entsog
european network
of transmission system operators
for gas

ENTSOG
WINTER SUPPLY OUTLOOK

2021/2022

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 2021 to March 2022). 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].

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

- **The European indigenous production continues to decrease year-on-year,**
- **On 1 October 2021, the EU storage level (75%) is one of the lowest in any ENTSOG Winter Supply Outlook (831 TWh), with different situations among countries, for two main reasons:**
  - Record high use of storage flexibility during winter 2020/2021, resulting in a low level of storage (336 TWh) at the beginning of the injection season,
  - Low injection during Summer while observing unusual high gas prices,
- **The European gas infrastructure offers sufficient flexibility to ensure security of gas supply in Europe, provided gas is imported by the market on similar volumes as in recent years,**
- **It can be noted that the EU gas infrastructure has been fully operational and functioning during the Summer season and this status is expected to be maintained for the Winter season 2021/22.**
- **However, in case of a cold Winter, the gas market would need to increase gas imports from pipelines and/or LNG from 5% to 10% higher than the maximum volumes observed in the recent years,**
- **It is important to emphasize that an early and significant withdrawal from storages will result in low storage levels at the end of the Winter season. This will have negative impact on the flexibility of the gas system – and can increase the exposure to demand curtailment in the later part of the Winter season.**
- **South-Eastern Europe has significantly reduced its exposure to demand curtailment following the commissioning of new infrastructure.**
- **However, countries within the risk groups of Ukraine and Baltic States/Finland can be exposed to demand curtailment in case of extreme temperatures combined with import route disruptions from Ukraine or Russia.**

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

- **The European gas system is also capable of supplying Energy Community Contracting Parties and other EU neighbouring countries with significant volumes of gas,**
- **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 2021/2022 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.

1. Introduction

This edition builds on previous Winter Supply Outlooks as well as on the supply assumptions of the Security of Supply Simulation Report 2017 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.

Safety measures implemented in Europe and other continents, as a response of an extremely rapid spread of the COVID-19 disease, are affecting global and local economy. 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 visions: winter period and high demand situations

As for previous reports, Winter Supply Outlook 2021/22 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. 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.
Given the exceptional situation of the storage level on 1 October 2021, ENTSOG additionally performed a sensitivity analysis of the storage level at the end the winter season to assess the interaction between imports and storage levels in case of a lower storage level than usually observed.

Observations of the supply situations in the past show that the underground gas storages are the most important flexibility assets in order 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 aggregated inventory level of underground gas storages levels on 1st October is 831TWh.

Winter Supply Outlook relation to SoS simulation report:

Consistency with SoS simulation report: The results obtained in the Union-wide Security of Supply Simulation Report 2017 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 TYNDP 2020 Scenario Report[2] 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.
Assessment of supply disruptions: in line with the previous editions of the Winter Supply Outlook, this report assesses the impact of the main supply disruption scenarios defined in the SoS EU Regulation 2017/1938. The WSO assesses the impact of supply disruptions occurring during a Peak Day or a 2-Week Cold Spell. The assessment of long supply disruptions on the EU gas system is available in the EU-wide SoS simulation report on ENTSOG website[3].

2. Assumptions

The simulations consider the existing European gas infrastructure as of 11th May 2021 (when data collection started) and actual gas storage working gas volumes at the end of September 2021.

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

The Winter Supply Outlook 2021/22 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 shippers' decisions.

2.1. 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 report[4] and represents a historical high demand winter (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.

[2] https://www.entsos-tyndp2020-scenarios.eu/
[3] https://www.entsog.eu/security-of-supply-simulation
[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

For comparison purpose, **Figure 1** shows the European aggregated demand for the Reference Winter and Cold Winter compared to the historical demand over the last 10 winters.

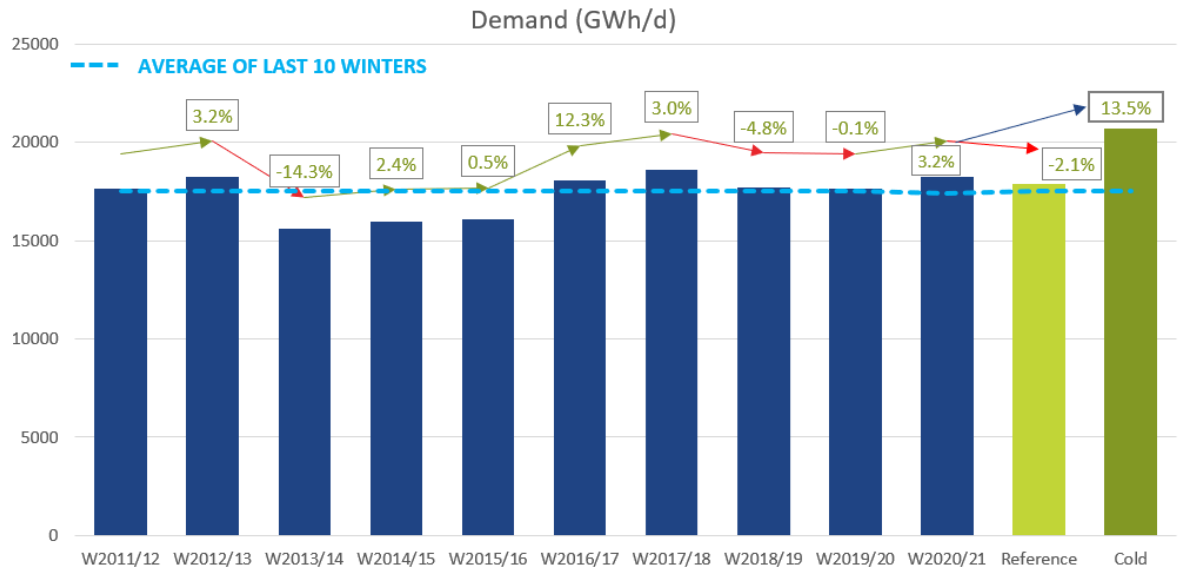

Figure 1. - European seasonal demand in the last 10 winters compared with the two visions.

The Reference Winter demand is slightly lower than the one observed during the last winter (-2.1%) which was considered as cold. The Cold Winter demand is higher than the last ten winters, and shows an overall demand of 13.5% higher than the total demand of winter 2020/21.

Furthermore, Reference and Cold Winter are higher compared with average demand of last 10 winters, 2.7% and 19% respectively.

2.2. 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, occurring on 15 February
1-in-20 2-Week Cold Spell	High demand during a 14-day period in February (Cold Spell), occurring 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 10 winters, and **Figure 3** shows the European aggregated Peak Day demand.

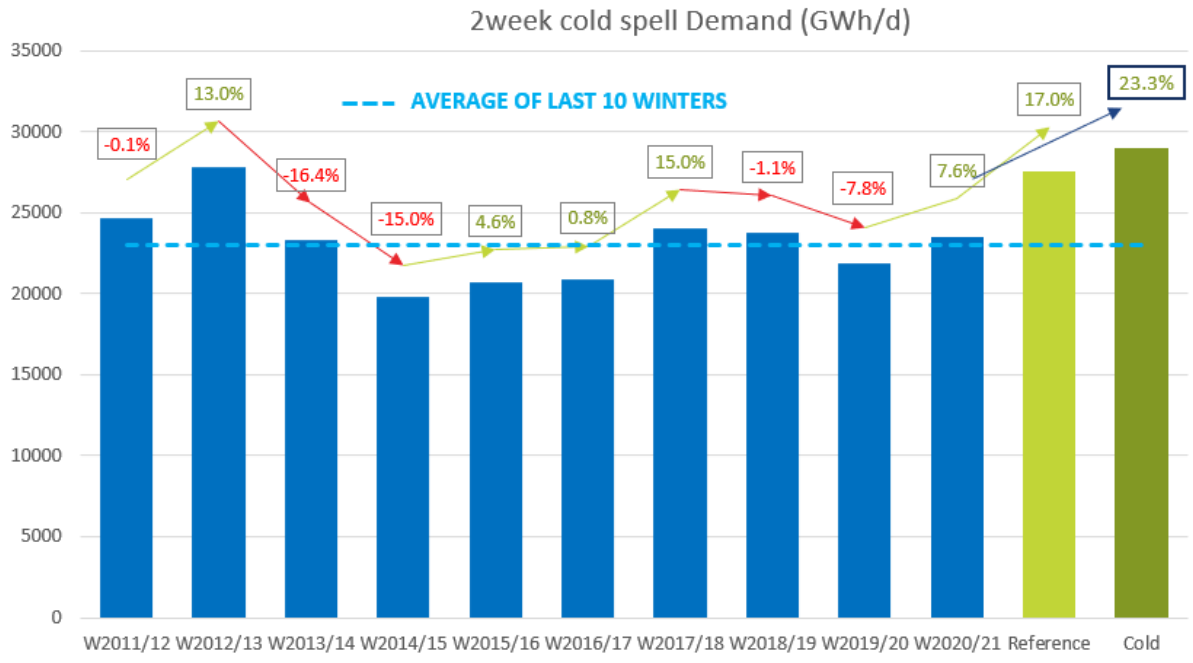

Figure 2.- European 2-week demand history (2011 – 2021) compared with Reference and Cold winter 2-week demand.

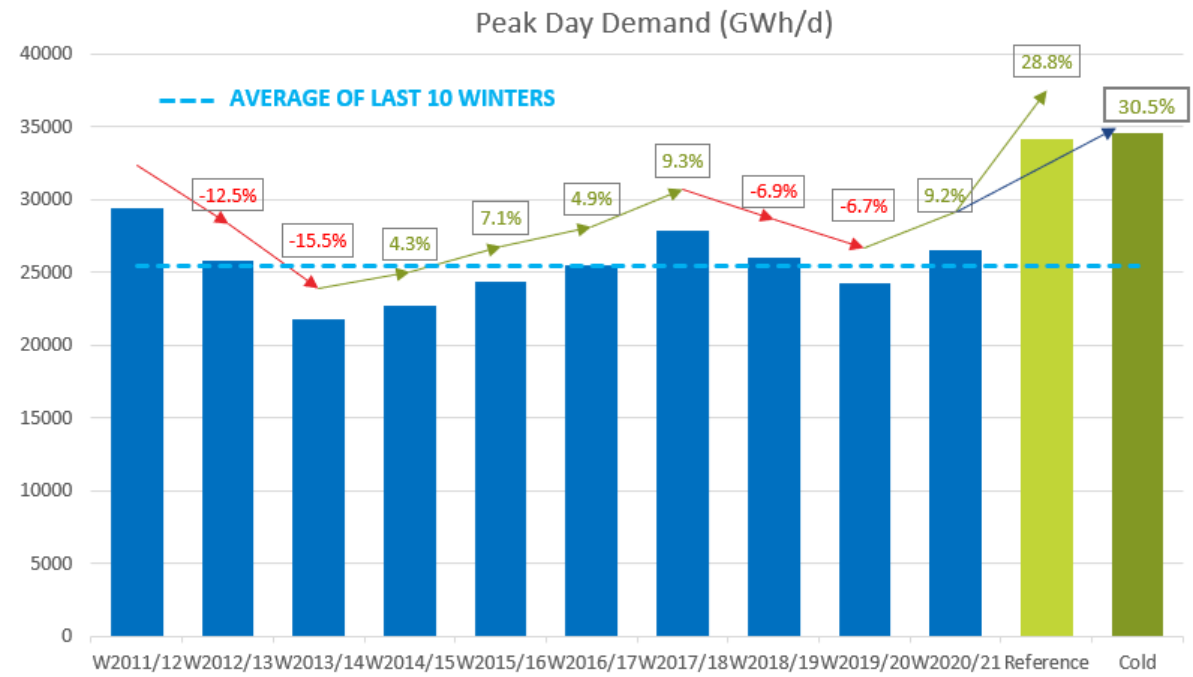

Figure 3.- European Peak Day demand history (2011 – 2021) compared with Reference and Cold winter peak demand.

