entsog

european network
of transmission system operators
for gas

Winter Supply Outlook 2018/2019

OCTOBER 2018

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 2018 to March 2019). 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 national production keeps on following a decreasing trend;**
- **the storage level on 1st October is in the average of the last 5 years;**
- **in case of cold winter, the LNG terminals utilization would need to be significantly higher than observed over the last 5 years and comparable to 2009-2011 period, prior to the Fukushima nuclear disaster, otherwise the storages at the end of the season could fall to historical low levels;**
- **shippers keeping on filling storages by 1 November could secure higher flexibility;**
- **nevertheless, the European gas system offers sufficient flexibility across the season in Europe, provided gas is available;**
- **the European gas system is also capable of supplying Energy Community Contracting Parties and other EU neighbouring countries with significant volumes of gas;**
- **limited entry capacity in Bosnia could expose it to demand curtailment during the peak demand day;**
- **South-East Europe would be significantly exposed in case of a transit disruption through Ukraine under high demand situations.**

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

1. Introduction

This edition builds on previous Winter Supply Outlooks as well as on the supply and demand assumptions of the Security of Supply Simulation Report 2017 and the TYNDP 2018 Scenario Report. It aims to assess the ability of the European gas network to provide sufficient 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.

Two different visions: winter period and high demand situations

As for previous reports, the Winter Supply Outlook 2018/19 captures two different visions of the season. The first one is an outlook of demand and supply and the resulting evolution of UGS inventory along the Reference Winter and the Cold Winter demands. The second one is the analysis of specific events being high demand situations (1-day Design Case and 2-Week Cold Spell), considering also an LNG supply sensitivity in the cold winter high demand situations.

As for previous WSO reports, these two visions are assessed separately in the Winter Supply Outlook 2018/19.

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 legal parameters.

Currently, the European aggregated inventory level of underground gas storages levels on 1st October (897 TWh) is the lowest level observed over the past years, with much lower levels in some countries such as Sweden or United Kingdom.

The main changes considered in this report from the previous Winter Supply Outlook are:

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 the "Cold Winter" demand and supplies assumed in that report with the updated capacities sent by the TSOs for this winter.

Disruption assessment: in line with the previous editions of Winter Supply Outlooks, this report assesses the impact of the Ukrainian supply disruption, complemented by the assessment 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 the impact of long supply disruptions on the EU gas system is available in the EU-wide SoS simulation report on ENTSOG website.

France topology: The topology of the network model has been upgraded in order to reflect the new situation in France where both existing balancing zones will be merged in November 2018. The result of this merger involves the creation of the single trading zone (TRF) instead of two balancing zones considered so far (TRS for France South and PEG north for France North). The new topology consists in one demand node for H-gas in France (FR) with a separate L-gas node.

2. Assumptions

The simulations consider the existing European gas infrastructure as of 30th September 2018.

The modelling tool 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[2] with every WSO exercise.

The Winter Supply Outlook 2018/19 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

The seasonal demand is used to check if the gas stored in the UGS is enough to cope with the winter demand (Reference and Cold) and, at the same time, reaching the end of the period with a sufficient gas volume in the storage in order to preserve the flexibility of the system.

[2] For the OPAL pipeline, the partial availability of the pipeline taking into account the current exemptions were considered. For TENP pipeline, the current capacity restrictions as provided by Fluxys TENP and Open Grid Europe were introduced in the WSO simulations.

A Reference Winter has been defined as representing a 1-in-2 year climatic condition. 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[3] and represents an historical high demand winter (see Annex B for country detail). The Cold Winter shows an overall increase of 16.6% of the total demand compared to the Reference Winter submitted by TSOs.

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 9 winters.

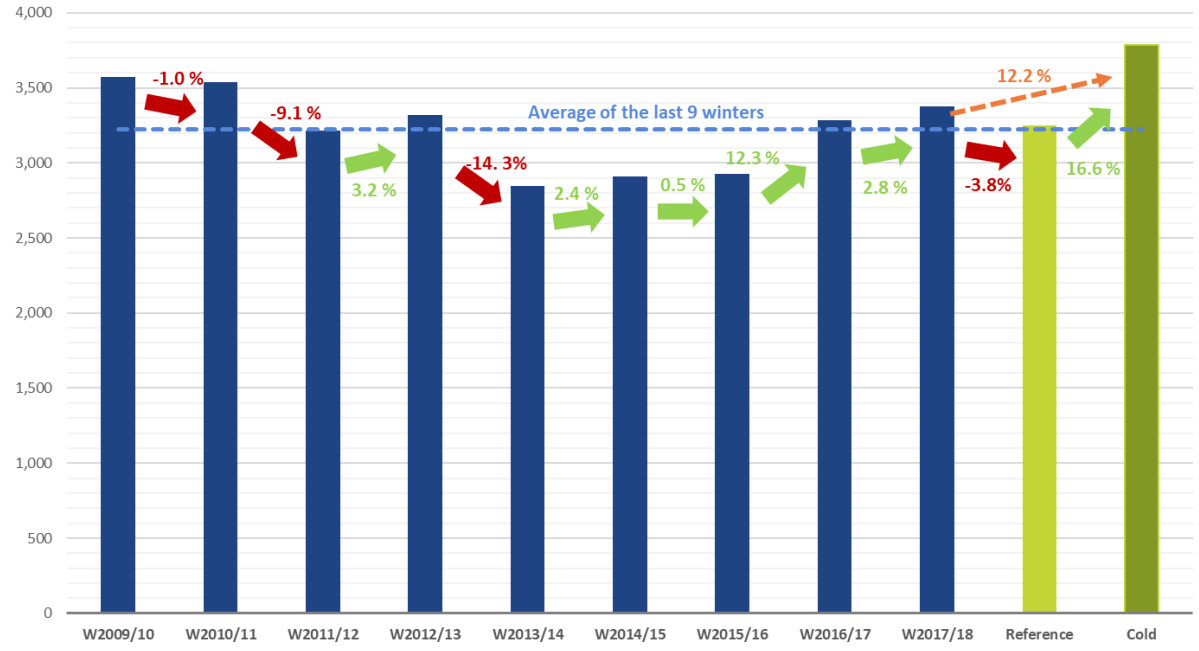


Figure 1.- European seasonal demand in the last 9 winters compared with the two visions

The Reference Winter demand is lower than the one observed during the last winter (-3.8%) and close to the Winter 2016/17 demand. The Cold Winter demand is higher than the last seven winters and close to the winter 2009/10 demand. Compared with the last winter, the Cold Winter demand shows an overall increase of 12.2% of the total demand.

[3] 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

Furthermore, Reference and Cold Winter are higher compared with average demand of last nine winter, 0.9 % and 17.6% respectively.

2.2. Peak demand

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

Period	Occurrence of the demand provided by each TSO
Peak day	National design standard for gas demand, taking place on 15th February
2-week Cold Spell	High demand during a 14-day period in February (cold spell), taking place 15th -28th February.

