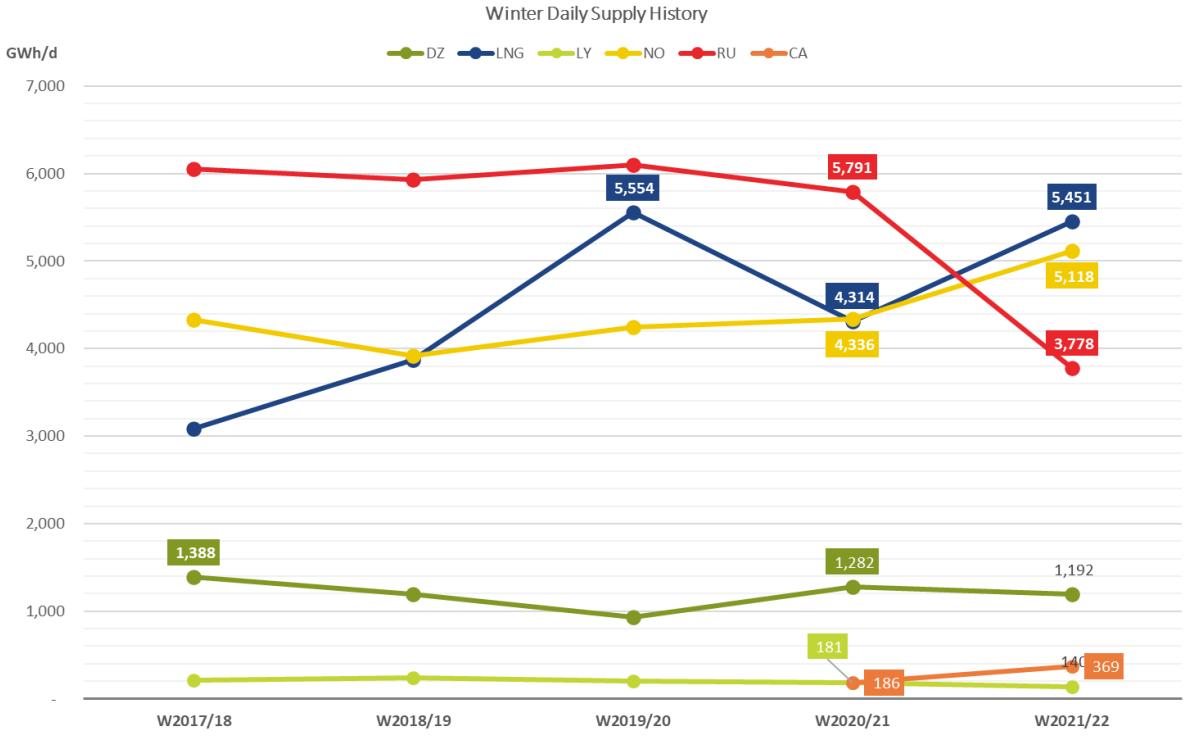


Figure 7.- Daily supply limitation.

2.3. 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, Moldova and Russia (Kaliningrad).

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.
- Exports to Ukraine are based on the observed exports of the last five years[9].
- Exports to Moldova have been set to zero following an investigation of the previous flows.
- Exports to the Kaliningrad region of Russia are not considered.
- No exports towards Turkey were considered since Turk Stream pipeline was commissioned.
- Albania, Montenegro and Kosovo are not connected to the gas grid.

[9] The value of the flow is indicated in the Annex B.

3. Storage inventory

3.1. Injection during summer

On 1 April 2022, beginning of the injection period, the EU gas storage inventory was 303TWh, much lower than the previous winter (336TWh) but more than in April 2018 value (190TWh) which however was the lowest value at the beginning of the injection period since 2011. **Figure 8** shows the total WGV, the initial gas in the storages on 1st April and the gas injected during the summer season (until end of September) between 2012 and 2022.

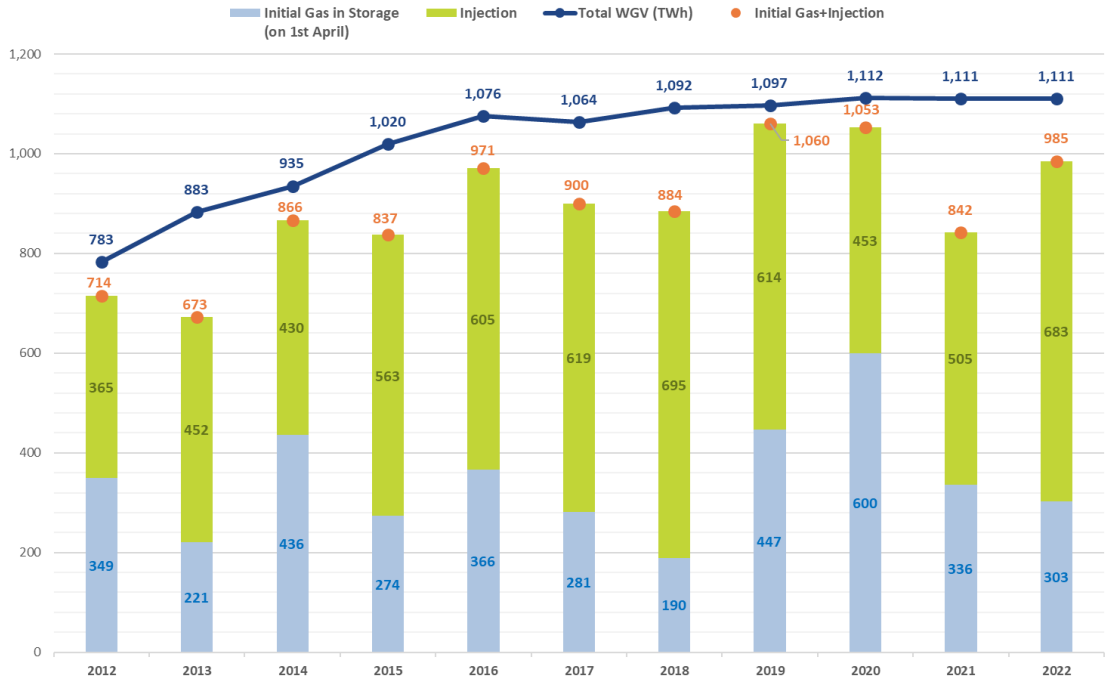


Figure 8.- Situation of the storages during summer seasons (2012 to 2022).

At the end of Summer 2022, the gas storage inventory was the third highest level from the last 10 years. The storages due to their utilisation to face cold winter periods at the beginning of the year 2022 reached a value of 303TWh at the beginning of the injection period 2022 (27%). Despite high prices in all European Hubs (see **Figure 10**), countries followed the European Commission encouragement to inject gas in storages to reach 90% or 35% of the winter gas demand when WGV allows it.

The storage level is on 1 October 2022 (985TWh) is comparable to 2016 levels (971TWh) and 68TWh lower than the storage of 1st October 2020. With the decline of the European indigenous gas production, the EU relies more on storages and imports (which in the actual context will be difficult) to ensure the supply and demand adequacy.

Storages play an important role to in providing supply in case of high demand situations to compensate imports and interconnection bottlenecks. Nevertheless, storages must be at a sufficient level at the beginning of winter to be able to ensure seasonal flexibility and at a sufficient level before the high demand situations (Peak Day and 2-week cold spell) to provide the necessary peak withdrawal capacities.

Figure 9 compare the stock level evolution of the last nine summers highlighting the initial level on 1st April 2022.

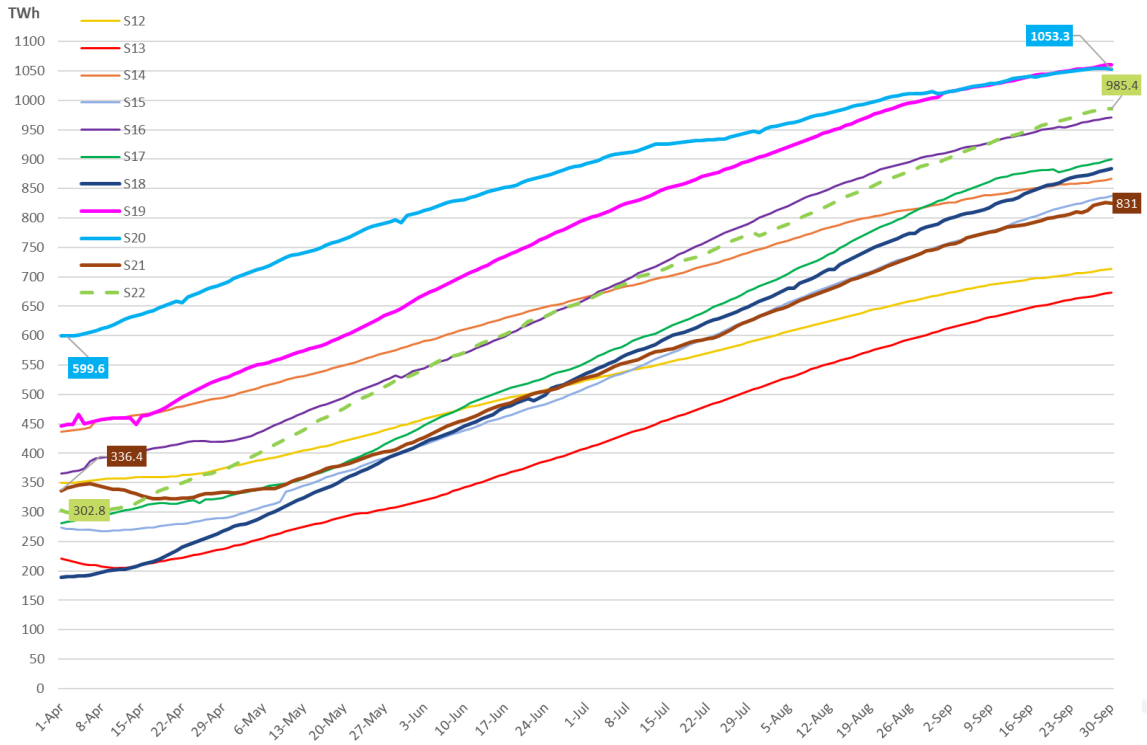


Figure 9. Evolutions of UGS stock level. Summers 2022 (TWh) (Source: AGSI+).