The 2-Week Cold Spell demand for Reference Winter is significantly higher than the one observed during the last winter (+17%) or the average of the last ten winters (+19.6%), 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 23.3% higher than in winter 2020/21.

Due to its probability of occurrence (1-in-20 years), the Peak Day demand for Reference Winter is higher than the one observed during the last winter (45.0%) and higher than the average of the last ten winters (+28.8%). In case of a Peak Day in a Cold winter the demand could be 30.5% than in winter 2020/21.

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

2.3. Supply

A new source of gas is available for Europe since last winter with Trans Adriatic Pipeline commissioned in November 2020 which connects Azerbaijan with Greece and Italy.
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).

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[6]. 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[7]</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.

[6] 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

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

Figure 4 shows historical seasonal supply for the last ten winters for pipeline imports and LNG imports. Note that for the first time, Caspian gas is indicated in the graph.

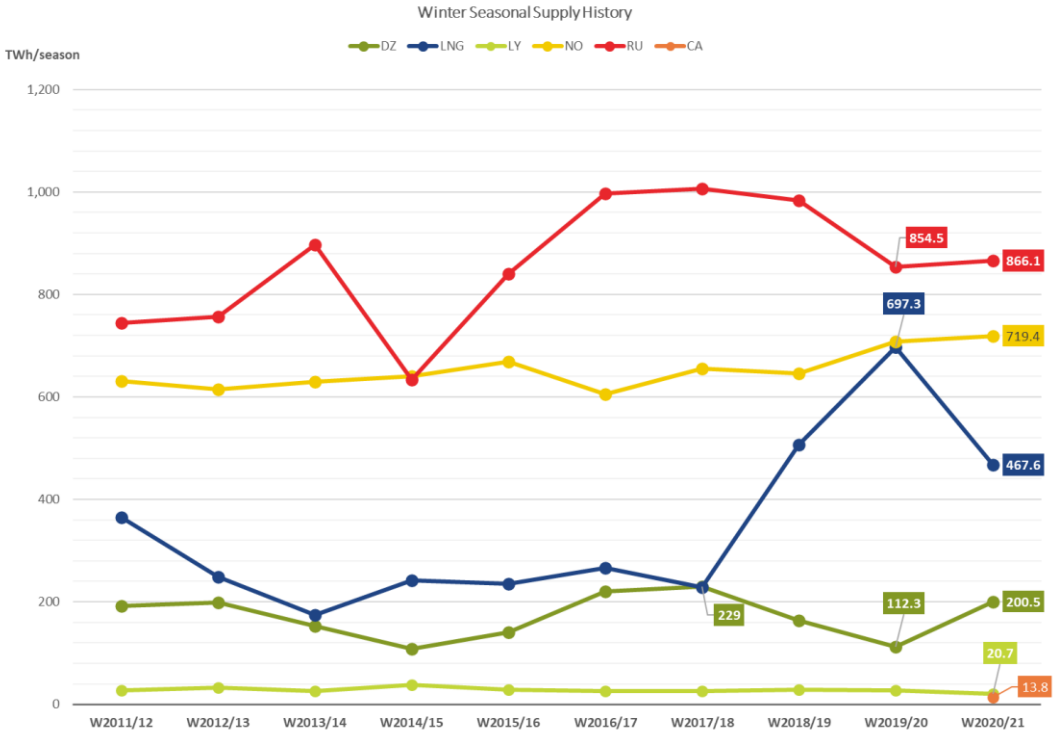

Figure 4.- Winter supply limitation.

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 Russian supply.

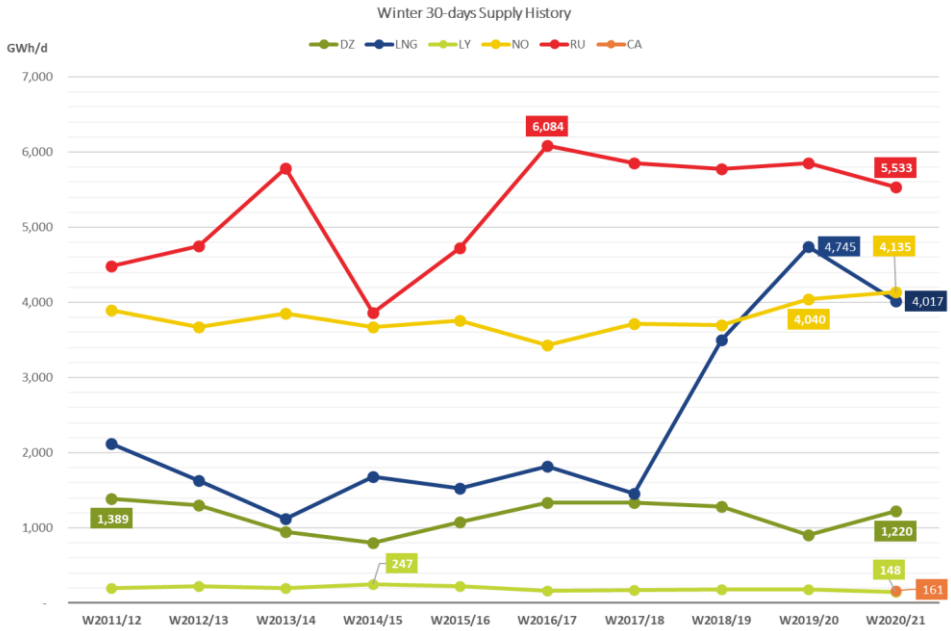

Figure 5.- 30-days supply limitation.

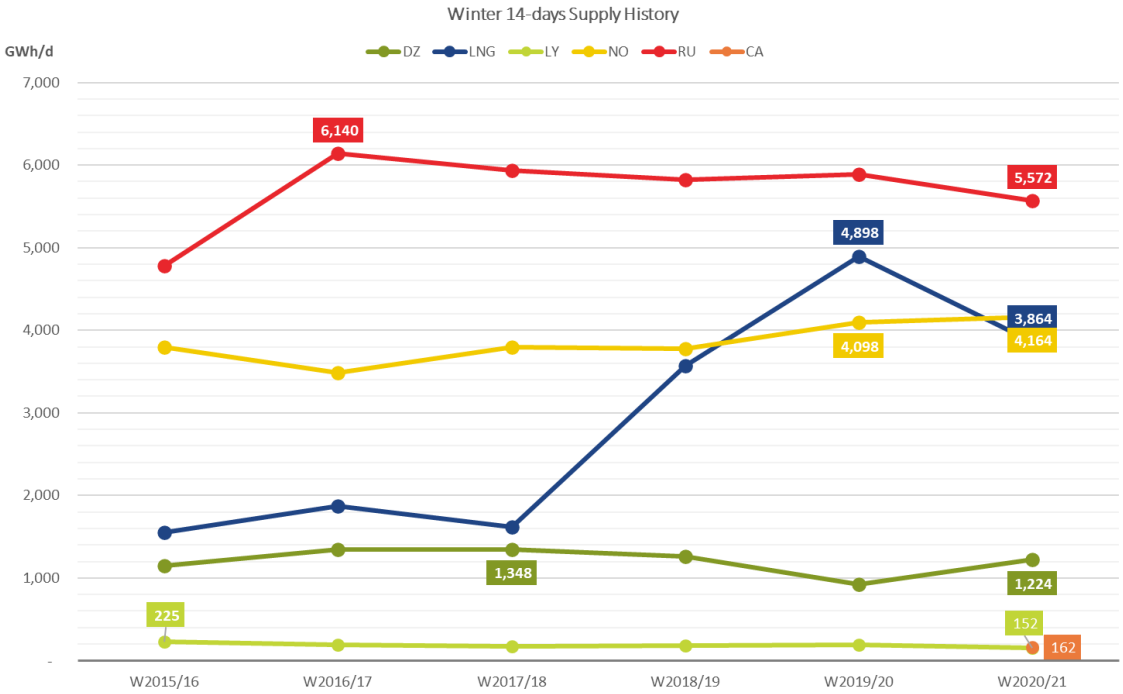

Figure 6.- 14 days supply limitation.

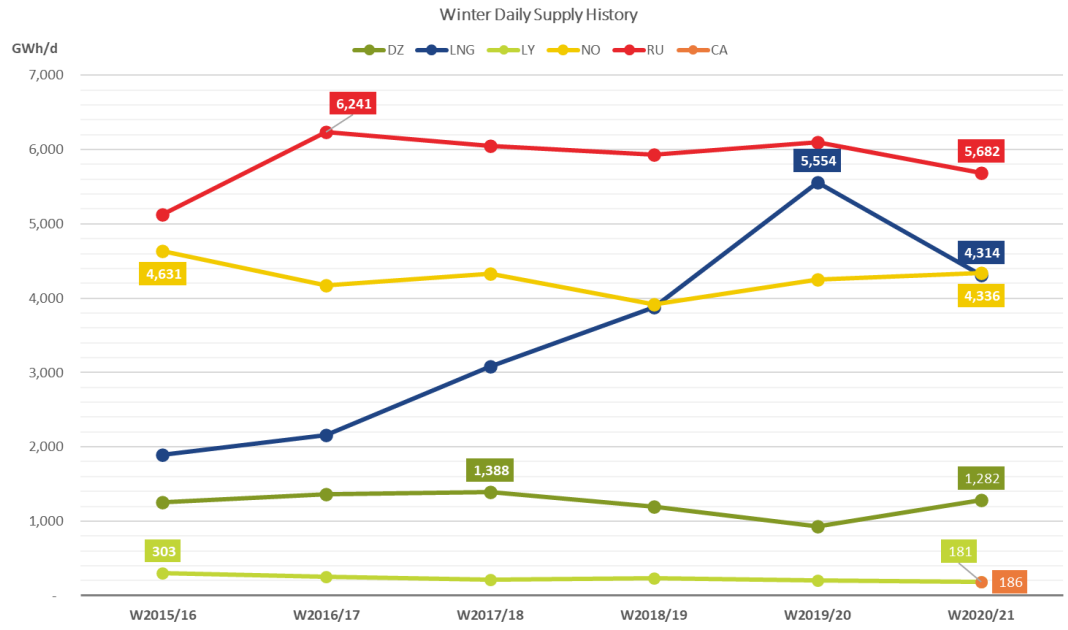

Figure 7.- Daily supply limitation.

2.4. 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 Kaliningrad (Russia).

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[8].
- 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.

3. UGS inventory

3.1. Injection during summer

According to AGSI+, the gas storage data platform operated by GIE, the highest storage withdrawals of the whole winter (2020-2021) reached 10.8 TWh on the 15th of January 2021.

On 1 April, beginning of the injection period, the EU gas storage inventory was 336TWh, much lower than the previous winter 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 between 2011 and 2021.