The peak day and 2-weeks demand is 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).

As well as in the case of seasonal demand, the **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 9 winters. Also, the **Figure 3** shows the European aggregated peak day demand.

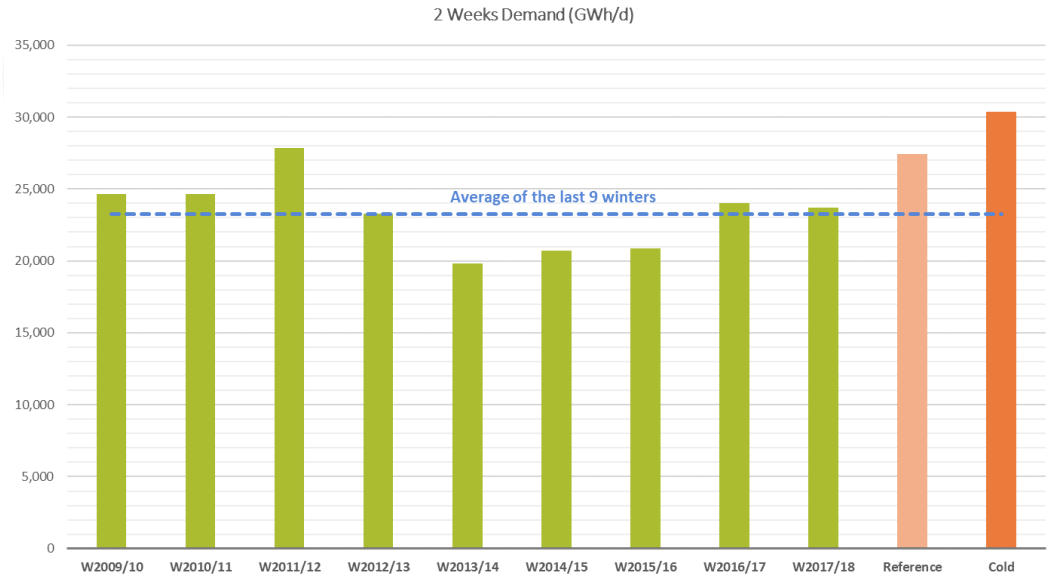


Figure 2.- European 2-week demand history (2009 – 2018) compared with Reference and Cold 2-week demand.

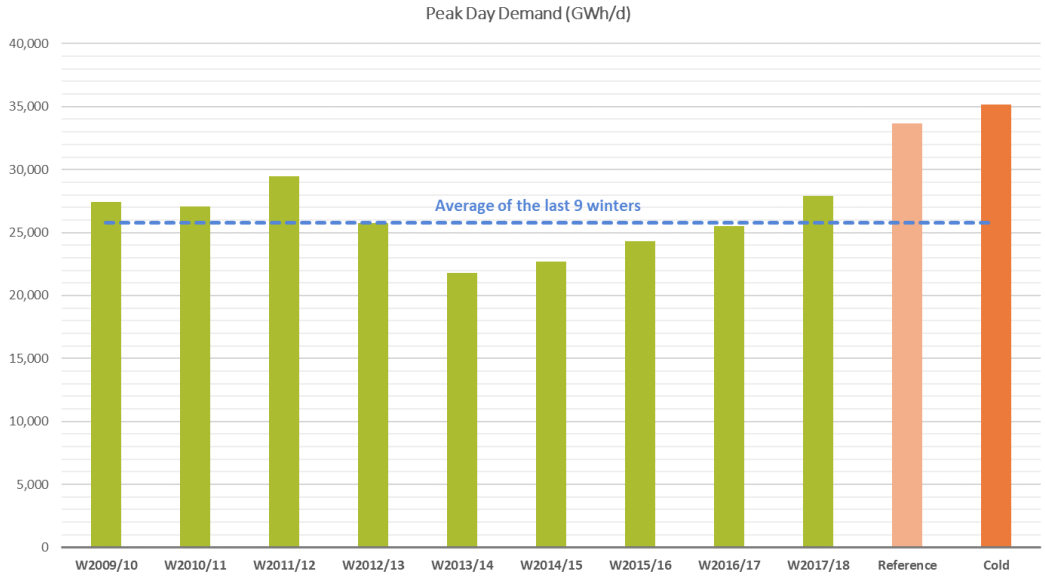


Figure 3.- European peak day demand history (2009 – 2018) compared with Reference and Cold winter.

The 2-weeks cold spell for Reference Winter demand is higher than the one observed during the last winter (+15.7%) and also higher to the average of the last nine winters (+17.9%). In the case of the 2-weeks cold spell[4] for Cold Winter the difference is even high (+28.1%) compared with the Winter 2017/18.

Peak day demand for Reference Winter is considerably higher than the last nine winters. Compared with the last winter, the peak day demand shows an overall increase of 20.7% and compared with the average of the last nine winters the increment is 17.9%.

2.3. Supply

The maximum supply potentials of the different sources providing gas to EU via pipeline (Algeria, Libya, Norway, Russia and LNG) are based on a five years history. Regarding Turkey and the different LNG basins, it is based on the maximum supply potential defined in TYNDP2018. The detailed data in provided in the annexes.

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

[4] 2 weeks 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.

historical observations5. For each of the winter demand profile and high demand situation, specific gas supply maximum availability has been defined as below:

<table>
<tr><th></th><th>National Production</th><th>UGS[6]</th><th>LNG**</th><th>Algeria, Norway, Libya, Russia</th></tr>
<tr><td>Winter Season</td><td>TSO forecast for winter</td><td rowspan="5">Limited for each country (or zone) by the stored volumes and the deliverability associated with the inventory level</td><td colspan="2">Limited for the whole winter period to the highest winter average supply observed during the last 5 winters and at monthly level to the to the maximum 30 days rolling average of the last 5 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</td></tr>
<tr><td></td><td>Limited to the maximum 14 days rolling average of the last 5 winters plus additional LNG that can be taken from the tanks to be shared with week 1.</td><td></td></tr>
<tr><td>1-day Design Case</td><td></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>

**In the case of Cold Winter demand a longer history has been considered for the LNG maximum supply in order to be properly reflected. In the case of pipeline maximum supply, the five last years' history reflects well enough the flexibility.

Figure 4 shows historical seasonal supply for last five winter for pipeline imports and LNG imports. In the graphs, the maximum supply potential considered are indicated.