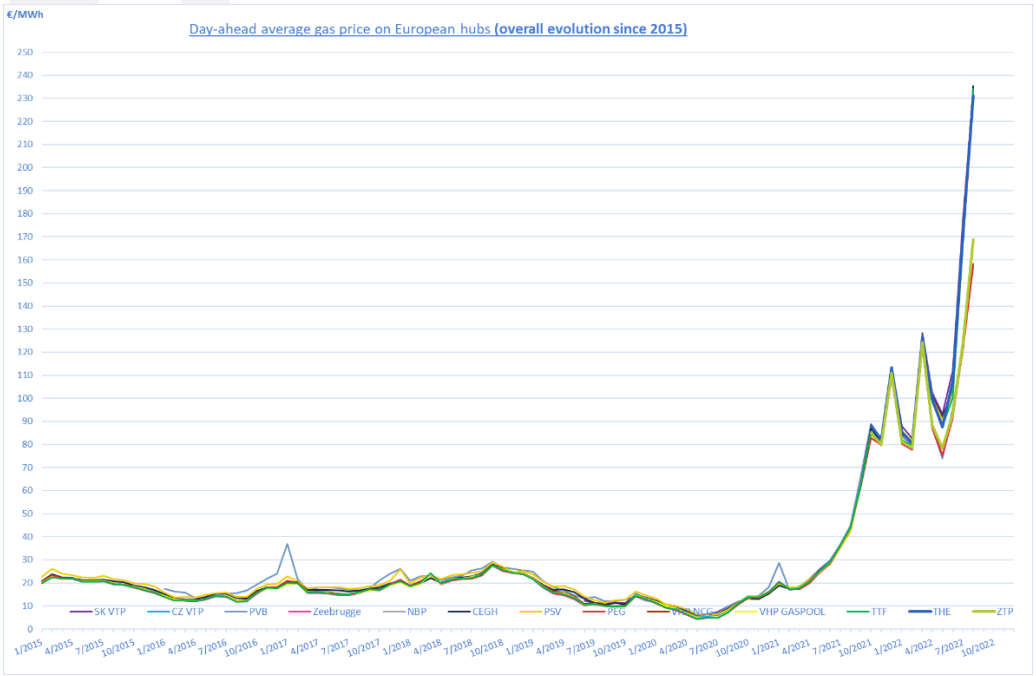
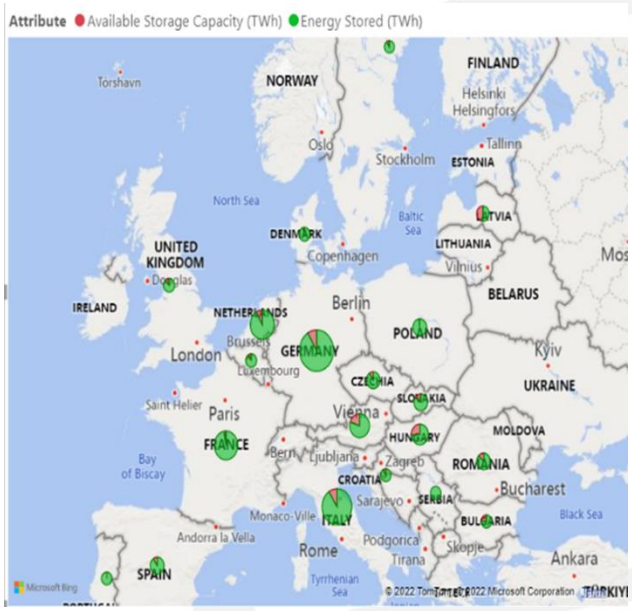


Figure 10. Day-ahead average gas price on European hubs (overall evolution since 2012 to September 2022).

3.2. Initial storage level on 1 October 2022

The Winter Supply Outlook considers the actual storage inventory level per country as of 1 October 2022[10] (see **Figure 11).** As shown in the next map the storage inventory levels differ from country to country.



Country	WGV (TWh)	Energy Stored (TWh)	Filling Level (%)
Austria	95.55	76.22	79.77%
Belgium	8.70	8.01	92.09%
Bulgaria	5.80	4.40	75.81%
Croatia	4.77	4.35	91.21%
Czech Republic	35.81	32.29	90.16%
Denmark	9.23	8.78	95.12%
France	132.61	129.00	97.28%
Germany	236.77	215.98	91.22%
Hungary	67.70	49.98	73.83%
Italy	193.44	175.52	90.73%
Latvia	24.07	12.67	52.63%
Netherland	138.99	127.37	91.64%
Poland	36.41	35.81	98.34%
Portugal	3.86	3.86	100.00%
Romania	32.79	28.27	86.19%
Serbia	4.53	4.53	100.00%
Slovakia	36.05	30.65	85.03%
Spain	35.25	31.78	90.14%
Sweden	0.10	0.09	92.89%
United Kingdom	10.62	9.25	87.08%
Total	**1,113.05**	**988.81**	**89%**

Figure 11. - Actual storage inventory level on 1st October (for some countries, the initial level includes strategic stocks).

In terms of absolute Working Gas Volumes (WGV) in gas storages, the largest ones are located in Italy, Germany, France and the Netherlands. On 1 October 2022, the initial total UGS inventory is around 985TWh compared to 1053TWh in 2020 and only 831TWh in 2021. The actual levels for each country show substantial differences from one country to the other with 89% average level.

In comparison to the previous year, most of the countries increased their storage level. Summer Supply Outlook 2022 simulations have shown that the gas infrastructure was able to reach 90% to 100% during the injection period and EU member states followed EU commission requirements to fill the storages at a minimum of 90% of WGV or 35% of winter demand.

These storage levels could however increase in October2022 since the injection season generally continues in some countries until 1st November.

[10] The gas in storage on 1st October 2022 for each country is based on the AGSI platform captured on 1st October 2022 complemented by other information sources for storages not reported on AGSI. The %Full has been calculated taking into account the Working Gas Volume from GSE Storage MAP database (the last update was July 2021), updated with AGSI values for WGV have been taken into account for those storages with remarkable difference.

4. Infrastructure assessment for Reference Winter and Cold Winter scenarios

Interconnection capacity development and supply sources availability in 2022 compared to previous year:

- Belarus import transit route is not available
- Nord Stream 1 import route is not available
- Supply from Russia via imports through Ukrainian transit route and Turk Stream is limited in order to be aligned with the structural reduction observed in last months
- Import from Russia to Finland, Estonia and Latvia (in Latvia still available from October to December) are not available anymore.
- Baltic Pipe import route from Norway to Denmark and to Poland is available
- FSRU terminals in Germany, the Netherlands and Finland are available
- Interconnection between Poland and Lithuania is now available

The assumptions considered for these scenarios are detailed in chapter 2.

4.1. Supply and demand adequacy

Figure 12 & 13 show the supply and demand balance at European level for the Reference Winter and the Cold Winter demands.

Figure 12. Supply and demand adequacy – Reference Winter and Cold Winter scenario.

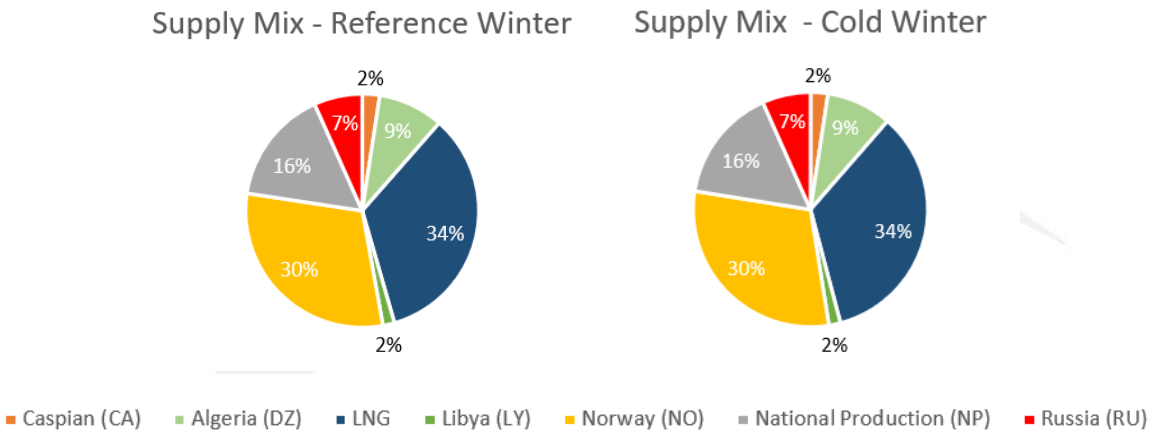


Figure 13. Supply and demand adequacy – Reference Winter and Cold Winter scenario.

These charts illustrate the evolution of supply and demand[11] for Reference and Cold Winter seasons. The simulation results show that, LNG and the storage facilities provide the necessary flexibility to meet the demand in Reference winter scenario while in Cold winter scenario, supply are not enough to meet demand. It should be noted that the import levels shown in **figure 12 & 13** represent one of the possible supply mixes, with LNG ensuring the import flexibility in this example and simulations were performed while minimizing the Russian supply. The Russian supply is used as described in the assumptions. This restricted supply from Russia is used at the maximum. Since 2020, the Caspian imports cover a part of the demand, allowing Europe to get access to a new competitive source of gas.

15% demand reduction

Figure 14 & 15 shows that in case of 15% demand reduction, for Reference winter scenario Russian supply is not used in October, February and March and in Cold Winter scenario, Russian supply is minimised as much as possible and other supply are used as much as possible.

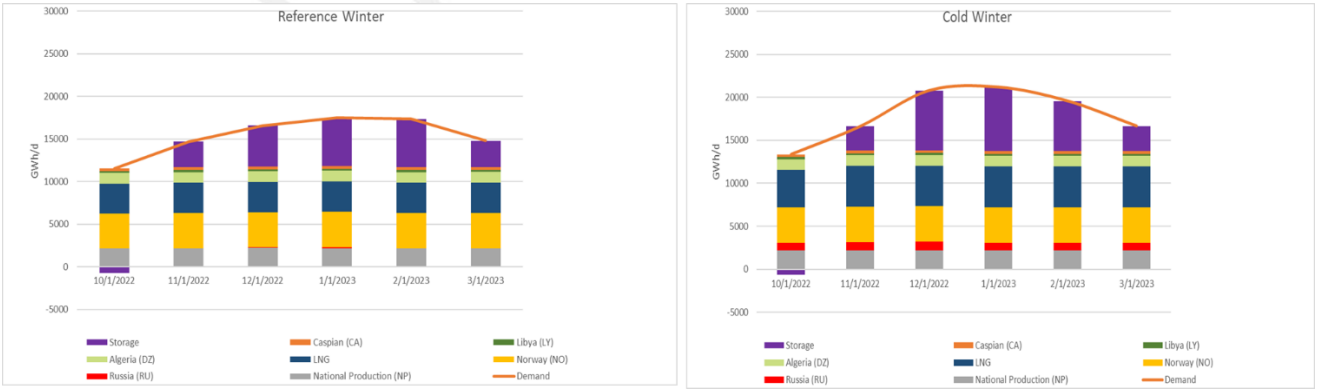


Figure 14. Supply and demand adequacy – Reference Winter and Cold Winter with 15% demand reduction.

[11] Demand data also considers exports and injection during October.

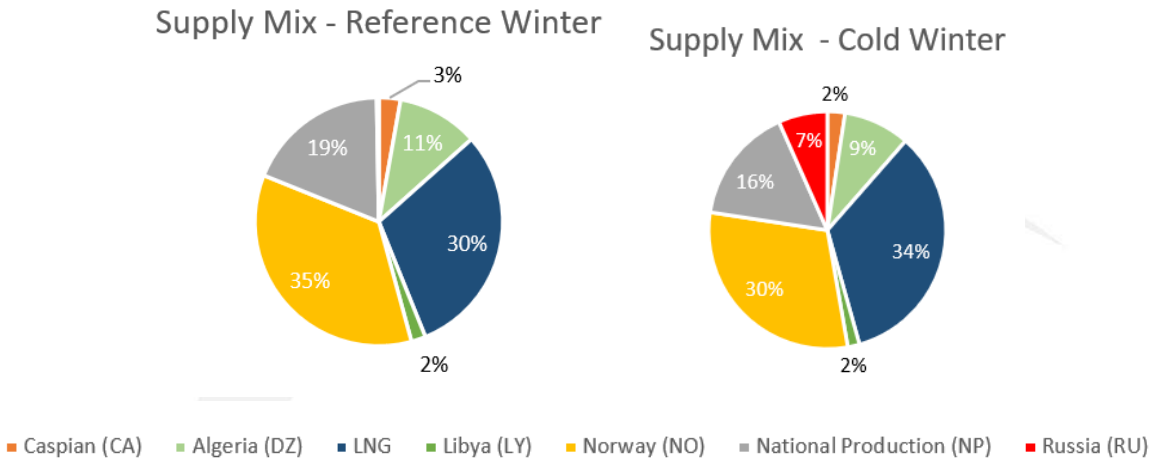


Figure 15. Supply and demand adequacy – Reference Winter and Cold Winter with 15% demand reduction.

Note: the supply assumptions (supply potential) are based on the supply observed in the last ten winters and should not be considered as a forecast. The actual supply mix will depend on market behaviour and other external factors.

4.2. Evolution of gas storages inventory level

Can the gas system reach a 30% storage level on 1 April 2023?

In Reference Winter scenario, the import potentials of the different supply sources allow the European storages to play their role as an additional source of flexibility and reach an inventory target level of 19% (55%[12] in the case of Spain) at the end of the winter[13]. Thus, storages can't reach the target of 30% storage level on 1 April 2023. The withdrawal capacities of the gas storages combined with the supply flexibility of imports is sufficient to cover the demand. In some countries, gas volumes can even be further injected until 1st November.