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

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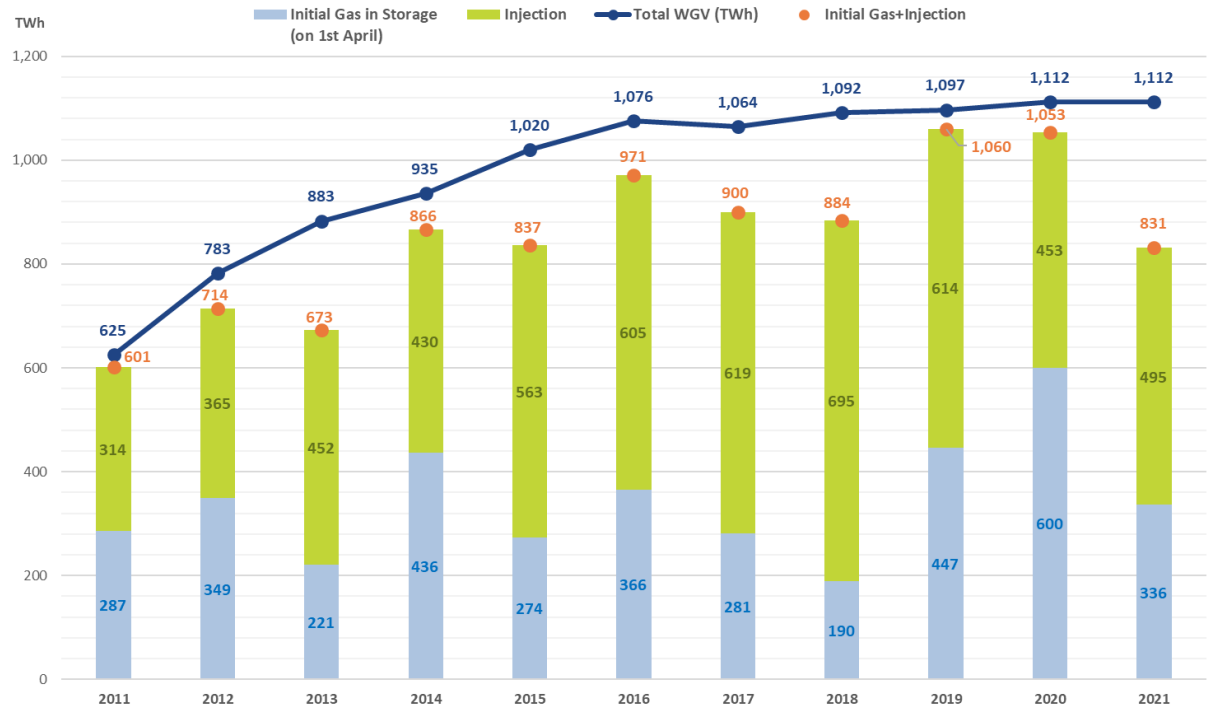


Figure 8.- Situation of the storages during summer seasons (2011 to 2021).

At the end of Summer 2021, the gas storage inventory was the lowest of the last 6 years. The storages due to their utilisation to face cold winter periods at the beginning of the year 2021 reached a value of 336TWh at the beginning of the injection period (30%). Additionally, limited volumes of gas were injected over summer in a context of increasing gas consumption in Asia and high prices in all European Hubs (see **Figure 10**). The storage level is on 1 October 2021 is equivalent to 2015 levels (800TWh) and 250TWh 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 to ensure the supply and demand adequacy. Therefore, an inventory at the beginning of winter similar to 2015, may translate in higher import needs compared to the same year.

Storages play an important role to increase 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 2020.

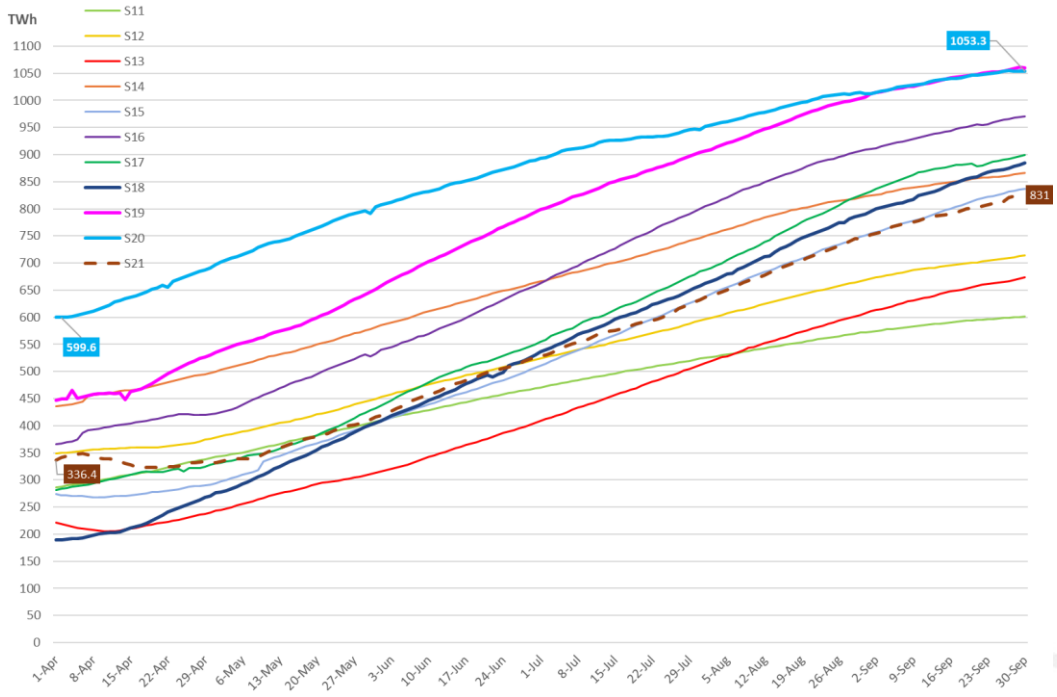


Figure 9. Evolutions of UGS stock level. Summers 2011-2021 (TWh) (Source: AGSI+).

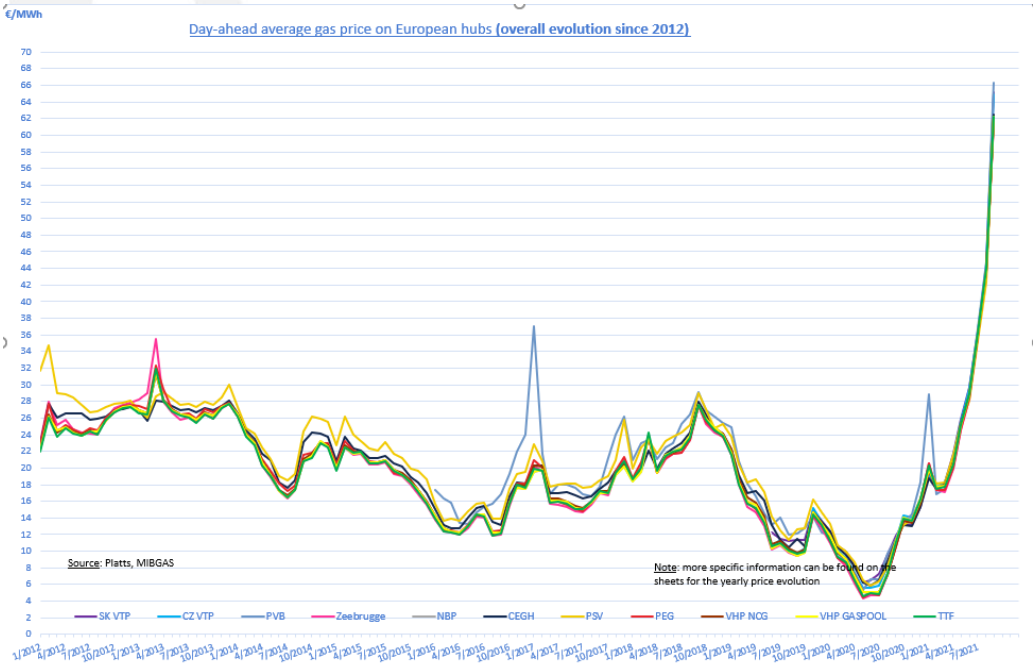
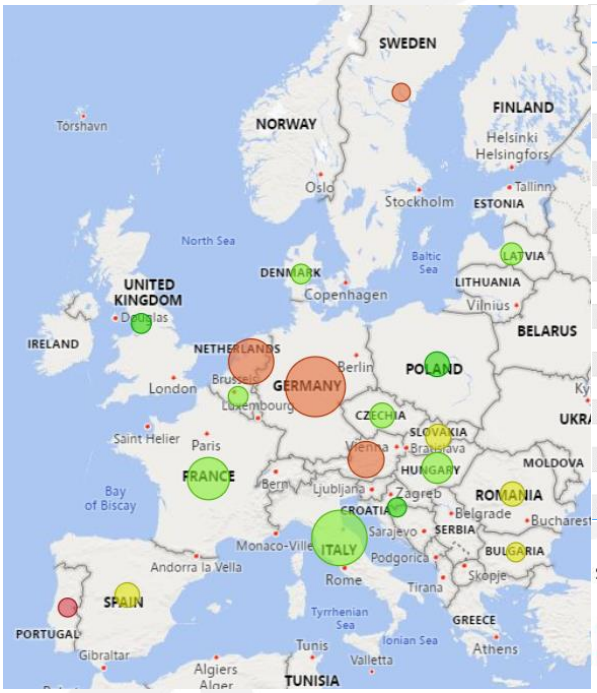


Figure 10. Day-ahead average gas price on European hubs (overall evolution since 2012 to September 2021).

3.2. Initial storage level on 1 October 2021

The Winter Supply Outlook considers the actual storage inventory level per country as of 1 October 2021[9] (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	95.48	50.84	53.25
Belgium	9.00	7.79	86.51
Bulgaria	6.27	4.40	70.18
Croatia	5.22	4.73	90.76
Czechia	35.99	30.62	85.07
Denmark	9.08	7.36	81.01
France	128.46	115.12	89.61
Germany	222.43	151.17	67.96
Hungary	67.70	56.40	83.31
Italy	197.73	169.14	85.54
Latvia	21.80	17.46	80.07
Netherlands	143.81	83.97	58.39
Poland	35.79	34.46	96.29
Portugal	3.57	1.78	49.82
Romania	32.99	23.82	72.19
Serbia	0.00	0.00	0.00
Slovakia	38.75	27.30	70.46
Spain	34.25	25.02	73.06
Sweden	0.01	0.01	66.35
UK	9.63	9.42	97.78

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

In terms of absolute volumes in gas storages, the largest ones are located in Italy, Germany, France and the Netherlands. On 1 October 2021, the initial total UGS inventory is around 831 TWh compared to 1053 TWh in 2020. The actual levels for each country show substantial differences from one country to the other.

In comparison to the previous years, Germany, the Netherlands, and Austria have a low storage level. Summer Supply Outlook 2021 simulations have shown that the gas infrastructure was able to reach 90% to 100% during the injection period. However, those three countries, which represent a cumulated storage capacity of 470 TWh, i.e. 42% of European storage, have seen limited injection over summer whilst The EU gas infrastructure has been fully operational and functioning.

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

[9] The gas in storage on 1st October 2021 for each country is based on the AGSI platform captured on 1st October 2021 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. Assessment of Reference Winter and Cold Winter seasons

4.1. Supply and demand adequacy

considering the UGS inventory level at the beginning of the season, as well as the supply availability, the gas system can ensure supply and demand adequacy in all countries for either a Reference Winter or a Cold Winter.