[5] The methodology and an example of the supply assumptions calculations can be found in SoS simulations report, point 3.4. (page 13).https://www.entsog.eu/public/uploads/files/publications/sos/ENTSOG%20Union%20wide%20SoS%20simulation%20report_INV0262-171121.pdf

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

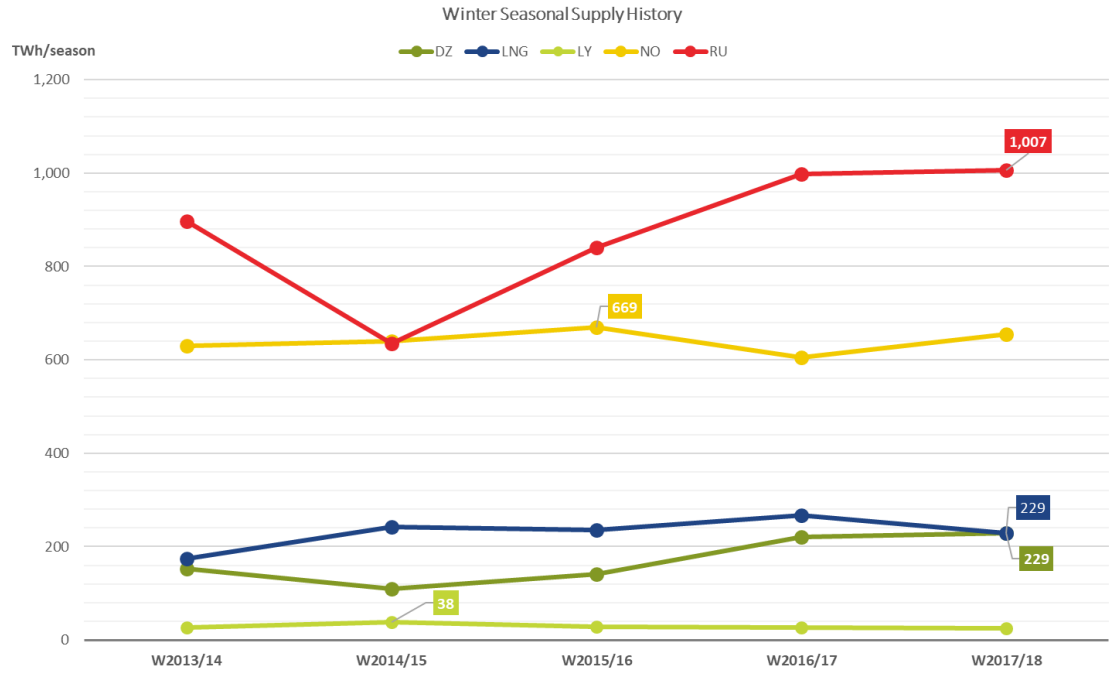


Figure 4.- Winter supply limitation.

Figure 5 and 6 show historical 30-days rolling average supply and historical 14-days rolling average supply for last five winters.

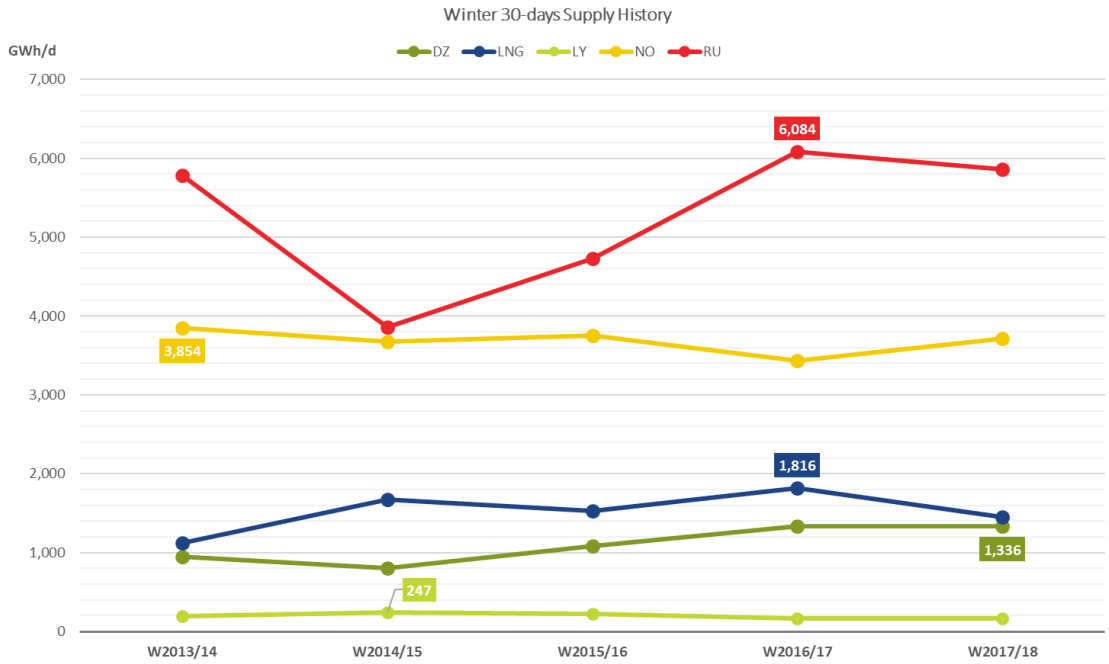


Figure 5.- 30-days supply limitation.

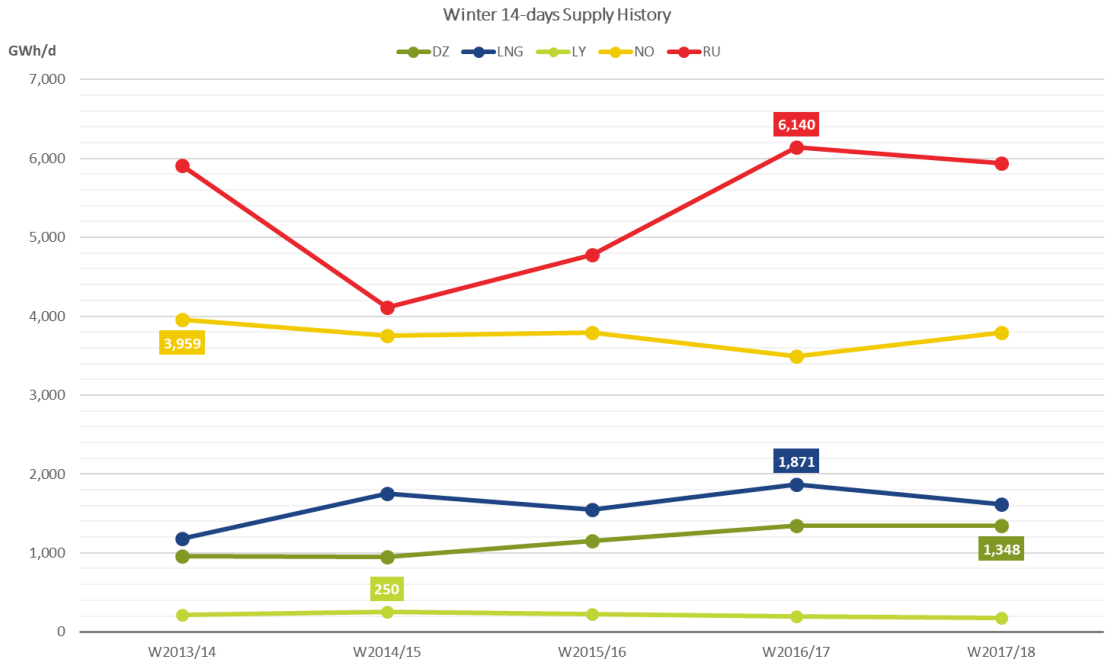


Figure 6.- 14 days supply limitation.