In Cold Winter scenario, storages are used at their maximum in some countries to meet demand and storages can't reach the target of 30%. At the end of winter storage level at European level is 1% of the Working Gas. All countries are in risk of depletion and injection period in next summer has to be anticipated to reach the target of 90%.

The withdrawal capacities of the gas storages combined with the supply flexibility of imports is not sufficient to cover the demand (9 to 10% of demand curtailment).

Figure 16 shows the evolution of the European aggregated UGS inventory level resulting from the assumptions defined in the previous chapters for the Reference Winter and the Cold Winter. The storage withdrawal capacities on 15 February are indicated for each scenario.

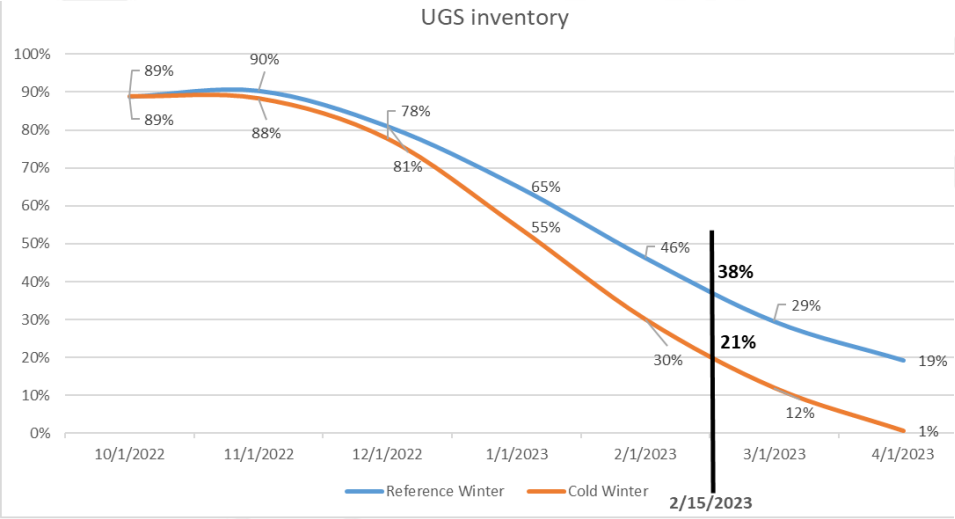


Figure 16. – Winter evolution of the aggregated UGS stock level.

% WGV	10/1/2022	11/1/2022	12/1/2022	1/1/2023	2/1/2023	3/1/2023	4/1/2023
Reference Winter	89%	90%	81%	65%	46%	29%	19%
Cold Winter	89%	88%	78%	55%	30%	12%	1%

Table 2. – Monthly EU inventory level evolution for Reference Winter and Cold Winter with a 30% inventory target

[12] Spanish TSO has confirmed that storages in Spain should not be used below 55% for Reference Winter and Cold Winter simulations. It can be used for particularly stressful situations as in the case of Algerian Disruption.

[13] Some European countries could be reserving part of their own gas stock constituted as strategic reserves to be used only for the purpose of satisfying their own demand. However, following a cooperative behaviour, the model assumes that countries could help themselves by fully sharing gas in the storages not considering actual constraints on the utilization of the strategic reserve. Therefore, storages can be depleted to avoid/reduce demand curtailment.

15% demand reduction

In case of 15% demand reduction in Reference Winter scenario, storages can reach 30% of storage level in all countries (55% in Spain). Consequence is that gas volume on 15 February will be higher for a high demand scenario and will help to lower the injection during summer 2023 (**figure 15**).

In Cold Winter scenario, storages can't reach 30% of storage levels at the end of winter. Some countries used their storages at the maximum to meet demand.

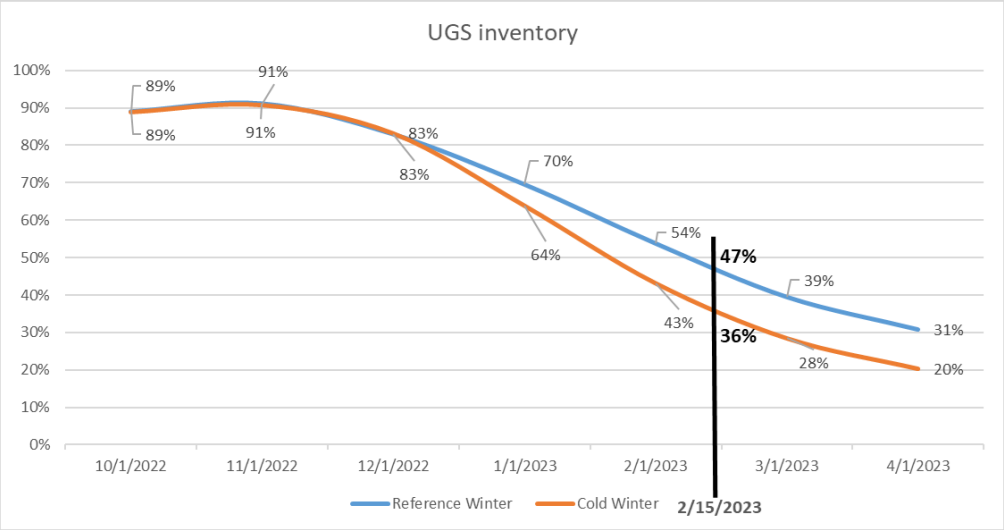


Figure 17. – Winter evolution of the aggregated UGS stock level with 15% demand reduction.

Impact of storage levels on the storage withdrawal capacities

It's possible is some countries to increase the use of the storages to decrease the supply imports. Nevertheless, the withdrawal capacities of the storages would be reduced as illustrated in **Figure 14** and the flexibility available from the storages in case of a peak day or a 2-week cold spell could be reduced at the end of the winter season. The withdrawal capacities are decreasing with the levels available in the storages. The more the storages will be used early to compensate imports, the less storages would have sufficient flexibility in case of peak demand at the end of the winter season.

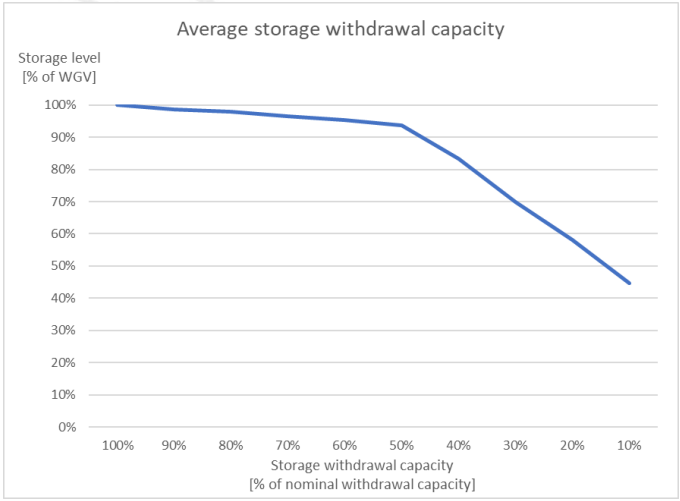


Figure 18. EU average withdrawal capacity for storages depending on their filling level

Interaction Imports / Storage use

During the winter season, the supply and demand adequacy is ensured by imported gas and gas withdrawn from the storages, the actual use of imports and storage are eventually determined by the decisions made by the market participants.

In **Figure 19**, the graph shows that the import needs are lower compared to previous winters due to high storage level (93%) at the beginning of Winter season. In Cold Winter scenario, supply mix is similar to Reference Winter scenario but with higher demand values, in cold Winter scenario, demand won't be satisfied.

In case of -15% demand values in Reference winter scenario, Russian supply can be fully minimised and in Cold Winter scenario, Russian supply is minimised as much as possible to the level we never observed in the past.

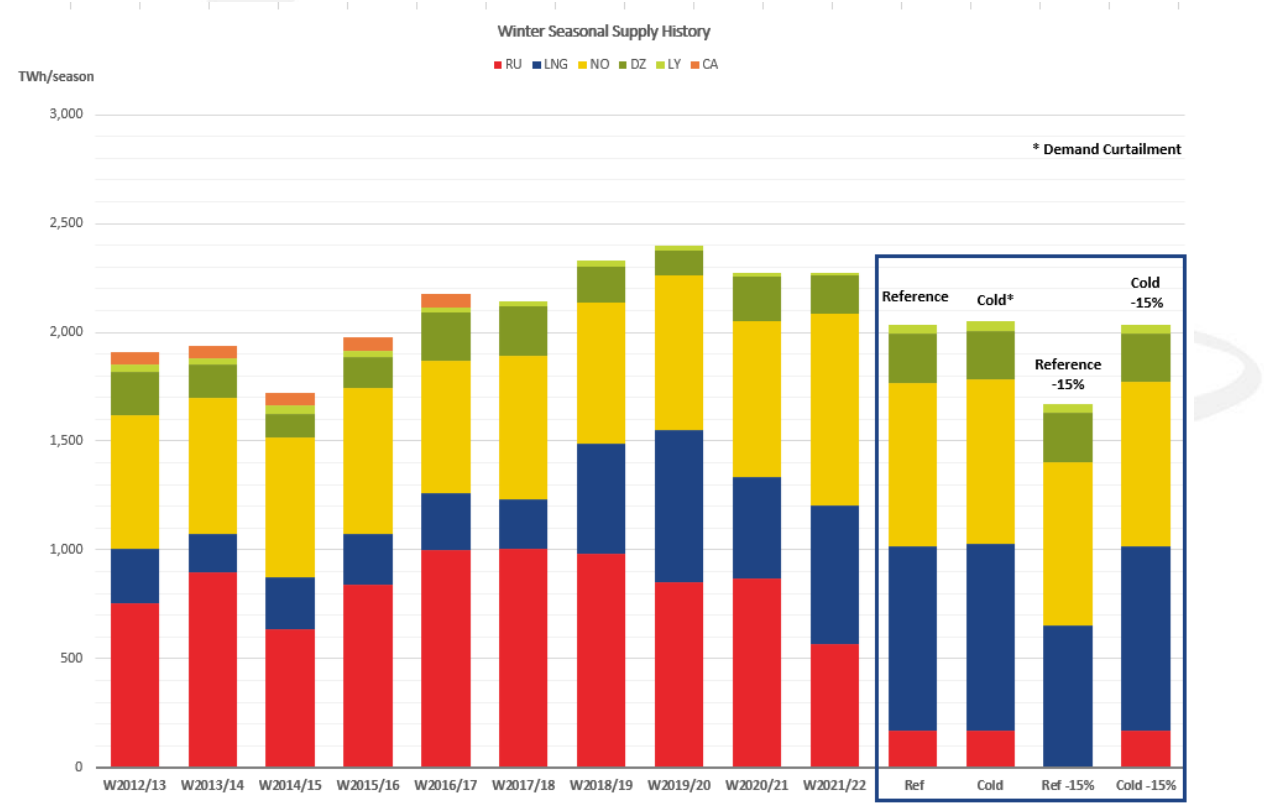


Figure 19: Winter Seasonal supply history and import needs for cold and reference winters (the supply mix is indicative and will be determined by the decisions of market participants)

In **Reference Winter scenario**, demand can be satisfied but, as shown in Figure 18, in Cold Winter scenario, where supply is at the maximum and not enough to meet demand.

Demand curtailment Cold Winter scenario

All European countries are facing 9 to 10% of demand curtailment without enough supply and despite a high storage level at the beginning of winter under the Cold Winter demand scenario. Thanks to the infrastructure interconnections, cooperation between countries allows to spread the demand curtailment equally in all Europe.

LNG sensitivity

Additional LNG during all the winter months could mitigate demand curtailment to 2 to 3% in most of the countries. While Spain, Portugal, France, Greece, Baltic states and Finland fully mitigate demand curtailment under the Cold Winter demand scenario.

15% gas demand reduction

Gas demand reduction gives more flexibility and fully mitigate demand curtailment.