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

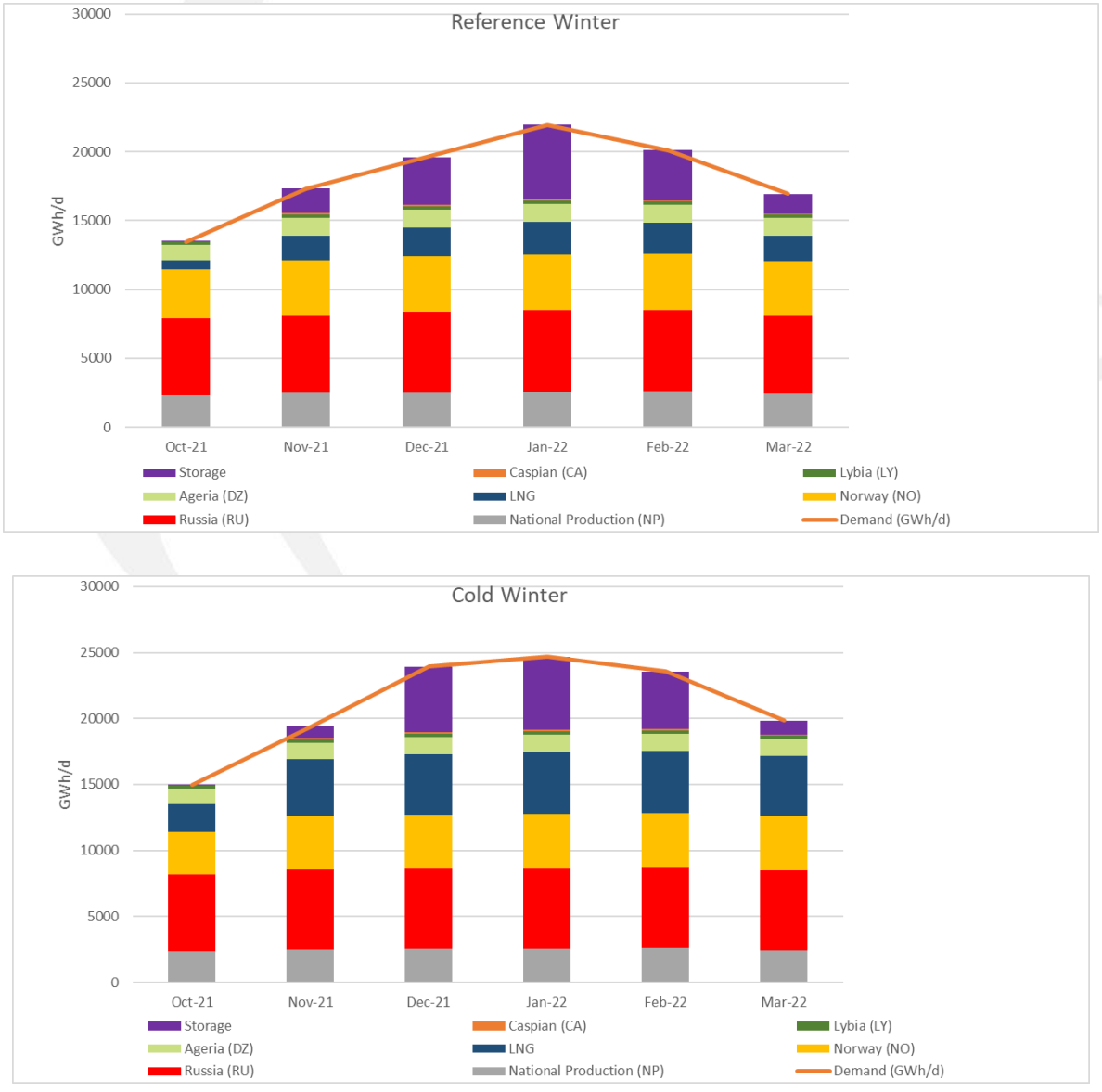


Figure 12. Supply and demand adequacy - Reference Winter and Cold Winter.

These charts illustrate the evolution of supply and demand[10] for Reference and Cold Winter seasons. As observed in recent history, LNG, Russian supply and storages can provide most of the flexibility. It should be noted that the import levels shown in figure 12 represents one of the possible supply mixes, with LNG ensuring the import flexibility in this example.
Since 2020, the Caspian imports can cover a part of the demand.

Note: the supply assumptions 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 2022?
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 30% (55%[11] in the case of Spain) at the end of the winter in all the EU countries for in a Reference Winter. In such scenario, 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.

However, in case of a Cold Winter, while imports are able to bring additional flexibility compared to the reference winter simulation, they cannot fully compensate the storage flexibility. Therefore, the EU aggregated inventory level at the end of the Cold Winter can't reach the 30% target inventory levels and, as additional gas has to be withdrawn from the storages to ensure the supply and demand adequacy, the inventory level ends at 28% on 1 April 2022. The level of imports consider in this simulation are in line with the assumed potential for each source, but is higher than the import levels observed in recent history (see Figure 15).

What could be the consequence of a lower storage level on 1 April?
In case of a higher use of the storages during the early winter season resulting in a low storage level at the end of the season (15% on 1 April), the withdrawal capacities of the storages could be reduced to less than 55% of their nominal capacity after 15 February. Therefore, 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.

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

Figure 13 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.

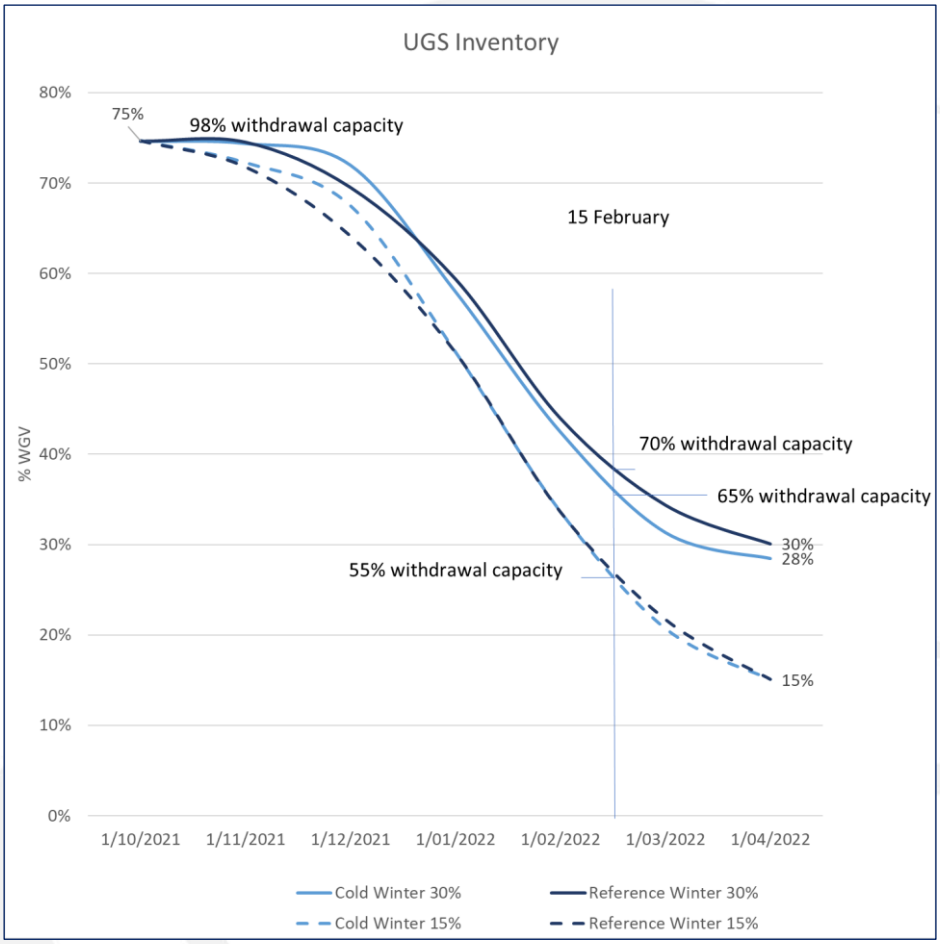


Figure 13. - Winter evolution of the aggregated UGS stock level.

% WGV	1/10/2021	1/11/2021	1/12/2021	1/01/2022	1/02/2022	1/03/2022	1/04/2022
Cold Winter	75%	74%	72%	58%	42%	31%	28%
Reference Winter	75%	73%	68%	58%	43%	34%	30%

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

Impact of storage levels on the storage withdrawal capacities

The capacity of the gas system to deliver gas during a peak day or a cold event depends on the storage level as illustrated by **Figure 14** (data for each storage is available in annex A table 4). Therefore, using more flexibility from the storages over winter will reduce the need for imports but can reduce the flexibility of the gas system in case of a cold spell late in the winter, when storage levels are low.

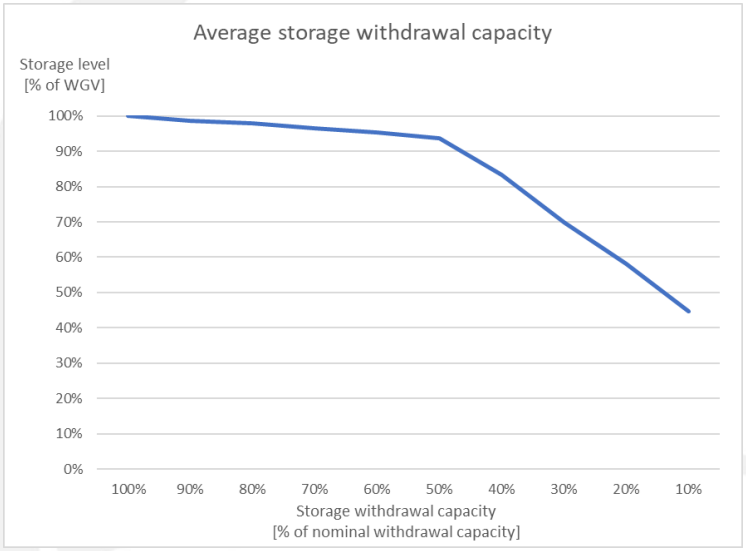


Figure 14. EU average withdrawal capacity for storages depending on their filling level

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 15, a sensitivity analysis of the final storage level at the end of the winter shows that:

- In the Reference Winter (1-in-2 years) scenario, the level of imports needed to reach 30% of the storage level at the end of the season would require a level of imports comparable to previous winters.
- In the Cold Winter scenario, the assumed import potentials are too limited to reach a 30% storage level and additional gas needs to be withdrawn from the storages to ensure the supply and demand adequacy. In this scenario, the average EU storage level reached on 1 April 2022 is 27%. Furthermore, reaching 27% inventory level requires higher imports than observed in recent history (+11% compared to winter 2020/2021).
- In a Cold Winter scenario, a storage level of 15% at the end of the winter would reduce the need for imports to reach levels close to recent history. However, it would also reduce the withdrawal capacities of the storages and thus, the supply flexibility of the gas system.

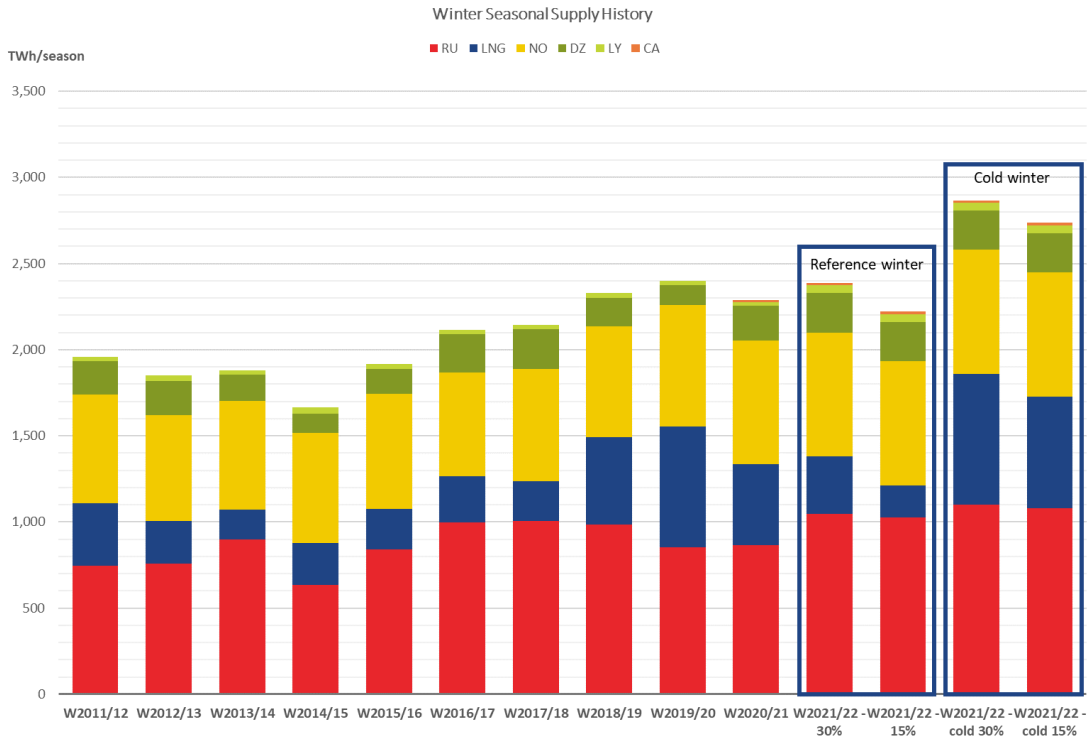


Figure 15 Winter Seasonal supply history and import needs for cold and reference winters (the supply mix is indicative and will be determined by the decisions of market participants)

4.3. Conclusion

The European gas system offers sufficient flexibility to ensure the security of the gas supply in Europe, provided imports can be maintained on a similar levels than in the recent years. No country is exposed to demand curtailment during an average day of a Reference or a Cold Winter. However, in case of a Cold Winter the import needs for the EU could be 5% to 10% higher than observed in the recent years.