Figure 7 shows the historical daily maximum supplies during the last five winters.

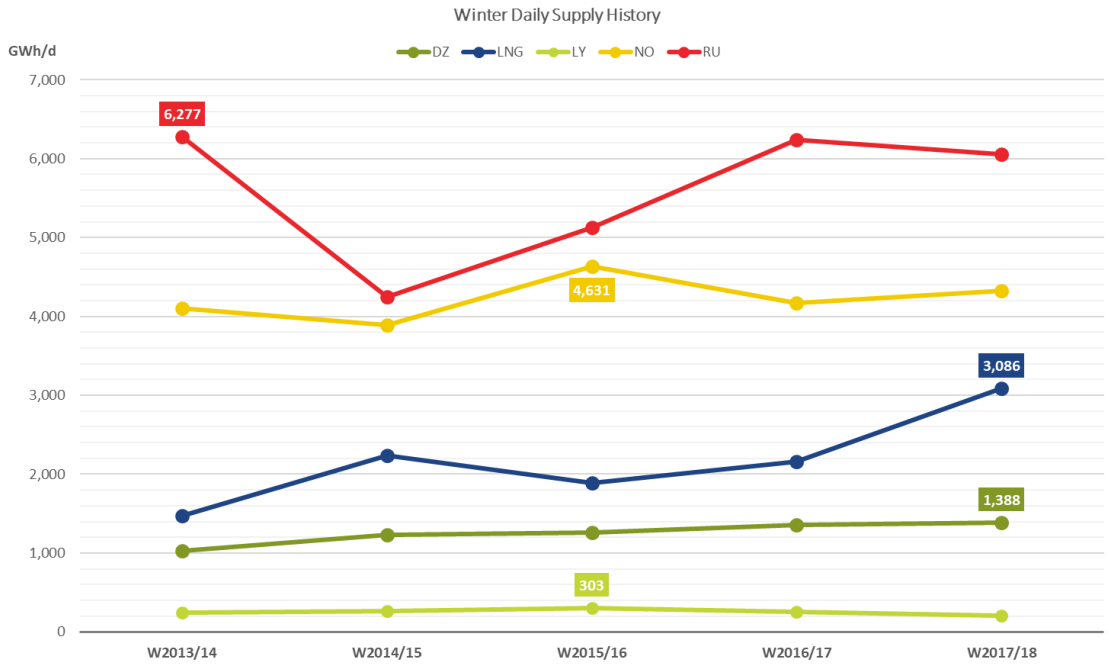


Figure 7.- Daily supply limitation.

2.4. Treatment of Non-EU countries

When assessing the supply adequacy at European level, ENTSOG takes into account the interactions with the countries neighbouring the EU: Switzerland, FYROM, 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:

- Switzerland, Bosnia, FYROM, Serbia are included in the modelling perimeter.
- Ukraine is considered based on the observed exports during the last three years[7].
- Exports to Moldova have been set to zero following an investigation of the previous flows.
- The transits towards Turkey and the Kaliningrad region in Russia are excluded from the Russian supply and the exports have been set to zero.
- Albania, Montenegro and Kosovo are not connected to the gas grid.

3. UGS inventory

3.1. Injection during summer

During the second half of last February and the first week of March, low temperatures in large parts of Europe increased the use of the gas infrastructure, especially storages, reducing their level down to historical minima. According to AGSI+, the gas storage data platform operated by GIE, the storage withdrawals reached 11.4 TWh on the 28th February 2018, not only the highest during the whole winter but also since 2011. In some countries, for example in Germany, more than half of the daily consumption was sourced from gas storages.

The heavy use of gas storage this year highlights the crucial role in coping with high demand variations that underground gas storages along with LNG terminals play.

On the 1st April, the gas in the storages was 190 TWh, the lowest value from 2011 to start the injection period. **Figure 8** shows the total WGV, the initial gas in the storages on 1st April and the gas injected during the summer season from 2011.