Map 1 - Demand Curtailment (average) – Cold Winter – Monthly

4.3. Conclusion

The European gas system offers sufficient flexibility to ensure security of gas supply in Europe, and a continuing lower Russian gas supply during winter 2022/23 (compared to previous winter) can be offset by high levels of storage on October 1. No country is exposed to demand curtailment during an average day of a Reference Winter scenario. In case of Cold Winter scenario, all European countries are exposed to demand curtailment. Additional LNG supply or reduction of demand can mitigate demand curtailment and respectively, fully mitigate demand curtailment.

5. High demand situations

5.1. Initial storage volume

In addition to the assessment of the gas system to cope with the winter demand seasonality, Winter Supply Outlook 2022/2023 assesses 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. The Peak Day is assessed on 15 February and the 2-week Cold Spell between 15 and 28 February for both Refence Winter and Cold Winter scenarios as shown as example in Figure 20 for Reference and Cold Winter scenarios. The initial storages levels are extracted from the winter simulations for 14th February (end of day), for both Peak Day and 2-Week Cold Spell. The corresponding storage withdrawal capacities are then considered for the assessment (see Annex A).

In case of 15% demand reduction, a 15% demand reduction is applied for monthly demand, Peak Day demand and 2-Week Cold Spell demand.

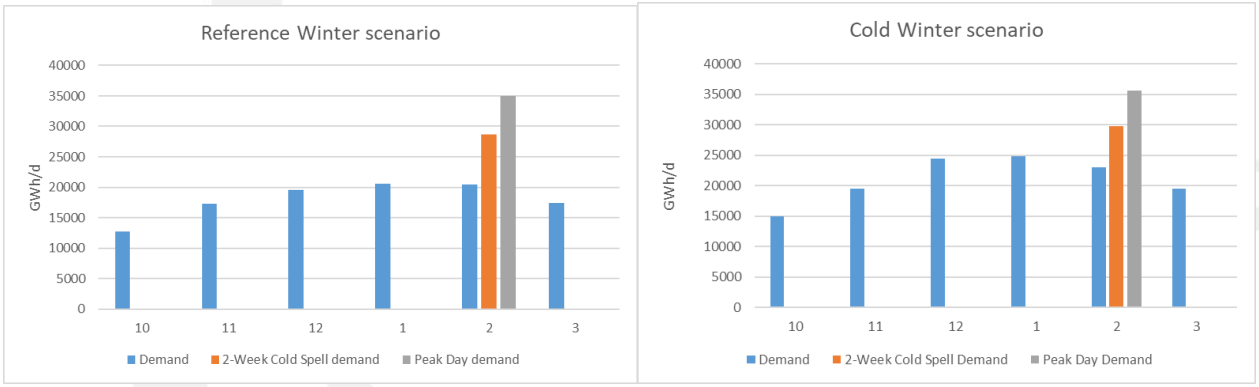


Figure 20.- 2-Week and Peak Day simulations in Reference and Cold Winter scenarios.

This year, ENTSOG introduced a sensitivity analysis for the initial storage level for the 2-Week cold spell and Peak day simulations. As for the first simulations, the initial level of the storages is extracted from the monthly simulations[14] results for both 2-Week cold spell and peak day simulations **figure 21**). Furthermore, ENTSOG ran 4 sensitivities for the initial storage levels: 50%, 40%, 30% and 20% of the Working Gas volume (WGV). That means that every storage in Europe is filled at 50%, 40%, 30% and 20% equally. With these sensitivities, the objective is to provide relevant information on the storage volume needed to meet high demand situations.

[14] The monthly storage inventories vary between the Member States and between the different storages.

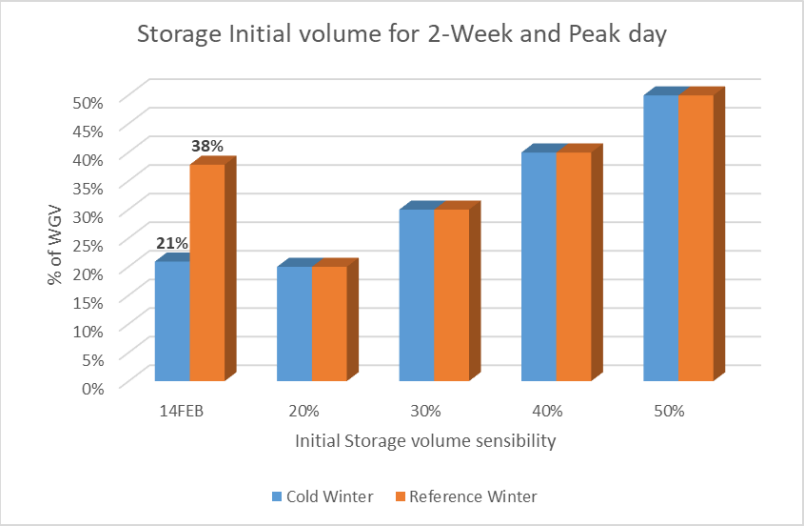


Figure 21.- 2-Week and Peak Day initial storage volume in Cold Winter and Reference Winter

Figure 22 shows that in case of -15% demand reduction, storage level on 14 February is increased to 47% in Reference Winter scenario and it increases to 36% in Cold Winter scenario. Demand reduction minimise the use of storages and allow storages to reach 30% target on 1 April in Reference Winter scenario and 20% in Cold Winter scenario.

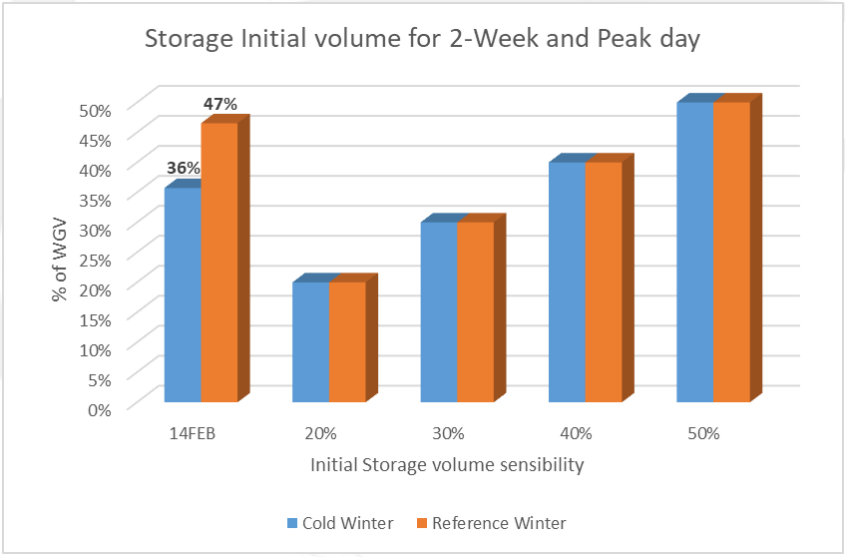


Figure 22.- 2-Week and Peak Day initial storage volume in Cold Winter and Reference Winter with 15% demand reduction

5.2. Supply mix

In high demand situations, all supply sources are used to higher levels. This additional supply comes from the sources with a high flexibility potential and is observed especially from the gas storages but also from LNG (see figure 23). Storage flexibilities are lower in Cold Winter scenario compared to Reference Winter because in Cold Winter scenario, initial storage levels, for the period considered, are lower compared to Reference Winter scenario. The other supply being equivalent (at the maximum), demand is not satisfied in Cold Winter scenario.

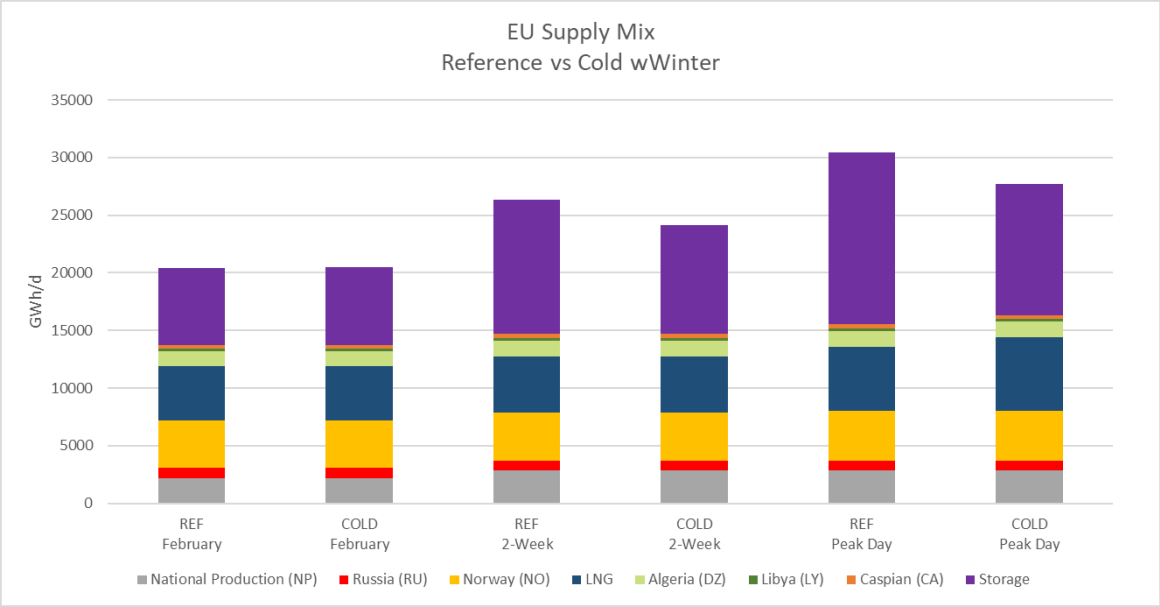


Figure 23. – Comparison of supply mixes in February vs high demand situations (LNG includes tanks withdrawal).

In Reference Winter scenario, during a 2-Week Cold Spell, an evolution between the 1st and the 2nd week can be observed due to the flexibility available from the LNG tanks and different withdrawal capacities from gas storage, the values in the graph are the average of these 2 weeks. Withdrawal capacities from gas storages depends on their level (see figure 14). In case of a Peak Day or 2-Week Cold Spell, storages are essential to cover the demand, while the other supply (except Russia) are at their maximum potential. In Peak Day, storage levels are not enough to meet demand.

And in Cold Winter scenario, in case of a Peak Day or 2-Week Cold Spell, storage volume is not enough to cover demand while the other supplies are at their maximum potential. With more gas in storages (50% to 30% of WGV in all European storages), demand curtailment is fully mitigated in 2-Week cold spell and mitigated in Peak Day.

In case of 15% gas demand reduction, **Figure 22** shows that in Reference and Cold Winter scenario, all suppliers are used at their maximum, and storages flexibility are used to meet demand (no demand curtailment).