Interconnection capacity development in 2021
Some changes compared to the previous Winter Supply Outlook should be noted:

- due to the recent EU restriction on the use of OPAL, 50% of the capacity has been considered in the simulations
- the interconnection Negru Voda 1 / Kardam between Bulgaria and Romania has entered in operation in August 2021. Resulting in additional capacities between Bulgaria and Romania.

5. High demand situations

5.1. Assumptions

In addition to the assessment of the gas system to cope with the winter demand seasonality, Winter Supply Outlook 2021/2022 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. 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 as shown as example in Figure 16for Cold Winter situation. The corresponding storage withdrawal capacities are then considered for the assessment (see Annex A).

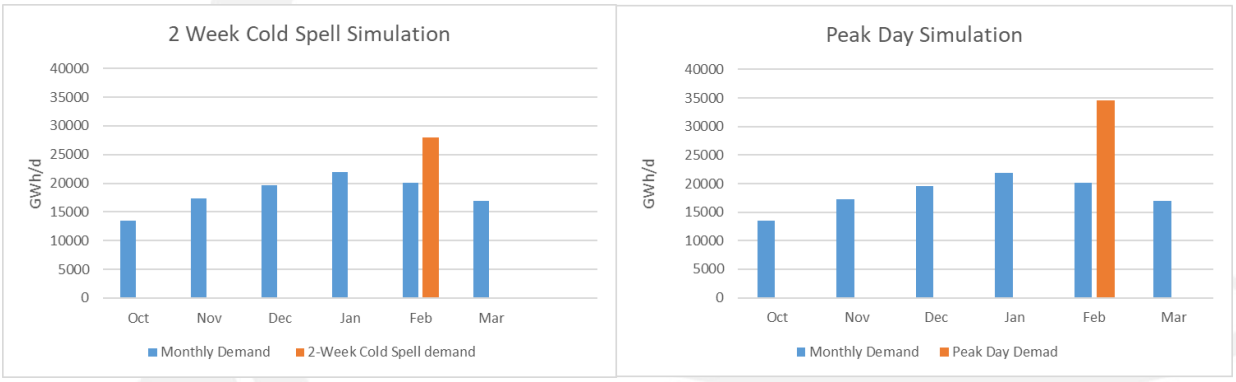


Figure 16.- 2-Week and Peak Day simulations.

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 and Russian imports.

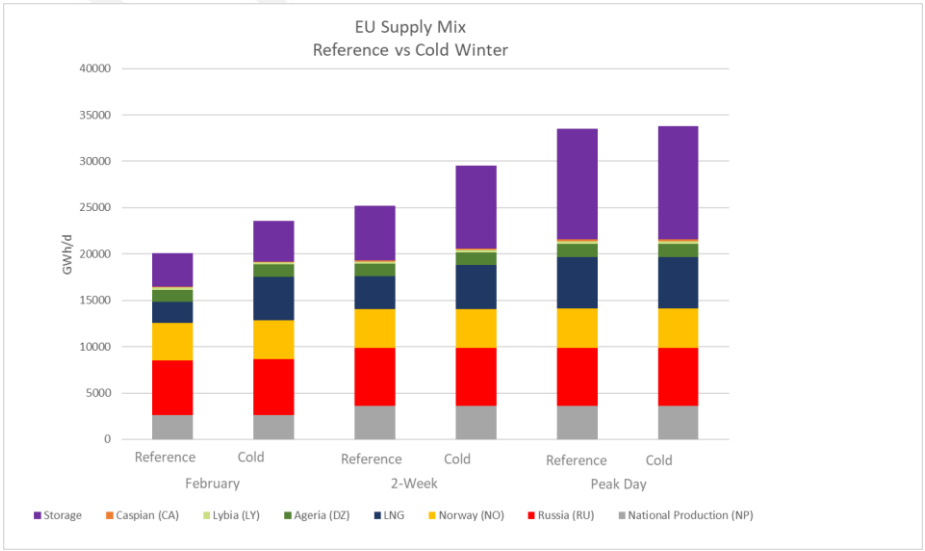


Figure 17. - Comparison of supply mixes in February vs high demand situations (LNG includes tanks withdrawal).

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 17). In case of a Peak Day, LNG and storage flexibilities are essential to cover the demand.

5.3. Conclusion

Indicators

For each high demand situation and each zone, modelling results consist in the calculation of:

- Curtailment Rate: 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.
- Remaining Flexibility: this indicator measures resilience at balancing zone level during climatic stresses (see Annex C for detailed calculation process).

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 not considered in the results and should be given due attention when interpreting the risk exposure to demand curtailment in the different countries. This is why an exposure to few percentiles of demand curtailment observed in a country is generally considered as a limited risk in this assessment.

Summary

		Reference Winter	Cold Winter
1-in-20 **Peak Day**	Demand Curtailment	No exposure	No exposure
	Remaining Flexibility below 20%	DK 10% UK 10%	DK 10%, IE 16%, UK 14%
1-in-20 **2-week Cold Spell**	Demand Curtailment	No exposure	No exposure
	Remaining Flexibility below 20%	None	None

Table 3. – Exposure to demand curtailment and remaining flexibility for Reference and Cold Winter.

Conclusions for the **Reference Winter** scenario:

- **Peak Day**: No demand curtailment, some countries have limited Remaining Flexibility (Denmark and United Kingdom) below 20%.
- **2-Week Cold Spell**: No demand curtailment, all countries having more than 20% Remaining Flexibility.

Conclusions for the **Cold Winter** scenario:

- **Peak Day**: No demand curtailment, some countries have limited Remaining Flexibility (Denmark, Ireland and United Kingdom) below 20%.
- **2-Week Cold Spell:** No demand curtailment, all countries having more than 20% Remaining Flexibility.

Further information regarding the evolution of the Remaining Flexibility since Winter Supply Outlook 2020/2021:

- **In Peak Day, Reference Winter**:
- Denmark shows slight decrease of Remaining Flexibility compared to previous exercise due to less flows from Germany and storage. Croatia is having 90% Remaining Flexibility, thanks to Krk Terminal operational in 2020. France improved its Remaining Flexibility for H-gas due to a lower demand but the indicator decreased in the L-gas region. UK with less than 10% of remaining flexibility has a lower value compared to previous edition due to reduced available capacities from its storages. Finland improved its Remaining Flexibility due to a decreasing demand.
- **In Peak Day, Cold Winter:** UK improved its remaining flexibility compared to reference winter with lower demand value in Cold Winter. The Cold Winter demand submitted by the UK considers the 2023 time horizon which anticipates a lower demand than expected for 2021/2022

5.4. Peak Day in Reference Winter and Cold Winter

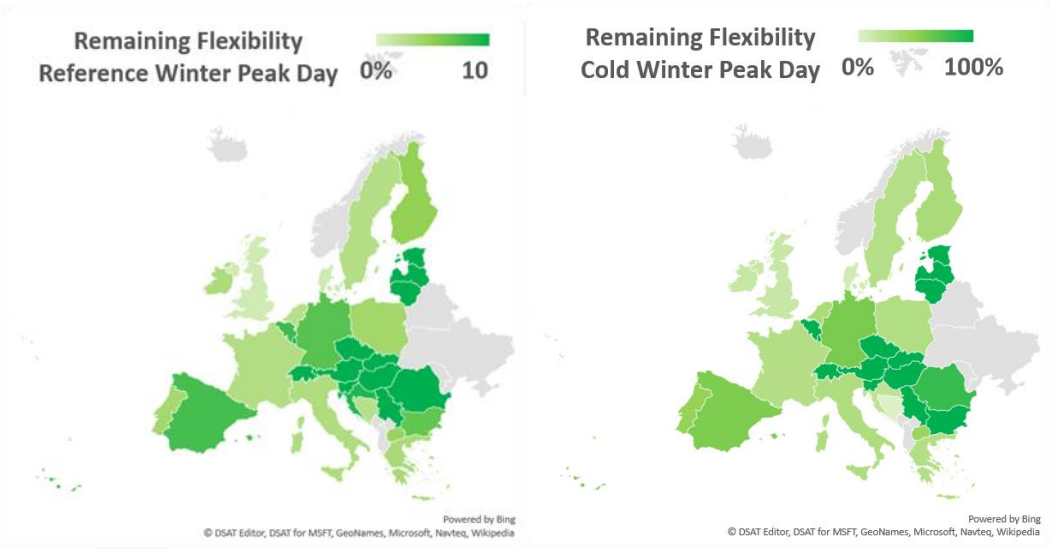


Figure 18.- Peak Day results (Remaining Flexibility and no Curtailment Rate) in Reference and Cold Winter[12].

No infrastructure or supply limitation is identified in case of a Peak Day in Reference and Cold Winter and therefore, no country is exposed to demand curtailment.

Denmark and Sweden are facing a period where the supply might be tight in the event of exceptional high demand or in case of a serious technical incident due to the ongoing reconstruction of the Tyra complex in the Danish North Sea. Denmark and Sweden will, from November 2019 to July 2022, be almost fully dependent on gas supplies from Germany via the interconnection point Ellund. WSO 2021/2022 considers the reduction of the Danish national production, and the increased capacity at the Ellund interconnection point.

[12] In all maps, the value of RF for Belgium, France and Germany are the weighted average of the different balancing zones of H-gas and L-Gas.

5.5. 2-Week Cold spell in Reference Winter and Cold Winter

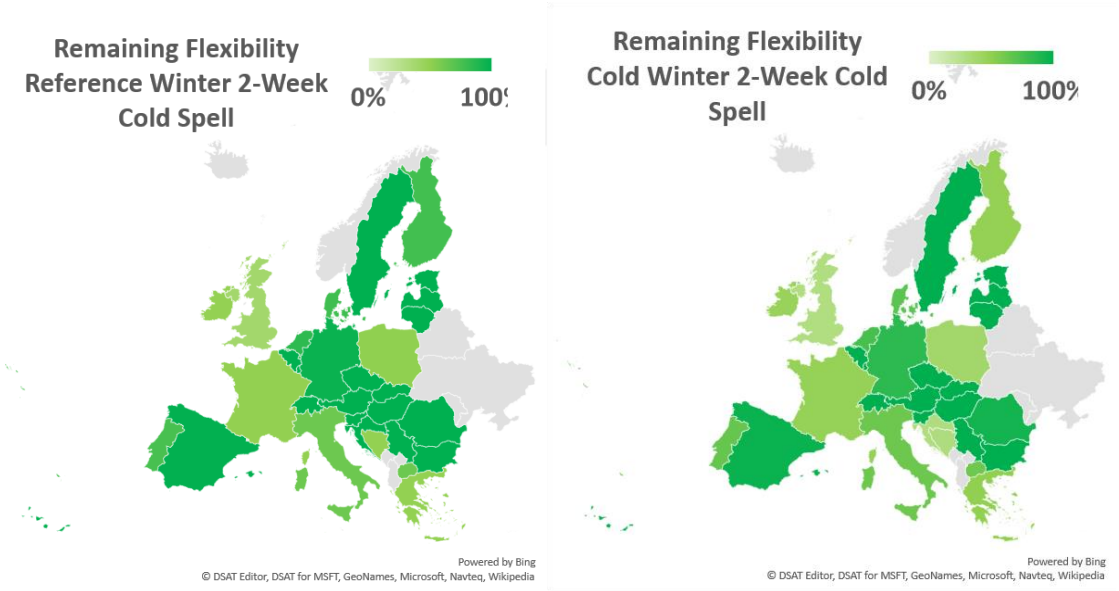


Figure 19. 2-Week Cold Spell results (Remaining Flexibility and Curtailment Rate) in Reference and Cold Winters [13].