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

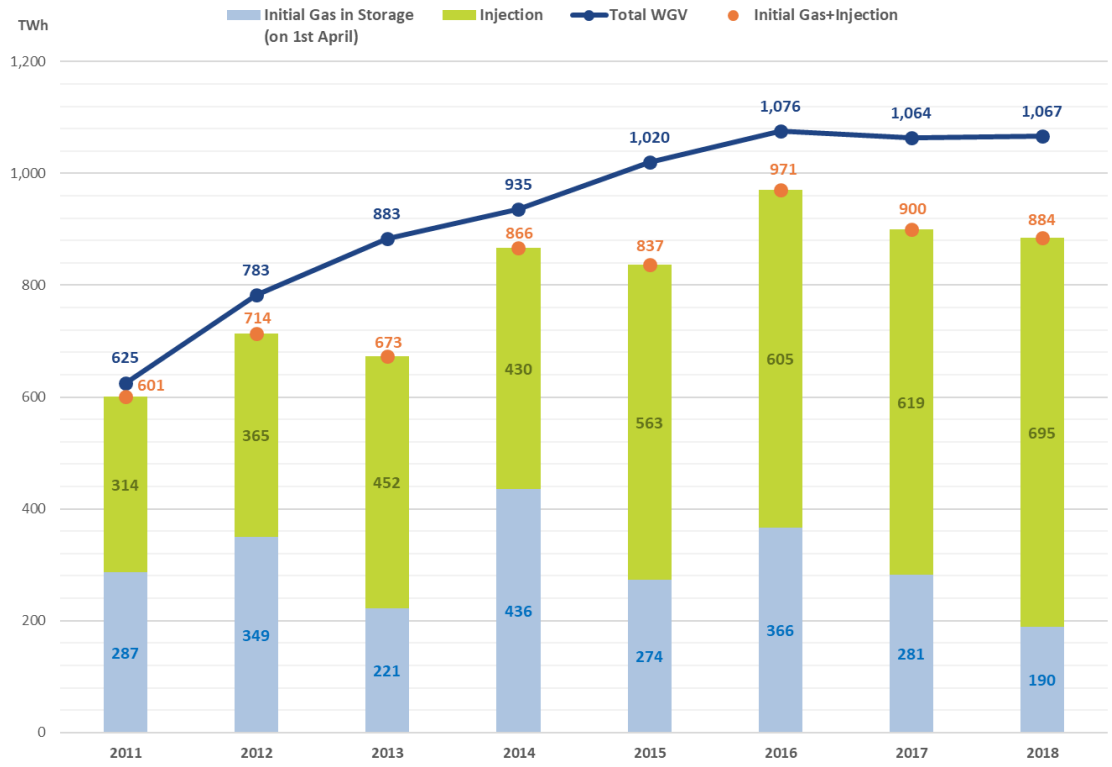
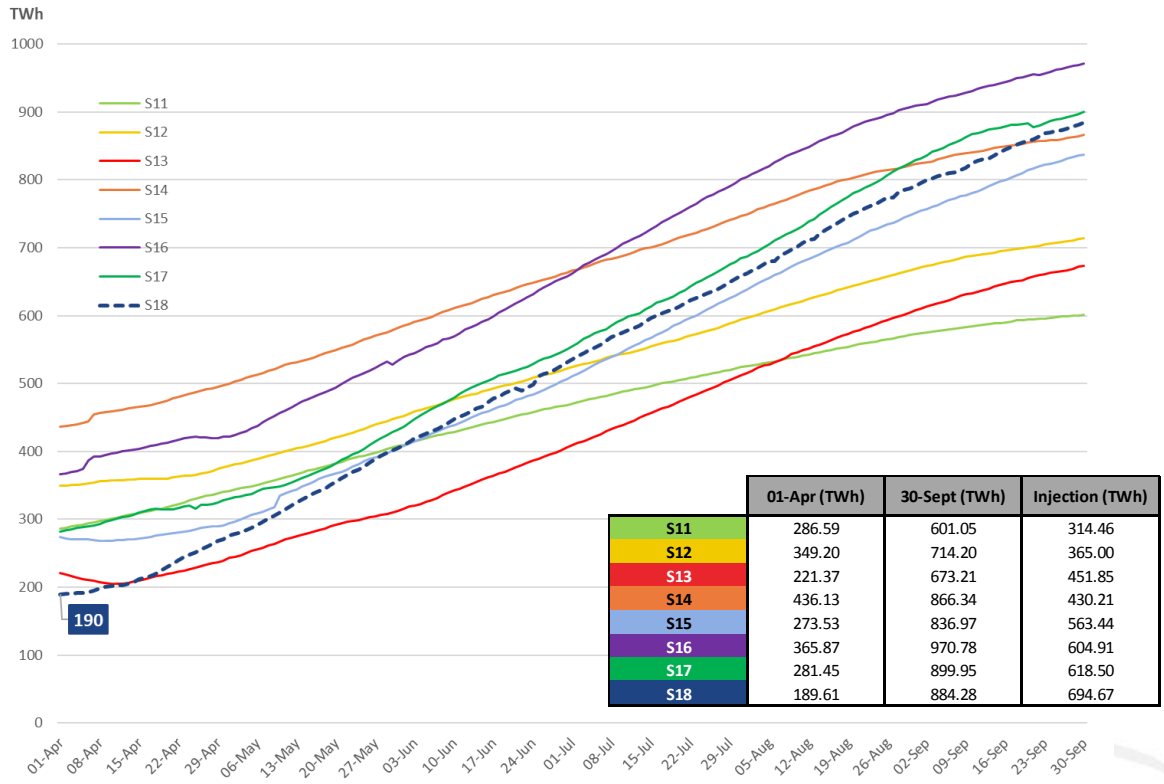


Figure 8.- Situation of the storages during summer season from 2011 [8].

In the summer injection period in 2018, the volume of injected gas is the highest in last seven years and compensates for the historically low gas level in storages on 1st April 2018. Therefore, the level of inventory is similar to previous years. Also, it is important to highlight that the injection volume increases year by year.

Figures 9 compare the stock level evolution of the last eight summers highlighting the initial level on 1st April 2018.

[8] The total WGV and gas in storages is based on the AGSI+ platform data captured on 1st October of each year. This total WGV is not used in the simulations or in the calculation of % WGV total and per country. In these calculation, WGV from GSE map is used. The total gas in storages in 1st October is 884 TWh plus 13 TWh from Latvian storage (information not available in AGSI+).



	01-Apr (TWh)	30-Sept (TWh)	Injection (TWh)
S11	286.59	601.05	314.46
S12	349.20	714.20	365.00
S13	221.37	673.21	451.85
S14	436.13	866.34	430.21
S15	273.53	836.97	563.44
S16	365.87	970.78	604.91
S17	281.45	899.95	618.50
S18	189.61	884.28	694.67

Figure 9.- Evolutions of UGS stock level. Summers 2011-2018 (TWh) (Source: AGSI+).

3.2. Initial storage level on 1st October

The Winter Supply Outlook takes into account the actual storage inventory level per country as of 1st October 2018[9] as the initial situation exposed in **Figure 10.** As shown in the next map the storage inventory levels differ from country to country.

[9] The gas in storage on 1st October 2018 for each country is based on the AGSI platform captured on 1st October 2018 complemented by other information sources for storages not reported on AGSI. For Latvia, the initial storage level is based in the information provided in the TSO website (data from Latvian INČUKALNS UGS UTILISATION https://capacity.conexus.lv/?lang=eng). For Serbia, the initial storage is considered 0% due to no availability of data.