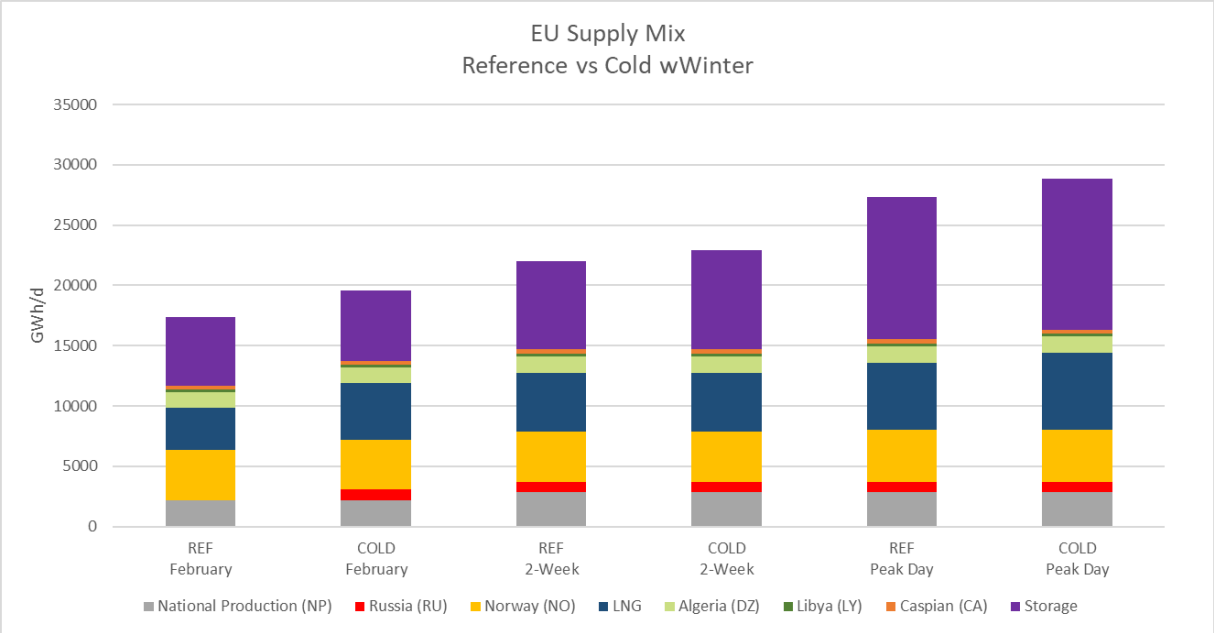
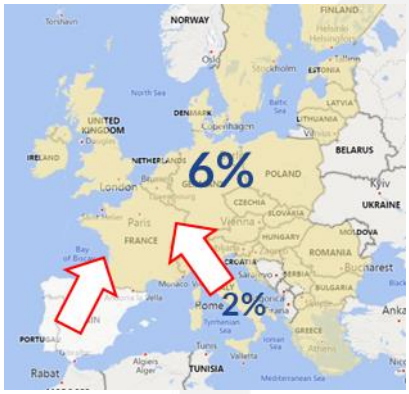


Figure 24. – Comparison of supply mixes in February vs high demand situations (LNG includes tanks withdrawal) – 15% demand reduction.

5.3. Demand

5.3.1. Reference winter scenario

- **2-Week Cold Spell**: No demand curtailment
- **Peak day:**



15 February initial storage level

With storage initial level extracted from Reference Winter simulation on 15 February (38% EU average), most of the Northern and Eastern countries are exposed to 6% of demand curtailment (2% in Italy). Infrastructure bottlenecks between Southern European countries and the north do not allow any solution to mitigate demand curtailment.

Map 2 - Demand curtailment – Peak Day – Reference Winter scenario

Initial storage volume sensitivity.

With 50% of WGV in each storage, demand curtailment is mitigated to 1 to 2% in most of the countries. Italy fully mitigates demand curtailment.

With 40% of WGV in each storage, demand curtailment is mitigated to 3% in most of the countries. Italy is mitigating demand curtailment to 1%.

With 30% and 20% of WGV in each storage, demand curtailment is mitigated to 7% and 14% respectively in all European countries.

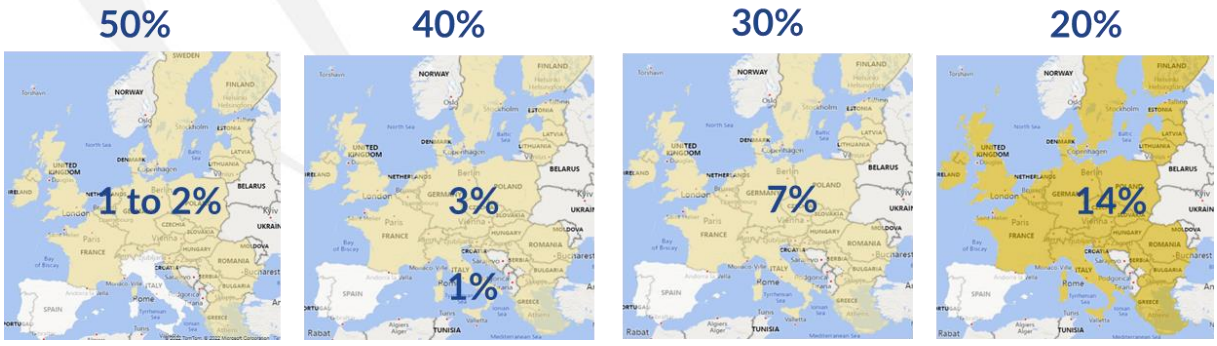


Figure 25. – Demand curtailment – Initial Storage sensitivity

LNG sensitivity

Additional LNG during all the months and specially for Peak Day mitigate demand curtailment to 2-3% in countries already curtailed.

15% gas demand reduction

Gas demand reduction gives more flexibility to storages and LNG supply and fully mitigates demand curtailment.

5.3.2. Cold winter scenario

> **2-Week Cold Spell**

15 February initial storage level

With storage initial level extracted from Cold Winter simulation on 14 February (21% in average), all European countries are exposed to 10 to 11% of demand curtailment.

Map 3 - Demand curtailment - 2-Week Cold Spell – Cold Winter scenario

Map **Initial storage volume sensitivity.**

With 50%, 40% and 30% of WGV in each storage, demand curtailment is fully mitigated. With 20% of WGV in each storages demand curtailment is mitigated to 8-9%.

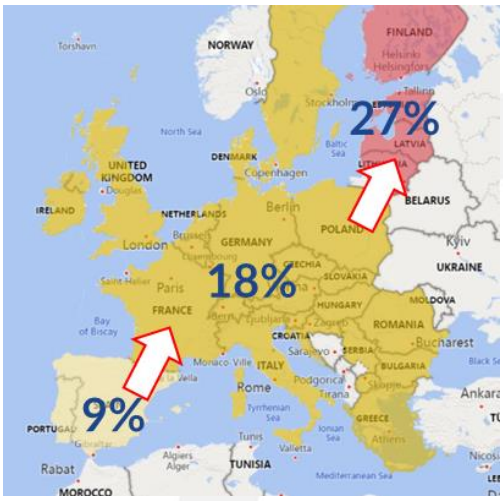
LNG sensitivity

Additional LNG during all the months and specially for this 2-Week Cold Spell fully mitigate demand curtailment in Spain and Portugal. Italy mitigates demand curtailment to 6% and Baltic states and Finland to 8%. Other countries are facing demand curtailment to 11%.

15% gas demand reduction

Gas demand reduction gives more flexibility and fully mitigate demand curtailment.

> Peak Day



Map 4 - Demand curtailment - Peak – Cold Winter

15 February initial storage level

With storage initial level extracted from Cold Winter simulation at 15 February, due to the Russian disruptions in the Baltic countries area, Baltic States and Finland are exposed to 27% demand curtailment.

Most of the northern, central, and southern European countries are exposed to 18% of demand curtailment. Bottlenecks between Southern European countries and the north do not allow any solution to mitigate demand curtailment. Spain and Portugal are not additionally exposed compared to monthly simulations (9% of demand curtailment).

Initial storage volume sensitivity

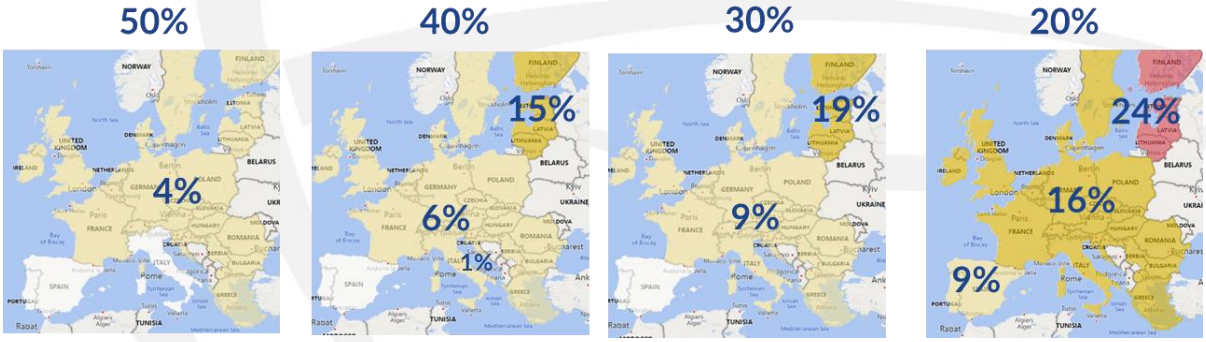


Figure 26. – Demand Curtailment - Initial level sensitivity

- Additional gas in storages (50% in all storages) before a high demand mitigate most of the demand curtailment to 4% in Europe. With additional LNG supply from LNG tanks, Spain, Portugal, and Italy fully mitigate demand curtailment. Baltic States and Finland face demand curtailment of 9-10%.
- With 40% of WGV in each storage, Baltic states and Finland are exposed to 15% of demand curtailment and the rest of the countries are exposed to 6% of demand curtailment (Italy 1%). Spain and Portugal fully mitigate demand curtailment.
- With 30% of WGV in each storages Baltic states and Finland are exposed to 19% of demand curtailment and the rest of the countries are exposed to 9% of demand curtailment. Spain, and Portugal fully mitigate demand curtailment.
- With 20% of WGV in each storages Baltic states and Finland are exposed to 24% of demand curtailment and the rest of the countries are exposed to 16% of demand curtailment. Spain and Portugal are not additional exposed compared to monthly simulations (9% of demand curtailment).

LNG sensitivity

Additional LNG during all the months and specially for this peak day fully mitigate demand curtailment in Portugal and Spain. Other countries with LNG terminal are already at the maximum LNG send out flow and can't improve the situation.

15% gas demand reduction

Gas demand reduction gives more flexibility and fully mitigate demand curtailment except in Baltic states and Finland (1%).

5.3.3. Reference scenarios conclusions

In Reference and Cold Winter scenarios, with limited supply from Russia, most of Europe is exposed to risks of demand curtailment in Peak Day demand situation only. With higher storage levels before Peak Day, risks of demand curtailment will be mitigated. Additional LNG supply will mitigate the risk of demand curtailment, but risks will still exist. With 15% demand reduction, risk of demand curtailment is fully mitigated except in Baltic states and Finland with 1% risk of demand curtailment.

6. Prolonged disruption of the supply from Russia

This section investigates the potential impact of the Russian supply routes disruption during Reference Winter and Cold Winter scenarios.

Russian supply routes disruption means no Russian imports to EU countries. Nevertheless, the following assumptions have been made: Serbia and North Macedonia will, in all cases, satisfy their demand using Turk-stream flows. Therefore, Turk-stream capacities have been updated to correspond to the demand values in Serbia and in North Macedonia. Serbia and North Macedonia do not cooperate in case of disruption of Russia, while all other countries cooperate.

Winter Supply Outlook assessment focuses on disruption scenarios during Reference and Cold Winter demand scenarios for winter season (6 months), Peak Day and 2-Week Cold Spell.

Scope of the assessment

Supply route disruption:

- Russian import routes

Demand cases

- Reference winter: normal demand for average winter temperatures
- Cold winter: 1-in-20 Monthly Average (October to March)
- 1-in-20 Peak Day during
- 1-in-20 2-week Cold Spell

Capacities

- Enhanced capacities based on the assumptions “no Russian gas” provided for Yearly Outlook 2022

Initial Storage levels for monthly simulations: 1 October 2022 storage level (extracted from AGSI platform).
Initial Storage levels for 2-Week Cold Spell and Peak Day simulations:

- 15 February storage level extracted from Monthly simulation. Monthly simulation are done with the following assumptions: Russia supply routes disruption, 1st October storage level, enhanced capacities.
- 50%, 40%, 30% and 20% of Working Gas Volume

6.1. Storage inventory

In Reference and Cold Winter scenarios, storages can't reach the 30% target. At 15 of February (initial storage value for high demand simulations), storage level will 29% and 21% in Reference and Cold Winter scenarios.