No infrastructure or supply limitation is identified in case of a Peak Day in Reference and Cold Winter and therefore, no country is exposed to demand curtailment.

[13] The results shown are average of the 2-Week Cold Spell.

6. Supply route disruptions

This section investigates the potential impact of a supply route disruption during high demand situations and during a Cold Winter. Results presented in this report show the additional effect of the supply route disruptions. In case a country would be exposed to demand curtailment under high demand situations – but without supply route disruption, only the additional impact is analysed and highlighted in the maps.

This vision is included in ENTSOG's Winter Supply Outlooks since Winter Supply Outlook 2013/14. However, since 2017, the disruptions scenarios considered in the Winter Supply Outlooks are aligned with the Security of Supply Simulations Report where 17 supply and infrastructure disruption scenarios are assessed. For this WSO, the purpose is to provide an update of the situation for the upcoming winter for those disruption scenarios showing some risk of demand curtailment. Cold Winter demand data are those provided by TSOs for SOS 2021.

Winter Supply Outlook assessment focuses on disruption scenarios during Peak Day and 2-Week Cold Spells. All other disruption scenarios, including the 2-month disruptions, are considered in Union-wide Security of Supply Simulation Report[14] and are updated every 4 years according to the regulatory requirements.

The disruption scenarios and the risk groups considered in this report are aligned with the Annex I of the 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. Further information on the impact of supply route disruptions on the gas system can be found in the Union-wide Security of Supply Simulation Report published by ENTSOG in 2017. The new edition of the report will be published in November 2021.

Scope of the assessment

Supply route disruption:

- Ukraine
- Belarus
- Baltics states and Finland supply
- Algerian pipeline imports.

Demand cases

[14] https://www.entsog.eu/security-of-supply-simulation#union-wide-simulation-of-supply-and-infrastructure-disruption-scenarios

- 1-in-20 Peak Day during a Cold Winter
- 1-in-20 2-week Cold Spell during a Cold Winter

The approach for the allocation of demand curtailment is applied according to the Security of Supply report: all member States within a risk group as defined in Annex I of Regulation 2017/1938 cooperate by avoiding a demand curtailment to the extent possible and, be it the case, by sharing the curtailment equally in such a way that they try to reach the same Curtailment Rate. For SOS 2021, risk groups will be updated to take in consideration the infrastructure projects commissioned in 2022.

6.1. Ukraine transit disruption

This case considers the disruption of the transit through Ukraine and the risk group is formed by Austria, Bulgaria, Croatia, Czech Republic, Germany, Greece, Hungary, Italy, Luxembourg, Poland, Romania, Slovenia and Slovakia.

Figure 20.- Risk group for Ukraine transit disruption

1-in-20 years Peak day:

Most of the countries of this group could be exposed to demand curtailment, however to a limited extent (2% of curtailment rate). The gas infrastructure generally allows for an efficient cooperation among the Member States of the risk group, who can limit the level of demand curtailment to its minimum.. The implementation of Turkstream, Trans Adriatic Pipeline and other investments in South-Eastern Europe mitigate any risk of demand curtailment in Greece, Bulgaria and North Macedonia. However, some infrastructure limitation between Bulgaria and Romania prevents Bulgaria and Greece to further cooperate with the rest of the risk group. This explains why they are not exposed to demand curtailment and show some remaining flexibility.

The overall demand curtailment results from supply deficit due to limited withdrawal capacities from the storages (consequence of the low storage level on 15 February) and infrastructure limitations preventing higher imports from the other supply routes.

Important: all exports to Ukraine can be maintained during the event.

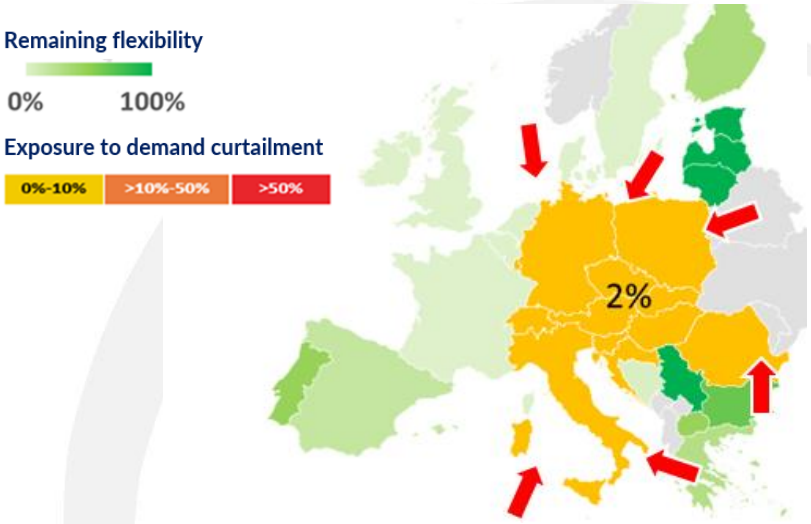


Figure 21. Peak Day results (Remaining Flexibility and Curtailment Rate) for Ukraine transit disruption.

1-in-20 years 2-Week Cold Spell:

As for the Peak Day, the situation in this risk group has improved compared to last year with the implementation of TurkStream, Trans Adriatic Pipeline and other investments in the region. The simulation results show that in case of 2-Week Cold Spell combined with a disruption of Ukrainian supply route, the gas infrastructure allows for an efficient cooperation among the countries, and no Member State is exposed to demand curtailment. However, the whole region shows a limited remaining flexibility.

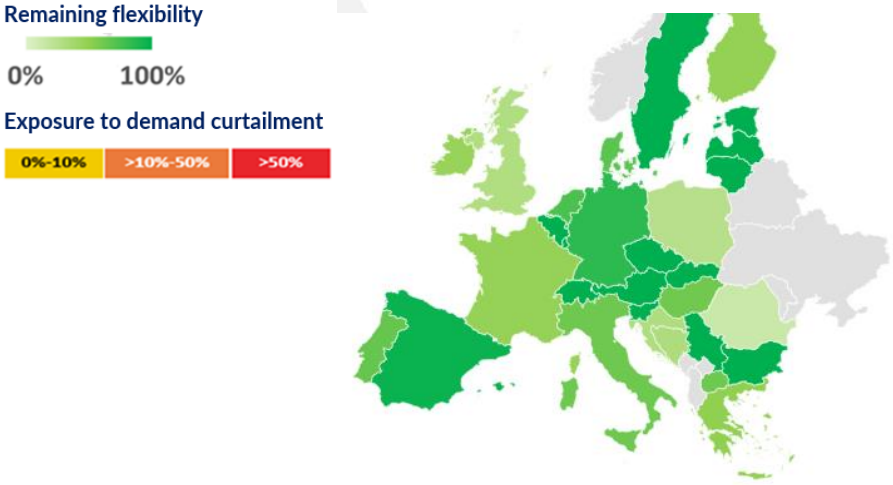


Figure 22. 2-Week Cold Spell results (Remaining Flexibility and Curtailment Rate) for Ukraine transit disruption

6.2. Belarus transit disruption

This case considers the disruption of the transit through Belarus and the risk group is formed by Czech Republic, Belgium, Estonia, Germany, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Slovakia

Figure 23. Risk group for Belarus disruption.

1-in-20 years Peak day:

The results show that in the case of a Peak Day combined with a Belarus supply route disruption, the gas infrastructure allows for an efficient cooperation among the countries and no Member State is exposed to demand curtailment. However, Poland, Latvia, Lithuania and Estonia show a decreasing Remaining Flexibility.

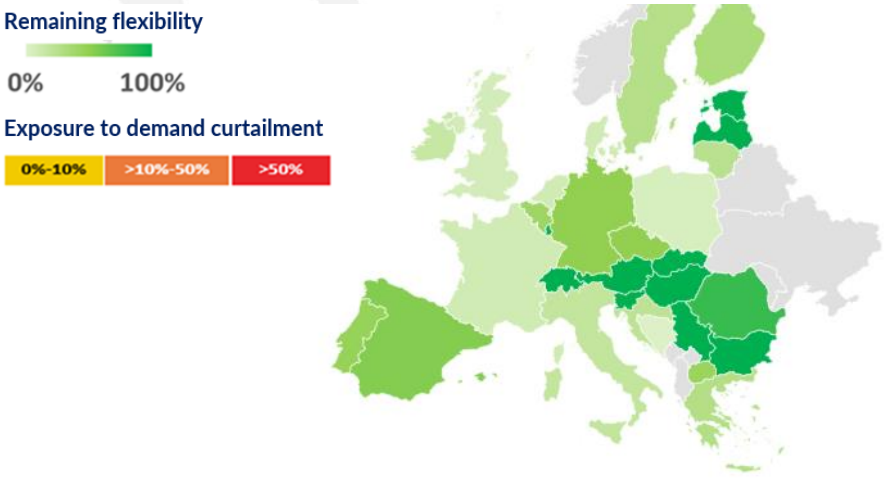


Figure 24. Peak Day results (Remaining Flexibility and Curtailment Rate) for Belarus disruption.

1-in-20 years 2-Week Cold Spell:

The results show that in the case of a 2-Week Cold Spell combined with a Belarus supply route disruption, the gas infrastructure allows for an efficient cooperation among the countries and no Member State is exposed to demand curtailment. However, Poland, Latvia, Lithuania and Estonia show a decreasing Remaining Flexibility.

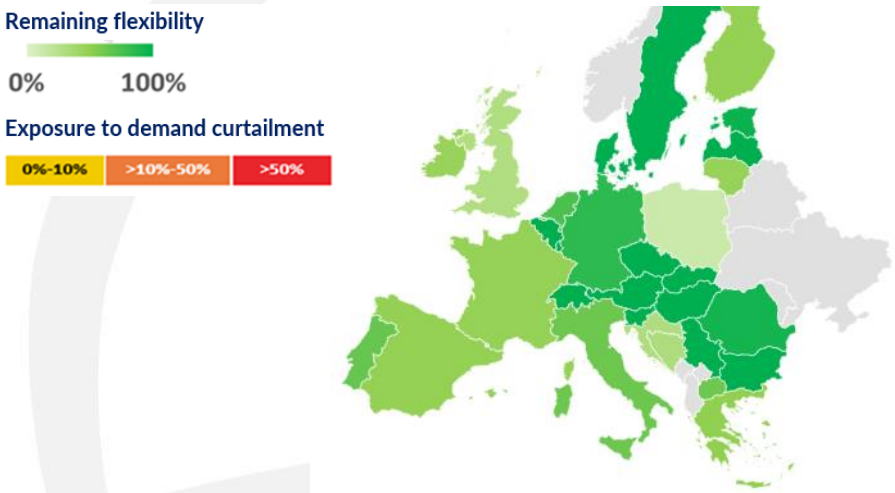


Figure 25. 2-Week Cold Spell results (Remaining Flexibility and Curtailment Rate) for Belarus disruption.