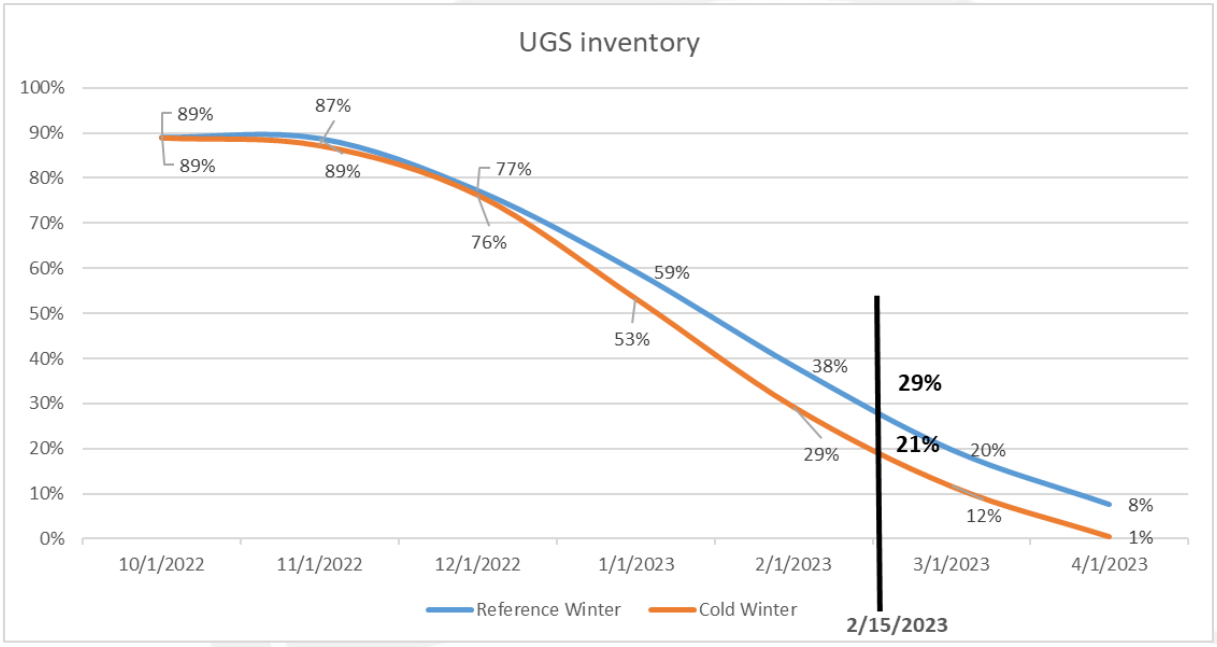


Figure 27. - Winter evolution of the aggregated UGS stock level.

In case of 15% demand reduction, storages can reach the 30% storage level target in Reference Winter scenario but reach only 8% in Cold Winter scenario. 15 February storage (initial storage value for high demand simulations), storage level will be 47% and 27% in Reference and Cold Winter scenarios.

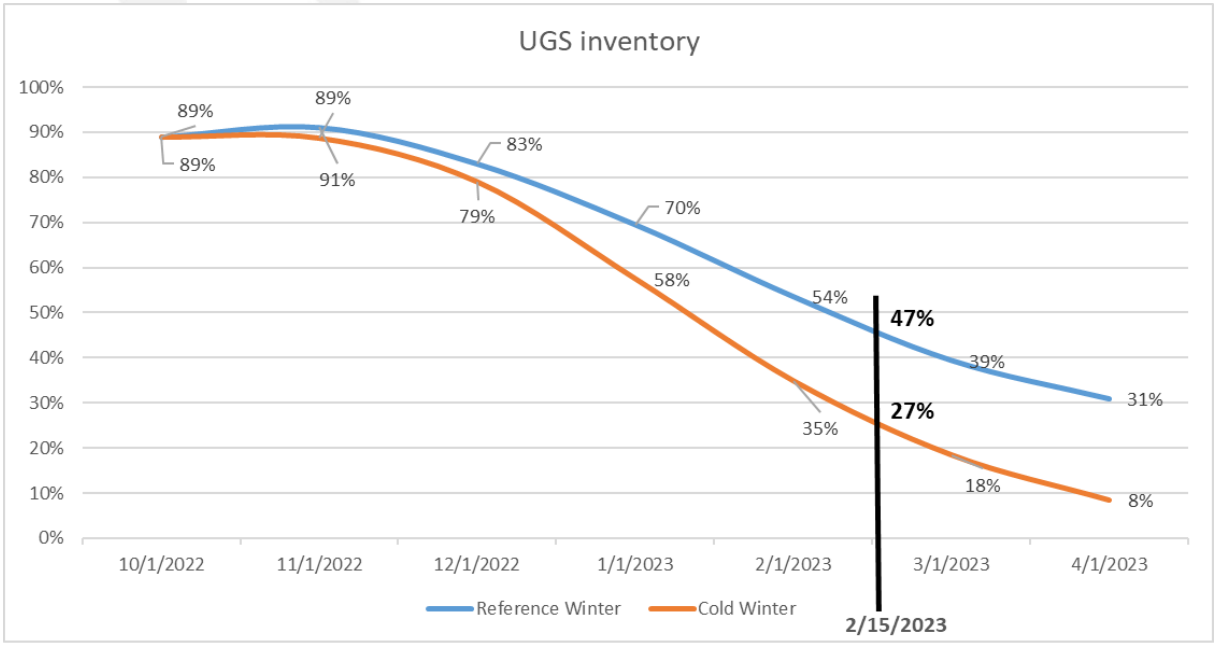


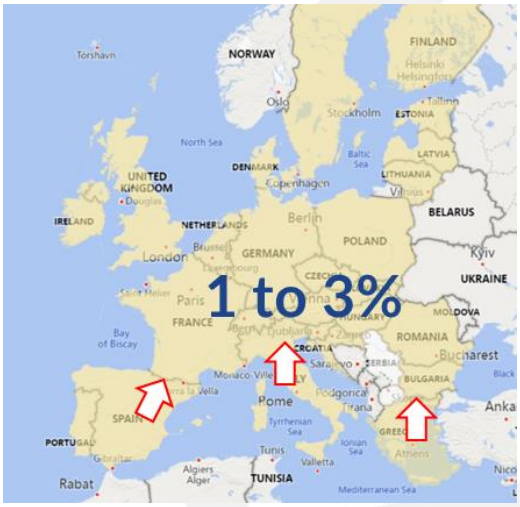
Figure 28. - Winter evolution of the aggregated UGS stock level with 15% demand reduction.

6.2. Reference winter

6.2.1. Monthly simulation

No Demand curtailment

6.2.2. 2-Week Cold Spell



Map 5 - Demand curtailment – 2W - Reference Winter

15 February initial storage level

All European countries are facing 1 to 3 % demand curtailment. Infrastructure bottlenecks between the south and the north do not allow better cooperation.

Initial storage volume sensitivity.

With 50%, 40% and 30% of WGV in each storages, demand curtailment is fully mitigated. With 20% all European countries are exposed to 8% of demand curtailment.

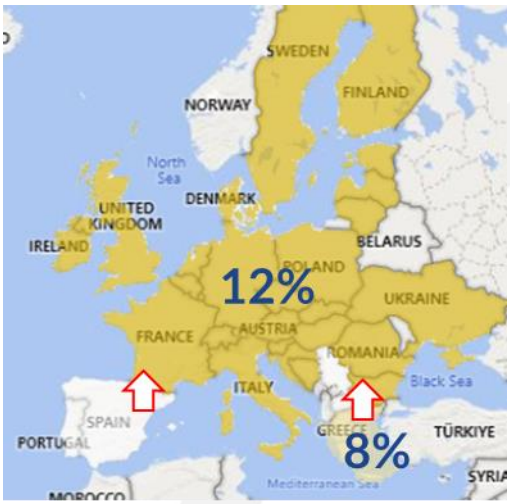
LNG sensitivity

With additional LNG for monthly and specially for the 2-Week Cold Spell, demand curtailment is fully mitigated in all European countries.

15% demand reduction

With 15% reduction of the demand, demand curtailment is fully mitigated.

6.2.3. Peak day



Map 6 - Demand curtailment – Peak – Reference Winter

15 February initial storage level

Most of the European countries are facing 12% demand curtailment. Greece is exposed to 8% and Spain and Portugal are not exposed thanks to LNG tanks available.

Initial storage volume sensitivity.

With 50%, 40% and 30% of WGV in all storages, demand curtailment is mitigated to respectively 3%, 5% and 9%. With 20%, demand curtailment increases to 17% in all countries except in Greece, Portugal and Spain.

LNG sensitivity

With additional LNG for monthly and specially for the Peak day, demand curtailment is fully mitigated for Italy, while for other countries to 8-10%.

15% demand reduction

With 15% reduction of the demand, demand curtailment is fully mitigated in Reference winter.

6.3. Cold winter

6.3.1. Monthly simulations

UGS inventory

With full Russia disruption, Storages are used at their maximum for additional supply, but it won't be enough to meet demand.

Without enough supply during these cold periods, all European countries are facing 12 to 13 % of demand curtailment in average during whole winter (all six months).

Storages are used at their maximum during these periods to mitigate demand curtailment.

Map 7 - Demand curtailment – Disruption of the supply of Russia - Monthly Simulations

LNG sensitivity

With additional LNG, demand curtailment is mitigated to 6-7% in all countries and Spain, Portugal, Finland and Greece fully mitigate demand curtailment.

15% reduction demand sensitivity

With 15% demand reduction, no country is exposed to demand curtailment and storages are used at the maximum in most of the countries. Only Spain (55%), Poland and Portugal can reach 30% and Belgium, France and the Netherlands are reaching 17%, 24% and 15%. Interconnection bottlenecks do not allow countries to cooperate to mitigate the storage use in the other European countries.

6.3.2. 2-Week cold Spell

15 February initial storage level

All European countries are facing 12% demand curtailment. Infrastructure bottlenecks between the south and the north do not allow better cooperation.

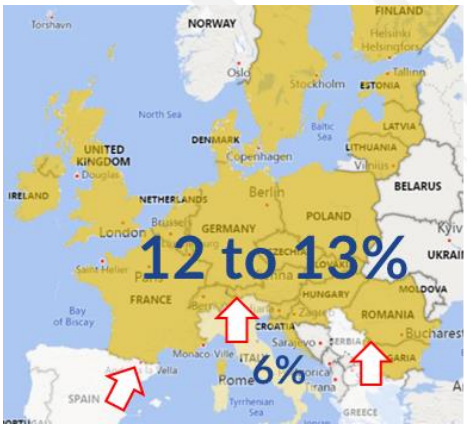
Map 8 - Demand curtailment – 2-Week cold spell - Cold Winter

Initial storage volume sensitivity

With 50% and 40% of WGV in each storages, demand curtailment is fully mitigated except in Romania (infrastructure bottlenecks with neighboring countries) for 40% exposed to 3% demand curtailment. With 30% all European countries and Romania are exposed to 2% of demand curtailment (Romania 14%). With 20%, all European countries are facing 10 to 11 % demand curtailment (Romania 22%).

LNG sensitivity

With additional LNG for monthly and specially for the 2-Week Cold Spell, demand curtailment is fully mitigated in Spain, Portugal and Greece only, and mitigated to 6% in Italy. Rest of European countries with already LNG send out interconnection at 100% can't improve the situation. And infrastructure bottlenecks between Southern and Northern countries don't allow to improve situation.

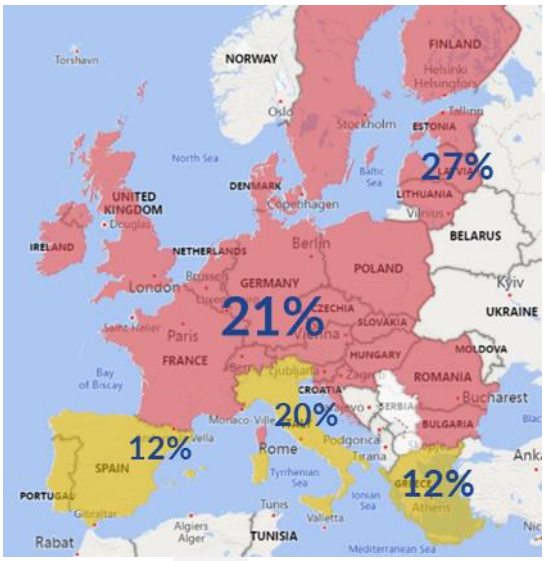


Map 9 - Demand curtailment – 2-Week cold spell - Cold Winter – LNG sensitivity

15% gas demand reduction

With 15% reduction of the demand, demand curtailment is fully mitigated except in Romania (7% of demand curtailment), due to infrastructure bottlenecks.

6.3.3. Peak day



Map 10 - Demand curtailment – Peak Day - Cold Winter

15 February initial storage level

Most of the European countries are facing 21% demand curtailment (20% in Italy). Baltic states and Finland are exposed to 27% of demand curtailment. Spain, Portugal and Greece are not additionally exposed compared to monthly simulations.

Interconnection limitations (bottlenecks) between Spain and France and Between Italy, Greece and France with neighbouring countries do not allow more cooperation.

Initial storage volume sensitivity

With 50%, 40% of WGV in each storages, demand curtailment is mitigated in almost of the countries to 5 to 7% (in Italy fully mitigated) and mitigated to 10% to 15% in Baltic states and Finland.

With 30% of WGV in each storages, demand curtailment is mitigated to 11% in most of the countries and to 19-20% in Baltic states and Finland. With 20% of WGV, most of the European countries are exposed to 18-19% and Baltic states, Finland and Romania are exposed to 23%.

LNG sensitivity

With additional LNG for monthly and specially for the Peak Day, Spain and Portugal are not exposed to demand curtailment, and Greece and Italy to 8% and 20% respectively. The other countries already LNG maxed out remain at the curtailment rate of 21%.

15% gas demand reduction

With 15% reduction of the demand, demand curtailment is mitigated to 4% for most of the countries, 13% in Baltic states and Finland (fully mitigated in France, Greece, Portugal and Spain).

6.4. Supply Route disruption conclusions

With less supply, European countries are facing risks of demand curtailment. But simulations have shown that additional LNG could mitigate the risk of demand curtailment across Europe. However simulations indicate that in order to fully mitigate demand curtailment in all European countries a European wide 15% gas demand reduction over the winter of 2022/2023 has to be realized.

7. Conclusions

The **main findings of the Winter Supply Outlook** are:

- **The gas storages significantly contribute to security of gas supply. On 1 October 2022, the EU storage level (89%) is one of the highest on record (985TWh), with different situations among countries.** This level is higher than the objective set for Member States to inject during the summer 2022 a minimum of 80% their capacity of storages, or 35% of their annual gas demand (when the storages Working Gas Volume allows it).

- **The gas infrastructure**, including projects to be commissioned over the upcoming winter, **allows for efficient cooperation** among the different Member States. **However,** under specific circumstances, **some possible supply limitations are identified.**

- **Reference case** (reflects the currently reduced Russian imports via Ukraine and Turk stream)

  In case of a normal winter (1-in-2 years) the gas system can ensure demand and supply adequacy. However, due to supply constraints, in case of a peak day most Member States are exposed to a limited risk of demand curtailment (6%). **In case of a cold winter (1-in-20 years) all European countries are exposed to a risk of 10% demand curtailment for the entire winter season** and of 10% to 27% in case of a peak day.

- **Russian supply disruption during a cold winter**

  In case of Russian supply disruption, **cooperation among all European countries can partially mitigate the risk of demand curtailment. Demand curtailment is limited to 13% on a daily basis.** Furthermore, in case of a peak day, the level of demand curtailment could be in a 12% - 27% range across Europe.

- **Additional LNG supply sensitivity**

In case of high demand situations and in a cold winter period, **provided that LNG is available on the global market, LNG imports could be increased up to 100 bcm (1150 TWh) over the winter**, significantly higher than the maximum volumes ever observed in winter (63 bcm / 700 TWh in winter 2019/2020)**.** In case of Russian supply disruption, this additional supply could reduce the risk of demand curtailment from 13% down to 6% across Europe during a cold winter. In case of a normal winter demand, **LNG import could increase up to 90bcm (1000 TWh] in case of total Russian supply disruption, even considering -15% demand reduction.**

- **Demand reduction assessment**

  Demand reduction of ca. -15% (as a result of organic reduction due to high prices or policy-based demand measures) **and Member States cooperation would**

efficiently mitigate the risk demand curtailment in EU countries during winter season, including during a Russian supply disruption. With -15% demand reduction, Europe would be exposed to 4% - 13% demand curtailment only during a peak day under Russian supply disruption.

Conclusions

- **With the current high storage levels, the gas infrastructure, including new projects to be commissioned in the upcoming winter, can efficiently reduce the dependence on Russian supply thanks to enhanced cooperation and additional LNG import capacities.**
- In case of Russian supply disruption, **cooperation among all European countries can partially mitigate the risk of demand curtailment. However, without demand reduction most countries would be exposed to significant risk of demand curtailment in case of a cold winter.**
- **An early and significant storage withdrawal** will result in low storage levels at the end of the winter season. This **will have a negative impact on the flexibility of the gas system** - and may increase exposure to demand curtailment in the second half of the winter season especially in case of cold and high demand events. Therefore, **it is important that all European storages continue to inject gas to the extent possible and that the European gas system continues to use imports to prepare for high demand situations as well as to ensure security of supply also in the following periods.**
- **Reminder from the Yearly Outlook 2022-2023 report:** Storages play an essential role to ensure security of supply. However, **without preparedness for Winter 2023/2024**, **the situation could deteriorate over the next gas year**: storages would be depleted in April 2023 and sites located in Central and South-Eastern Europe would be filled less than 15% on 1 October 2023, leaving the EU more exposed to risks of SoS for the winter 2023/2024.
- **The European gas system is also capable of cooperating with Energy Community Contracting Parties and other EU neighbouring countries** to mitigate the exposure to demand curtailment to the minimum possible extent,
- ENTSOG will monitor the evolution of the storage levels and import volumes throughout the Winter and report on the situation on regular basis.

Important: ENTSOG Winter Supply Outlook 2022/2023 is an assessment of the readiness the gas infrastructure to manage the upcoming winter season under different scenarios, but the assessment is not a forecast of the expected gas supply situation. 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.

8. Legal notice

The current analysis is developed specifically for this Winter Supply Outlook. 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 31st March 2022 will depend on market behaviour and global factors.

ENTSOG has prepared this Winter Supply Outlook 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 - Underground Storages assumptions

UGS deliverability curve

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.

Country	Withdraw availability when working gas volume is at xx% level											
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	1%	0%
AT	100%	99%	98%	97%	96%	95%	88%	80%	71%	63%	57%	0%
BEh	100%	100%	100%	100%	100%	100%	100%	20%	20%	10%	10%	0%
BGn	100%	100%	100%	100%	100%	100%	95%	85%	75%	66%	57%	0%
HR	100%	100%	100%	100%	100%	96%	80%	65%	48%	32%	14%	0%
CY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
CZ	100%	100%	100%	100%	100%	97%	80%	70%	50%	40%	20%	0%
CZd*	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DK	100%	100%	100%	100%	100%	100%	100%	100%	85%	33%	25%	0%
EE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
FI	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fra	100%	95%	90%	85%	80%	75%	66%	57%	48%	39%	30%	0%
FRn	100%	96%	91%	87%	83%	78%	72%	65%	58%	49%	38%	0%
FRnL	100%	100%	100%	100%	100%	100%	100%	100%	100%	93%	85%	0%
FRs	100%	97%	94%	91%	88%	85%	79%	73%	66%	56%	27%	0%
FRt	100%	100%	100%	100%	100%	100%	91%	74%	57%	39%	22%	0%
DE	100%	100%	100%	99%	99%	99%	86%	74%	60%	46%	31%	0%
GR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HU	100%	100%	100%	100%	100%	97%	95%	84%	72%	52%	40%	0%
IE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
IT	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
LV	100%	100%	100%	90%	80%	70%	50%	40%	25%	20%	20%	0%
LT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NL	100%	98%	96%	95%	93%	91%	81%	70%	59%	48%	37%	0%
PL	100%	100%	99%	98%	97%	90%	84%	72%	65%	51%	29%	0%
PT	100%	100%	100%	100%	85%	85%	85%	85%	85%	85%	85%	0%
RO	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
RS	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
SK	100%	99%	97%	96%	93%	88%	82%	74%	65%	55%	44%	0%
SI	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ES	100%	80%	72%	67%	63%	60%	55%	50%	45%	40%	40%	0%
SE	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
UK	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%

* UGS Dolni Bojanovice located in Czech Republic but only connected the Slovak market

Table 3. - UGS deliverability curves.

Annex B - Data for Winter Supply Outlook 2021/22

Indigenous Production

GWh/d	OCT	NOV	DEC	JAN	FEB	MAR	2-Week	PEAK
National Production	2145.625	2153.9	2204.401	2185.25	2180.839	2192.247	2824.468	2824.468

Error! Not a valid link. **Table 4. – Supply assumptions indigenous production**

Supply assumptions (maximum per period)

GWh/d			DZ	LY	NO	RU	LNG	LNG*	CA
Winter Period	Max on Whole Winter		1,261	208	4,823	5,530	4,174	4,174	375
	Max per 30 days		1,336	247	5,009	6,084	4,745	4,745	375
High Demand	2-week Cold Spell	Week 1	1,348	190	5,033	5,939	***	***	375
		Week2	1,348	190	5,033	5,939	4,956	4,956	375
	1-day Design Case		1,388	236	5,118	6,102	5,554	6,357	375

** LNG sensitivity for Cold Winter (in line with SOS report only for High Demand)*

Table 5.– Supply assumptions imports.

LNG Tank flexibility

The LNG tank flexibility represents the difference between the actual fill level of the LNG tanks and the minimum operative tank level; it can be send-out as extra LNG during the 2-Week Cold Spell and 1-Day Peak. These figures represent a weighted average of the LNG terminals of each area. ENTSOG has used the LNG tank flexibility as made available by the LSOs via GLE.

Country	LNG Tank Flexibility
Belgium	35%
Spain	51%
France North	76%
France South	58%
Greece	47%
Italy	15%
Lithuania	47%
Netherlands	35%
Poland	59%
Portugal	43%
United Kingdom	64%

Table 6.-LNG tank flexibility

Reference Winter Demand

NAME	OCT	NOV	DEC	JAN	FEB	MAR	2-Week	Peak
AT	255.836686	358.971413	389.723762	412.485408	373.094474	336.476034	437.4	494.1
BA	6.83	8.21	10.58	11.77	10.22	9.55	12.69	14.32
BEh	471.554403	605.594317	672.241362	690.519233	672.079649	604.223927	1091.098232	1219.913864
BEl	66.32189	89.868299	106.262818	107.416239	106.976093	92.146677	206.608796	249.873164
BGn	78.15	96.2	120.19	137.88	120.59	119.65	135.54	172.1
CH	102.52	142.24	165.13	174.3	142.48	130.32	220	230
CZ	259.25	302.61	378.63	421.19	432.35	314.86	592.1	727
DE	1822.4	2717.08	3080.06	2889.06	3672.55	3092.27	4542.86	5575.69
DEl	372.28	554.47	628.38	589.49	749.03	630.87	926.26	1136.57
DK	54.537096	72.93	81.270967	80.530645	79.596428	65.120967	120.53	187.85
EE	10.5	13.7	17.5	19.7	18.6	18.3	35	45
ES	926.304582	1062.055532	1184.955039	1251.947731	1220.095141	1040.677788	1653.659515	1945.481783
FI	27	35	40	45	45	35	80	110
FR	1126.25	1745.05	1945.86	2155.24	1890.9	1616.1	3000	3651
FRnL	94.423034	151.736496	170.810767	149.616674	128.498505	109.595142	248	300
GR	181.180454	220.358324	247.978865	297.238408	256.94637	221.598768	313.142028	354.704759
HR	90.788463	122.355016	107.869277	124.44441	124.258456	98.906627	132.119671	160.114312
HU	317.8	438.3	528.6	569.2	497.3	416.7	620	650
IE	157.47	156.63	200.8	185.75	205.64	166.69	221.235099	240.756388
IT	1739.956457	2624.191496	2946.24022	3315.676139	3070.613904	2496.919334	3778.862504	4652.423339
LT	65.11	75.01	76.02	76.3	78.51	66.18	122.43	140.3
LU	22.67	31.27	30.9	38.98	34.36	30.1	49.2	60.1
LV	32.61	42.02	47.47	58.22	54.41	43.04	91.89	116.5
MK	8.51	12.31	13.61	15.21	15.9	13.95	16.8	19
NL	985.863365	1259.598543	1393.983819	1501.988135	1412.642908	1228.804625	3195.883927	3869.086766
PL	537.429298	650.613714	780.880836	743.022041	678.161511	605.782764	868.528847	1134.241446
PT	186.19	184.6	160.75	178.71	167.79	160.03	230.87	295.15
RO	295	370	480	530	450	380	565	635
RS	61.63	61.63	61.63	61.63	61.63	61.63	95.06	103.76
SE	17.883837	22.082358	32.325513	24.660964	21.316254	18.165836	38.06	45.74
SI	27.1	38.3	37	41.3	39.4	36.3	45	52
SK	132.484	179.493	222.448	259.755	225.485	177.573	334.569493	363.431942
UK	1812.039032	2490.790488	2799.271269	3035.919749	2994.342483	2624.036247	4194.54	5563.393
UKn	42.52	48.97	48.73	58.25	52.33	52.34	68.95	95.63