6.3. Baltics States and Finland Disruption

This case considers the disruption of the imports to the Baltic states and Finland and the risk group is formed by Estonia, Finland, Latvia, Lithuania.

Figure 26.- Risk group for Baltic states and Finland disruption.

1-in-20 years Peak day:

The results show that in case of a Peak Day combined with a disruption of the imports to Baltic states and Finland, all countries are exposed to significant levels of demand curtailment: Finland (77%), Estonia (17%), Latvia (17%) and Lithuania (17%). Some infrastructure limitations between the risk group and the rest of the EU prevents any cooperation with the other Member States. However, within the risk group the Baltic States can efficiently cooperate and share the same level of demand curtailment, but the connection between Estonia and Finland is limited and does not allow for further cooperation with Finland.

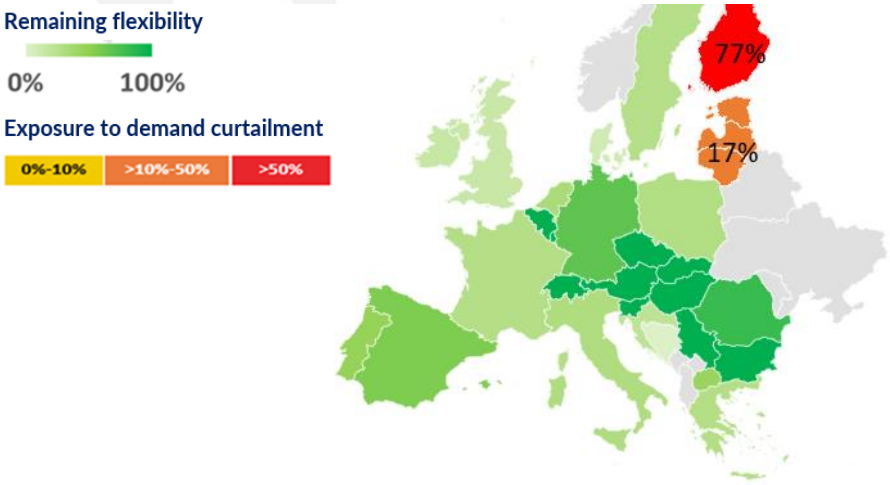


Figure 27. Peak Day results (Remaining Flexibility and Curtailment Rate) for Baltic states and Finland disruption.

Note: Demand curtailment in Finland is presented excluding the country-specific possibility to use other back-up fuels for gas. The implementation of the Balticconnector project allows gas to flow from the Baltic States to support Finland. However, Balticconnector has not reached its full design capacity yet.

1-in-20 2-Week Cold Spell:

The results show that, in case of a 2-Week Cold Spell combined with a disruption of the imports to Baltic states and Finland, Finland (74%), Estonia (8%), Latvia (8%) and Lithuania (8%) are facing demand curtailment. Some infrastructure limitations between the risk group and the rest of the EU prevents any cooperation with the other Member States. However, within the risk group the Baltic States can efficiently cooperate and share the same level of demand curtailment, but the connection between Estonia and Finland is limited and does not allow for further cooperation with Finland.

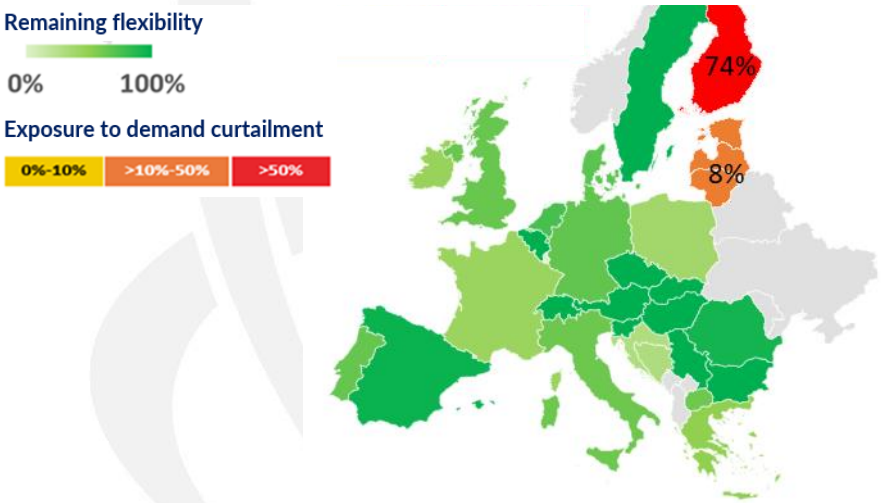


Figure 28. 2-Week Cold Spell results (Remaining Flexibility and Curtailment Rate) for Baltic states and Finland disruption.

6.4. Algerian Pipes Disruption

This case considers the disruptions of the imports from Algeria via pipelines and the risk group is formed by Austria, Croatia, France, Greece, Italy, Malta, Portugal, Slovenia and Spain.

Figure 29. Risk group for Algerian pipes disruption.

1-in-20 years Peak Day:

The results show that in the case of a Peak Day combined with Algerian pipeline imports disruption, the gas infrastructure, including LNG terminal capacities in Spain and Italy and Trans Adriatic Pipeline, allows for an efficient cooperation among the countries and no country is exposed to demand curtailment.

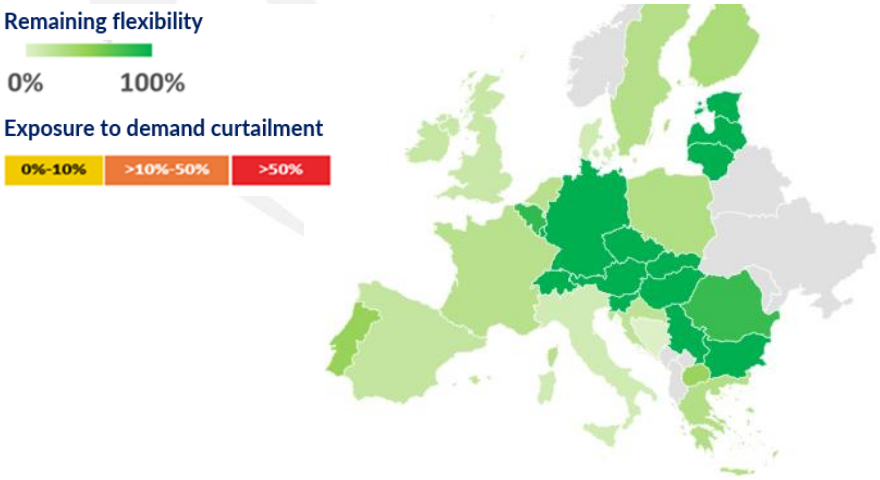


Figure 30. Peak Day results (Remaining Flexibility and Curtailment Rate) for Algerian disruption.

1-in-20 years 2-Week Cold Spell:

The results show that in the case of a 2-Week Cold Spell combined with Algerian disruption, the gas infrastructure allows for an efficient cooperation among the countries and no countries are facing demand curtailment.

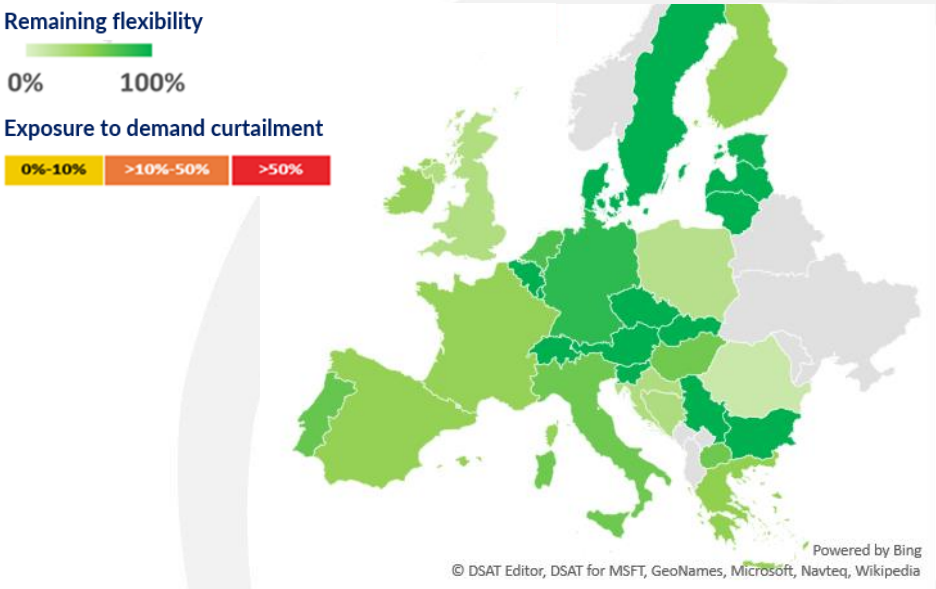


Figure 31. 2-Week Cold Spell results (Remaining Flexibility) for Algerian disruption.

7. Conclusions

According to the ENTSOG modelling and supply assumptions, this Winter Supply Outlook confirms the ability of the European gas infrastructures to face a Cold Winter 2021/2022 with sufficient flexibility in most parts of Europe. This assessment is valid throughout the season and under high demand situations.

Winter Supply Outlook 2021/2022 assessment highlights:

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

- **The European indigenous production continues to decrease year-on-year,**
- **On 1 October 2021, the EU storage level (75%) is one of the lowest in any ENTSOG Winter Supply Outlook (831 TWh), with different situations among countries, for two main reasons:**
  - Record high use of storage flexibility during winter 2020/2021, resulting in a low level of storage (336 TWh) at the beginning of the injection season,
  - Low injection during Summer while observing unusual high gas prices,
- **The European gas infrastructure offers sufficient flexibility to ensure security of gas supply in Europe, provided gas is imported by the market on similar volumes as in recent years,**
- **It can be noted that the EU gas infrastructure has been fully operational and functioning during the Summer season and this status is expected to be maintained for the Winter season 2021/22.**
- **However, in case of a cold Winter, the gas market would need to increase gas imports from pipelines and/or LNG from 5% to 10% higher than the maximum volumes observed in the recent years,**
- **It is important to emphasize that an early and significant withdrawal from storages will result in low storage levels at the end of the Winter season. This will have negative impact on the flexibility of the gas system – and can increase the exposure to demand curtailment in the later part of the Winter season.**
- **South-Eastern Europe has significantly reduced its exposure to demand curtailment following the commissioning of new infrastructure.**
- **However, countries within the risk groups of Ukraine and Baltic States/Finland can be exposed to demand curtailment in case of extreme temperatures combined with import route disruptions from Ukraine or Russia.**
- **The European gas system is also capable of supplying Energy Community Contracting Parties and other EU neighbouring countries with significant volumes of gas,**

> **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 2021/2022 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 4. - UGS deliverability curves.

Annex B - Data for Winter Supply Outlook 2021/22

Indigenous Production

GWh/d	OCT	NOV	DEC	JAN	FEB	MAR	2-Week1	2-Week2	DC
National Production	2,333.4	2,473.1	2,508.1	2,536.6	2,601.3	2,432.5	3,619.4	3,619.4	3,619.4

Table 5. – Supply assumptions indigenous production

Supply assumptions (maximum per period)

GWh/d			DZ	LY	NO	RU	LNG	LNG*	AZ
Winter Period	Max on Whole Winter		1,261	208	3,953	5,530	4,174	4,174	76
	Max per 30 days		1,389	247	4,135	6,084	4,745	4,745	161
High Demand	2-week Cold Spell	Week 1	1,348	225	4,164	6,140	***	***	162
		Week2	1,348	225	4,164	6,140	4,898	4,898	162
	1-day Design Case		1,388	303	4,631	6,277	5,554	6,357	186

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

Table 6.– 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.