Table 7.– Demand forecasts in Reference Winter

Gas zones: Germany (GASPOOL and NCG are now considered in one market zone in H-Gas, DE and L-Gas, DEl), French (FRnL: GRTgaz Nord L-gas), Belgium (BEh: H-gas zone, BEl L-gas zone) UKn (Northern Ireland), Bulgaria (BGn)

Cold Winter Demand

NAME	OCT	NOV	DEC	JAN	FEB	MAR	2-Week	Peak
AT	302.12	335.23	440.48	414.02	412.02	339.1	437.4	588.36
BA	4.91	7.16	10.32	12.86	8.03	5.98	13.7	17.78
BEh	680.914284	781.047182	981.672474	984.677407	974.35305	782.26398	1136.433115	1219.913864
BEl	162.368332	178.465192	216.695236	216.695236	216.695236	182.489407	226.755774	249.873164
BGn	87.61	119.65	125.67	140.77	140.44	137.3	156.2	156.2
CH	90.990763	153.649043	185.410058	159.248092	202.838287	159.606174	220	220
CZ	269	345	436	440	478	352	592.1	727
DE	2124.14	2830.55	3769.91	3941.67	2850.61	2585.91	4542.86	5575.69
DEl	433.73	577.58	768.86	803.83	581.66	527.76	926.26	1136.57
DK	73.048836	105.516633	115.888552	131.304493	127.7246	109.722502	139.92	215.41
EE	16.31	21.85	39.38	37.25	31.02	35.9	56.7	70.35
ES	1030.84	1257.39	1281.08	1291.92	1269.48	1135.31	1653.659515	1945.481783
FI	30	40	47	51	53	37	100	150
FR	1211.131	1865.238	2521.488	2265.562	2106.647	1725.904	3000	3651
FRnL	128.619	185.202	238.752	200.808	167.913	135.036	248	300
GR	153.211407	184.846062	211.747974	220.968121	174.903515	190.326809	313.142028	354.704759
HR	80.809655	103.58041	129.225011	129.967805	159.33732	90.336338	205.198324	223.161573
HU	361.9	468.3	600.1	645.7	658.5	450.8	700	760
IE	144.254849	163.759921	189.892042	199.202875	197.623745	185.65704	242.1	298
IT	2154.77426	2734.910438	3635.879078	3606.617507	3389.23659	2899.219352	3778.9	4652.423339
LT	75.92	82.91	95.43	99.52	106.03	85.43	128	151
LU	46.82	46.28	56.97	53.87	53.44	46.61	49.2	60.1
LV	59.478184	78.694423	79.036267	91.529086	116.50921	102.388956	91.89	116.5
MK	8.51	12.31	13.61	15.21	15.9	13.95	16.8	19
NL	920.510209	1459.58358	1901.775761	1896.350607	1856.681181	1484.910292	3195.883927	3869.086766
PL	612.472674	741.537911	829.777048	888.600429	902.408095	781.788976	1008.960122	1134.241446
PT	206.43	209.11	205.96	220.64	211.24	211.18	245.43	295.15
RO	351	536	526	559	635	483	716	772.5
RS	61.63	61.63	61.63	61.63	61.63	61.63	95.06	103.76
SE	24.107381	40.617323	41.541027	58.608863	48.736914	37.672631	64.93	77
SI	33.72	40.86	43.49	49.65	47.1	40.16	61.18	67.98
SK	156.43	204.71	268.67	281.39	252.8	229.11	441.2	496.4
UAe	335.47148	335.47148	335.47148	335.47148	335.47148	335.47148	416	416
UK	2450.07	3164.58	3968.61	4325.36	4107.1	3551.24	4403	5563.393
UKn	61.41	66.35	68.33	73.72	72.38	68.26	73.72	95.63

Table 8.- Demand forecasts in SOS Cold Winter[15].

Gas zones: Germany (GASPOOL and NCG are now considered in one market zone in H-Gas, DE and L-Gas, DEL), French (FRnL: GRTgaz Nord L-gas), Belgium (BEh: H-gas zone, BEl L-gas zone) UKn (Northern Ireland), Bulgaria (BGn)

Exports to Ukraine

Country	OCT	NOV	DEC	JAN	FEB	MAR	2-Week1	2-Week2	DC
UAe	335	335	335	335	335	335	416	416	416

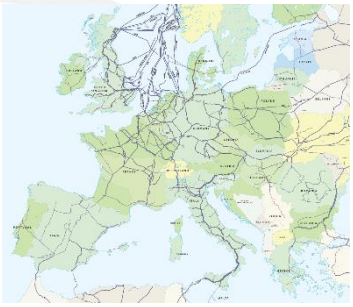
Table 9.-Exports to Ukraine.

[15] The Cold Demand for Germany has been updated due to the decrease of Las demand and the increase of Hgas demand.

Annex C – Modelling approach

The simulations consider the existing European gas infrastructure as of 1st October 2021.

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.



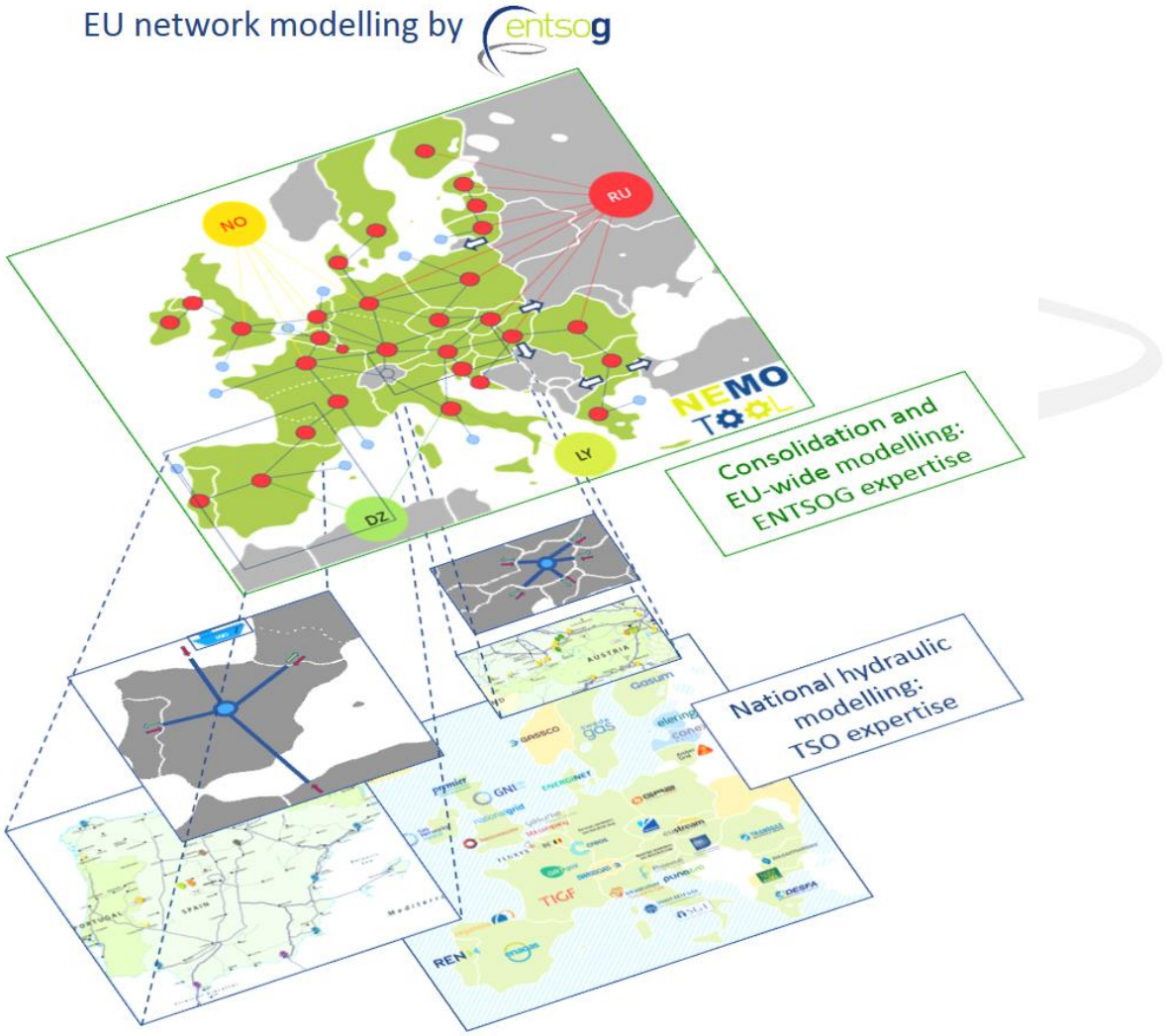


Illustration 1: Entsog model overview

In all cases, 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.

Underground gas storages:

Dynamic modelling is applied for the underground gas storages (UGS), taking into account the influence of UGS inventory on withdrawal deliverability by using withdrawal deliverability curves. These deliverability curves[16] have been revised in cooperation with GSE.

LNG supply:

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.

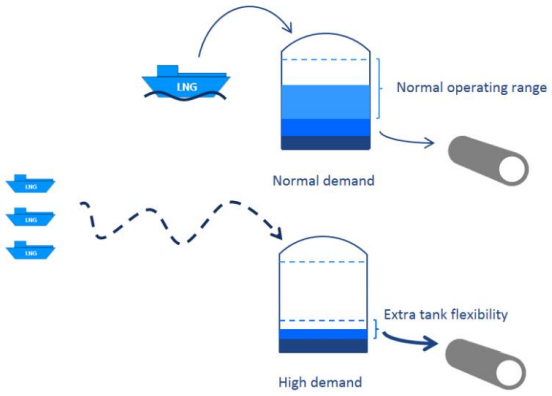
- First week, the model will determine the LNG send-outs using the level of LNG supply reached in LNG terminals for February as a result from the whole winter simulation, plus additional LNG that can be taken from the tanks.
- Second week allows importers to access a relevant number of cargos, so that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



[16] See Annex A

Abbreviations

CR	Curtailment Rate
DC	Design Case
LSO	LNG System Operator
RF	Remaining Flexibility
SO	Supply Outlook
TSO	Transmission System Operator
UAe	Exports to Ukraine
UGS	Underground Storage
WGV	Working Gas Volume
WSO	Winter Supply Outlook

> Supplies

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

> Countries

AT	Austria
BE	Belgium
BGn	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

- Low calorific gas zones:
  - **DEl** Germany L-gas
  - **BEl** Belgium L-gas
  - **FRnL** French Nord L-gas