LNG Tank Flexibility	
BE	35%
ES	68%
FRn	76%
FRs	60%
GR	57%
IT	63%
IT	33%
LT	3%
NL	35%
PL	74%
PT	43%
UK	64%

Table 7.-LNG tank flexibility

Reference Winter Demand

Country	OCT	NOV	DEC	JAN	FEB	MAR	2-Week1	2-Week2	DC
AT	262	336	376	426	361	317	427	427	521
BA	5	8	9	11	9	9	12	12	14
BEh	509	601	636	642	622	568	1,026	1,026	1,141
BEl	110	145	171	172	172	150	272	272	329
BGn	85	116	122	137	137	133	148	148	176
CH	97	146	171	185	171	139	220	220	230
CZ	269	345	436	440	478	352	592	592	727
DE	2,152	2,745	2,999	3,568	2,871	2,312	3,595	3,595	4,813
DEL	519	681	750	905	715	563	913	913	1,198
DK	51	79	97	98	92	79	140	140	215
EE	13	16	18	18	18	16	35	35	45
ES	971	1,148	1,129	1,251	1,270	1,086	1,490	1,490	1,650
FI	71	77	84	123	116	91	150	150	180
FR	1,133	1,496	1,799	2,073	1,750	1,557	3,150	3,150	3,834
FRnL	105	138	169	193	173	142	350	350	426
GR	145	196	201	260	227	194	267	267	297
HR	84	109	112	116	103	102	123	123	145
HU	280	385	530	590	480	383	620	620	650
IE	148	153	194	191	225	193	236	236	261
IT	1,751	2,416	2,935	3,253	3,121	2,381	3,801	3,801	4,893
LT	60	68	70	78	78	66	123	123	141
LU	22	31	32	38	37	31	49	49	60
LV	33	42	47	58	54	43	92	92	117
MK	8	16	16	16	16	16	17	17	19
NL	998	1,276	1,395	1,570	1,457	1,280	3,186	3,186	3,863
PL	571	700	788	847	861	740	962	962	1,069
PT	206	209	206	221	211	211	231	231	295
RO	270	355	475	585	490	380	610	610	657
RS	62	62	62	62	62	62	95	95	104
SE	21	25	30	37	33	28	56	56	77
SI	27	41	41	46	44	41	44	44	53
SK	136	177	219	235	207	171	285	285	343
UK	1,907	2,583	2,894	3,095	3,062	2,692	4,154	4,154	5,486
UKn	43	49	49	58	52	52	69	69	96
TOTAL	13,121	16,970	19,262	21,599	19,772	16,582	27,539	27,539	34,123

Table 8.– 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

Country	OCT	NOV	DEC	JAN	FEB	MAR	2-Week1	2-Week2	DC
AT	302	335	440	414	412	339	414	414	588
BA	5	7	10	13	8	6	14	14	18
BEh	681	781	982	985	974	782	1,136	1,136	1,202
BEl	162	178	217	217	217	182	227	227	239
BGn	88	120	126	141	140	137	156	156	183
CH	91	154	185	159	203	160	220	220	230
CZ	259	303	479	421	432	315	592	592	727
DE	2,042	2,575	3,099	3,531	3,136	2,645	4,045	4,045	4,813
DEL	490	635	778	896	788	654	1,178	1,178	1,198
DK	73	106	116	131	128	110	140	140	215
EE	16	22	39	37	31	36	57	57	70
ES	1,031	1,257	1,281	1,292	1,269	1,135	1,502	1,502	1,863
FI	95	114	148	152	140	125	180	180	200
FR	1,197	1,845	2,495	2,243	2,088	1,711	3,154	3,154	3,828
FRnL	143	206	265	223	187	150	323	323	394
GR	153	185	212	221	175	190	265	265	312
HR	81	104	129	130	159	90	205	205	223
HU	362	468	600	646	659	451	700	700	760
IE	144	164	190	199	198	186	242	242	298
IT	2,155	2,735	3,636	3,607	3,389	2,899	3,801	3,801	4,893
LT	76	83	95	100	106	85	128	128	151
LU	47	46	57	54	53	47	49	49	60
LV	59	79	79	92	117	102	92	92	117
MK	10	16	17	17	16	16	17	17	19
NL	921	1,460	1,902	1,896	1,857	1,485	3,165	3,165	3,832
PL	612	742	830	889	902	782	1,009	1,009	1,121
PT	206	209	206	221	211	211	245	245	277
RO	351	536	526	559	635	483	716	716	773
RS	62	62	62	62	62	62	95	95	104
SE	24	41	42	59	49	38	65	65	77
SI	34	41	43	50	47	40	61	61	68
SK	156	205	269	281	253	229	441	441	496
UAe	335	335	335	335	335	335	416	416	416
UK	2,450	3,165	3,969	4,325	4,107	3,551	4,403	4,403	5,144
UKn	61	66	68	74	72	68	74	74	96
TOTAL	14,975	19,377	23,927	24,670	23,556	19,839	29,528	29,528	35,004

Table 9.- 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

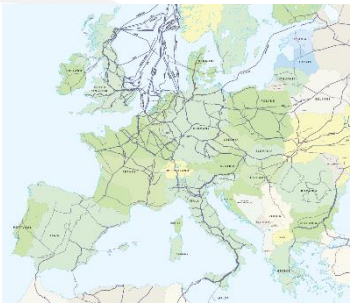
Table 10.-Exports to Ukraine.

[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.



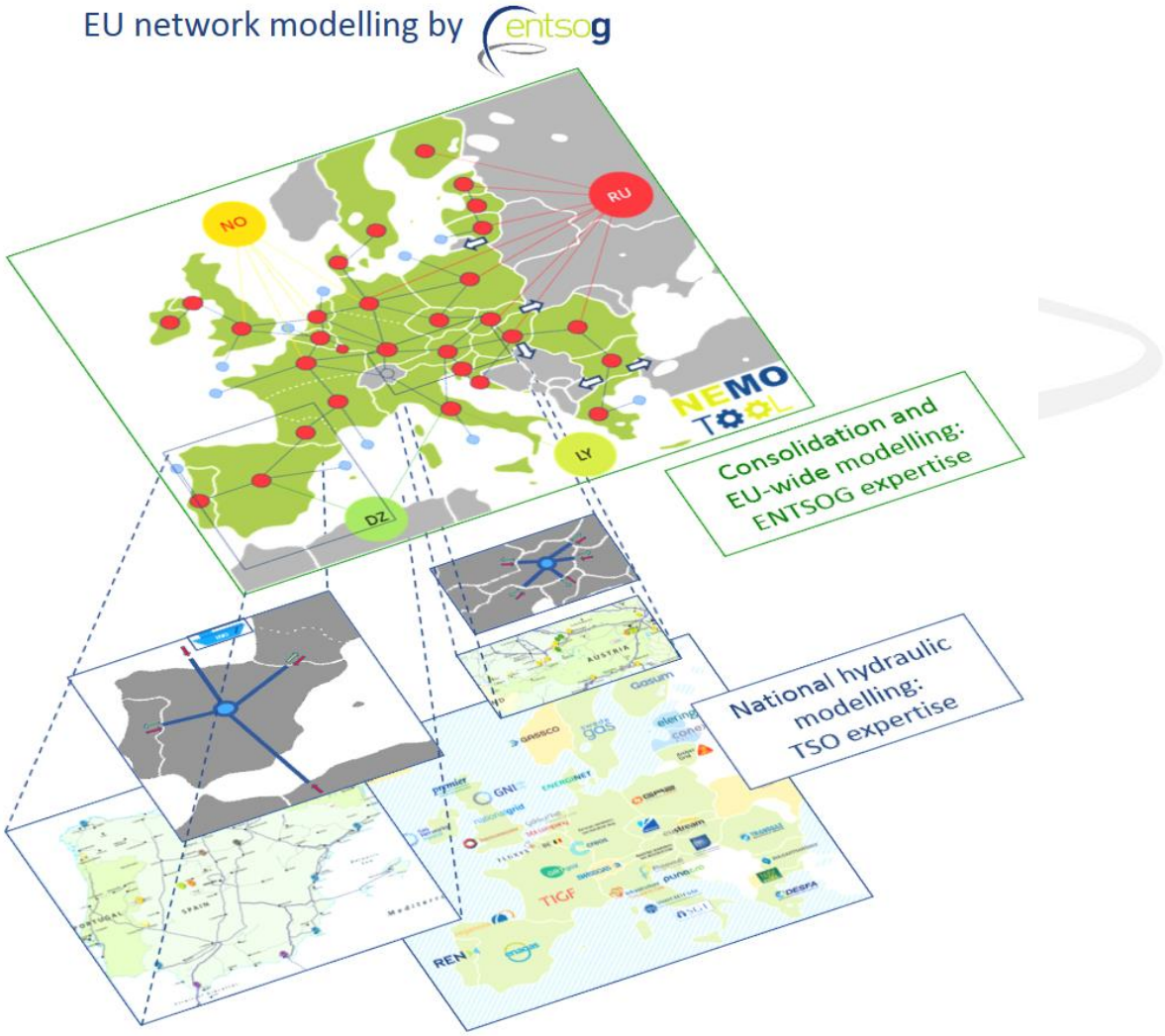


Illustration 1: Entsog model overview

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.

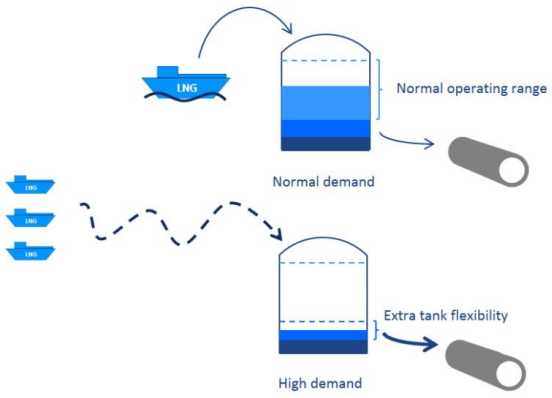
LNG supply:

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

Remaining Flexibility indicator

This indicator measures the resilience at balancing zone (zone) level to cope with climatic stress and route disruption. It aims at capturing the extra supply flexibility a country can access through its infrastructure.

This indicator is calculated as the increase (100%) of demand an area can accommodate before an infrastructure or supply limitation is reached somewhere in the European gas system. The value is expressed as 100% minus the percentage of disruption of the additional demand. The higher the value, the better the resilience is.

A zero value would indicate that the country is not able to fulfil any additional demand and experience disrupted demand. A 100% value would indicate that it is possible to supply a demand multiplied by a factor two.

The value of the indicator is set as the possible increase in demand of the Zone before an infrastructure or supply limitation is reached somewhere in the European gas system. Therefore, the approach enables the consideration of possible infrastructure or supply constraints beyond the entry into the Zone.
The Remaining Flexibility of the Zone Z is calculated as follows (steps 2 and 3 are repeated independently for each Zone):

1. Modelling of the European gas system under a given climatic case
2. Increase of the demand of the Zone Z by 100%
3. Modelling of the European gas system in this new case

Annex D – Results of Remaining Flexibility

The results for Remaining Flexibility are available online as an annex of this report. The data available is specifically:

- RF in Reference Winter. No disruption.
- RF in Cold Winter. No disruption.
- RF in Cold Winter. Disruptions (Algeria, Ukraine, Belarus and BalticFinland).

Abbreviations

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

> Supplies

AZ	Azerbaijan	**NP**	National Production
DZ	Algeria	**RU**	Russia
LY	Libya	**TR**	Turkey
NO	Norway		

> Countries

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

> Low calorific gas zones:

DEL	Germany L-gas	**BEl**	Belgium L-gas
		FR	French Nord L-gas

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