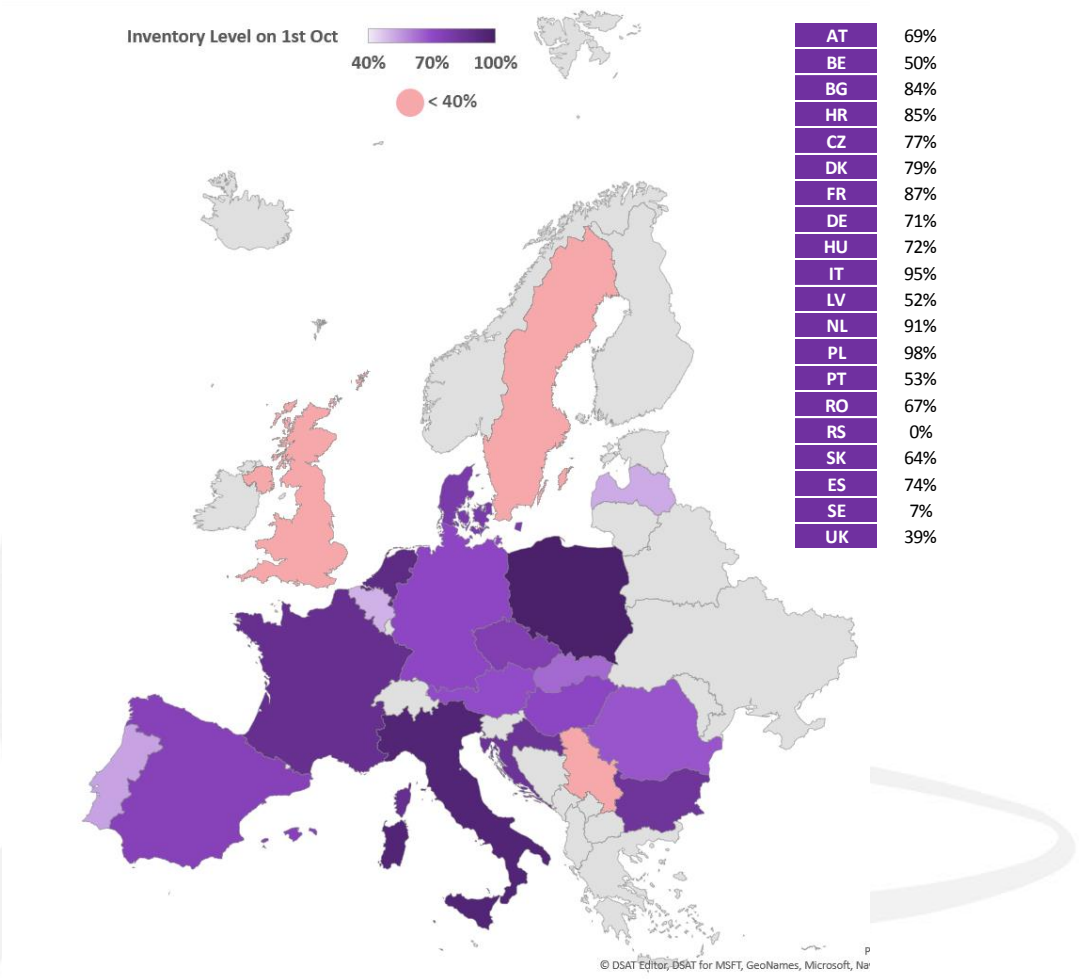


Figure 10.- Actual storage inventory level on 1st October (for some countries, the initial level includes strategic stocks)[10].

In terms of absolute volumes in gas storages, the largest ones are located in Germany, Italy, France and the Netherlands. On 1st October 2017, the initial average UGS inventory is around 897 TWh while the previous winter was 900 TWh. It means 5 points lower (79% vs 84%) with a mixed picture across EU countries. In particular, Serbia, Sweden and United Kingdom[11] face an inventory level on the 1st October below 40%.

[10] The percentage of the storage level is calculated considering the data from AGSI+ data platform (except for Latvia and Serbia) for gas in storage and from last GSE map for total WGV.

[11] Sweden's low initial inventory level is explained by a small WGV (105 GWh) which is also underutilized. This storage will be to take out of operation during 2019.

The actual levels for each country show substantial differences from one country to the other. These levels per country have been used as a starting point for the Winter Supply Outlook 2018/19.

These levels can change during the month of October because the injection season continues in some countries until 1st November.

4. Results for Reference Winter and Cold Winter

4.1. Demand balance along the winter

The actual UGS inventory level at the beginning of the season, together with the supply availability and the demand levels considered, enable the supply and demand balance in all the countries along both a Reference Winter and a Cold Winter.

Figure 11 shows the supply and demand balance at European level for the Reference Winter and the Cold Winter demands.

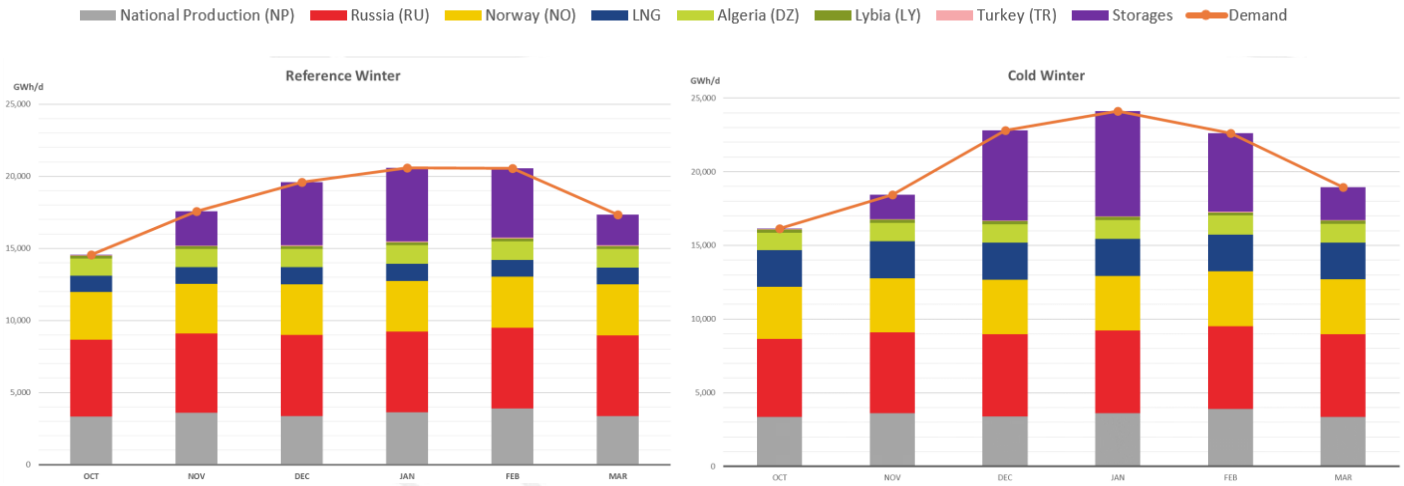


Figure 11: Supply and demand adequacy - Reference Winter vs Cold Winter

These graphs illustrate the changes in supply and demand[12] for the Cold Winter compared to the Reference Winter. For the Cold Winter simulation all supplies are used at their maximum level from November onwards, the extra supply of LNG and storages allow for the flexibility in the cold winter demand.

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

As a result of this analysis there are no indications that supply flows will significantly differ from the ones noted in the last years. The supply assumptions are based on the supply observed in the last five 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 UGS inventory level

Figure 12 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:

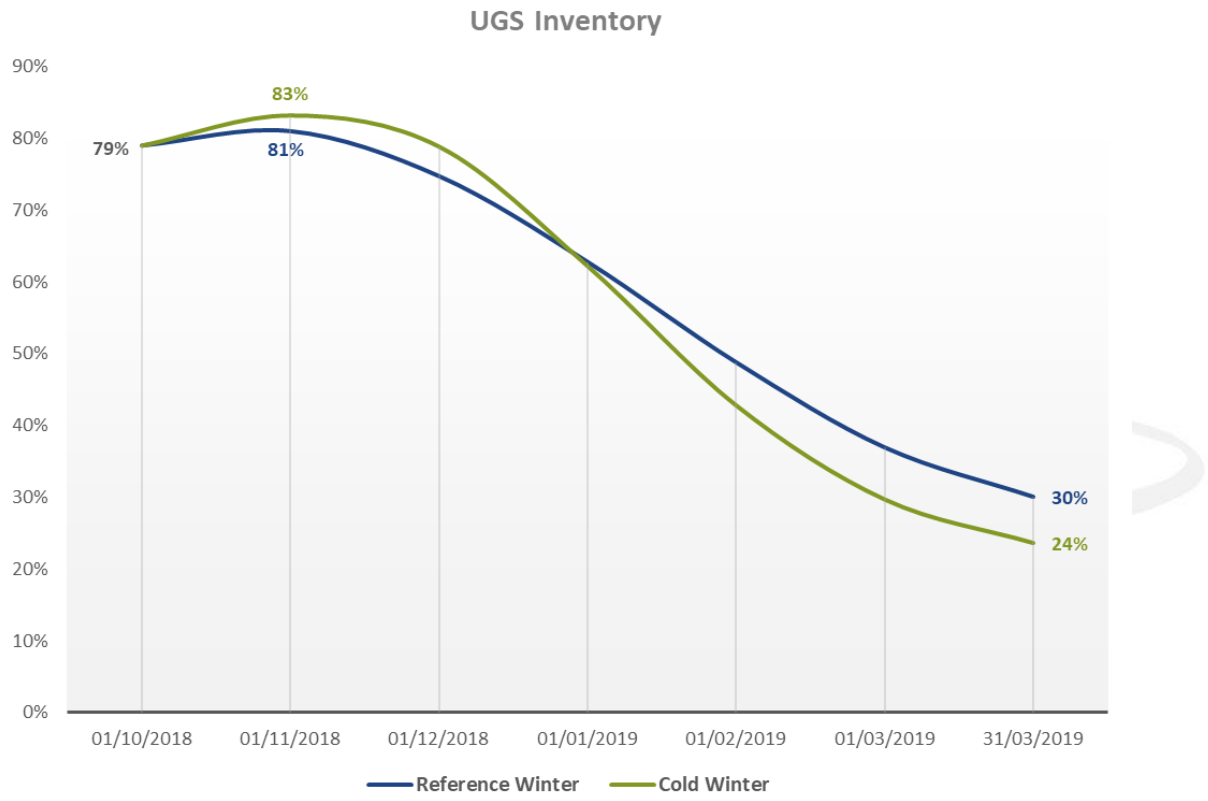


Figure 12 - Winter evolution of the aggregated UGS stock level

The inventory levels targets (30% and 55% in the case of Spain) can be reached at the end of the winter in all the EU countries for Reference Winter. The associated withdrawal of gas from storages combined with the supply flexibility is sufficient to cover the demand.

However, in order for shippers to get prepared for a cold winter, based on the assumed supply flexibility, further injection would be necessary in October. Under these assumptions, EU aggregated inventory level at the end of the Cold Winter would be 24%.

Moreover, storage levels would be even lower if the LNG flexibility would not materialize at the significant levels that have been assumed for the Cold Winter. Such flexibility was last observed more than five years ago during the period of years 2009 to 2011, prior to the Fukushima nuclear disaster.
The following table provides the results of the UGS inventory level evolution:

Table 1.- Monthly EU inventory level for Reference Winter and Cold Winter

% WGV	01/10/2018	01/11/2018	01/12/2018	01/01/2019	01/02/2019	01/03/2019	31/03/2019
Reference Winter	79%	81%	75%	63%	49%	37%	30%
Cold Winter	79%	83%	79%	62%	43%	30%	24%

5. Results for high demand situations

5.1. Demand balance

The high demand situations are considered as taking place in February and to happen in a Refence Winter situation or in the Cold Winter situation. The initial storages levels are based on the whole winter simulations for 14th February (end of day), for both Peak Day and 2-Week cold spell as shown as example in the following graphs for Cold Winter situation. The corresponding storage withdrawal deliverability curve is considered (Annex A).

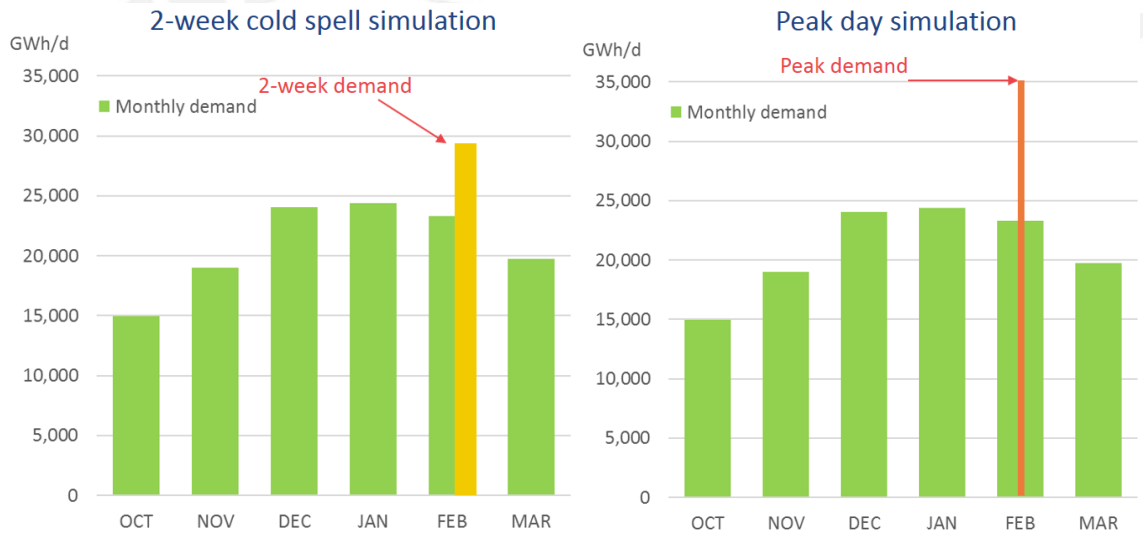


Figure 13.- 2-Week and Peak Day simulations

Figure 14 compares the supply mix for the winter in February and the two high demand situations:

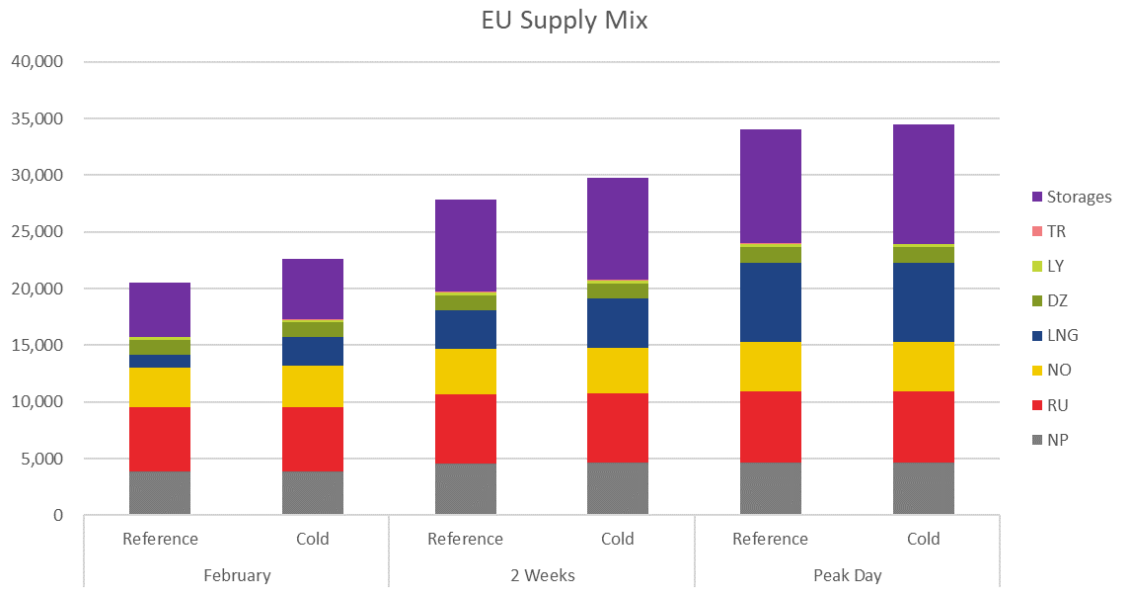


Figure 14.- Comparison of supply mixes in February vs high demand situations (LNG includes tanks withdrawal)

In high demand situations, there is an increment in all supplies sources compared with February flows. This increment is observed in LNG and storages.

In the 2-Week cold spell, there is a change between week1 and week2 due to the additional LNG flexibility from the tanks. In case of Peak Day demand, the LNG and storages flexibility are necessary to cover the demand. The maximum LNG send-out is reached as the indigenous production peak applies.

5.2. Indicators

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

- The potential level of demand curtailment (curtailment rate). The curtailment rate represents the share of the gas demand that cannot be satisfied (calculated as a daily volume). The level of curtailment is assessed considering a cooperative behavior between European countries in order to mitigate its relative impact. This means that countries try to reduce the disrupted rate of other countries by sharing it.
- The Remaining Flexibility indicator measures resilience at balancing zone level to cope with climatic stress and route disruption (see Annex C for detailed calculation process).

The next table represents the summary of all the results obtained:

Table 2.- Indicators results for high demand situations in Reference and Cold Winter.

		Reference Winter	Cold Winter
Peak Day	**Curtailment**	NONE	BA: 13%
	Rem. Flexibility below 20%	BA: 3% FI: 8% SE: 11%	BA: 0% SE: 2% FI: 8%
2Weeks	**Curtailment**	NONE	NONE
	Rem. Flexibility below 20%	FI: 18 %	SE: 2% BA: 17% FI: 18 %

The results for the **Reference Winter** indicate:

- **Peak day**: No demand curtailment but some countries show a very low Remaining Flexibility (Bosnia and Finland) and other countries below 20% (Sweden).
- During the **2-week Cold Spell**: No demand curtailment but Finland still shows low Remaining Flexibility below 20%.

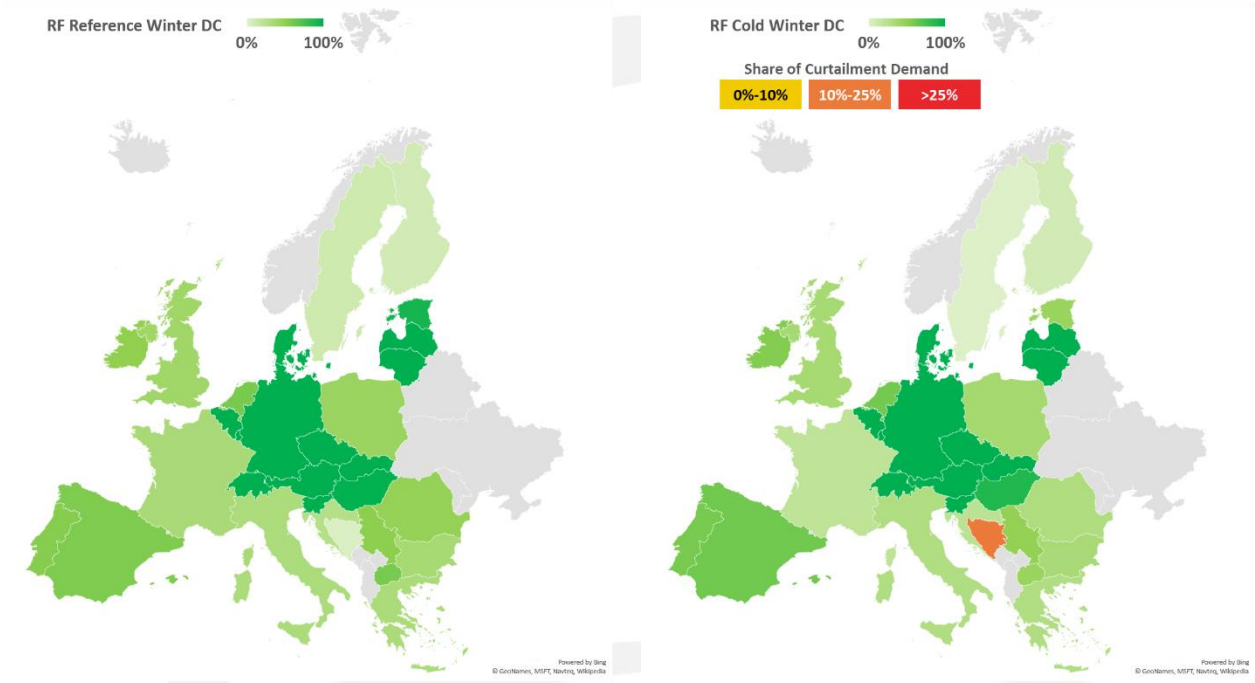
The main results for **Cold Winter** show:

- **Peak day**: Bosnia faces demand curtailment of around 13% of its demand. Sweden shows a lower Remaining Flexibility. Finland maintains its Remaining Flexibility in 8%.
- During the **2-week Cold Spell**: No country faces demand curtailment and only three countries show a low Remaining Flexibility (Sweden, Bosnia and Finland).

Compared with the indicators results of the previous WSO 17-18, the curtailment rate presents the same results. However, Remaining Flexibility shows some differences:

- **In Peak Day, Reference Winter:** Croatia (27%), FYROM (59%), and Greece (33%) increases its Remaining Flexibility because the demand estimated is lower than the previous season. Also, in the case of FYROM there is an increment in the entry capacity from Bulgaria and, in the case of Greece, the entry capacity from the LNG terminal is also increased.
- **In Peak Day Cold Winter:** the demand used in the WSO 17-18 and in this WSO is the same and in line with Security of Supply simulations report. FYROM (43%), Greece (29%) and United Kingdom (35%) increased its Remaining Flexibility due to the increment in the entry capacity from Bulgaria, LNG terminal and National Production respectively.

5.3. Results for 1-day Design Case during Reference Winter vs. Cold Winter



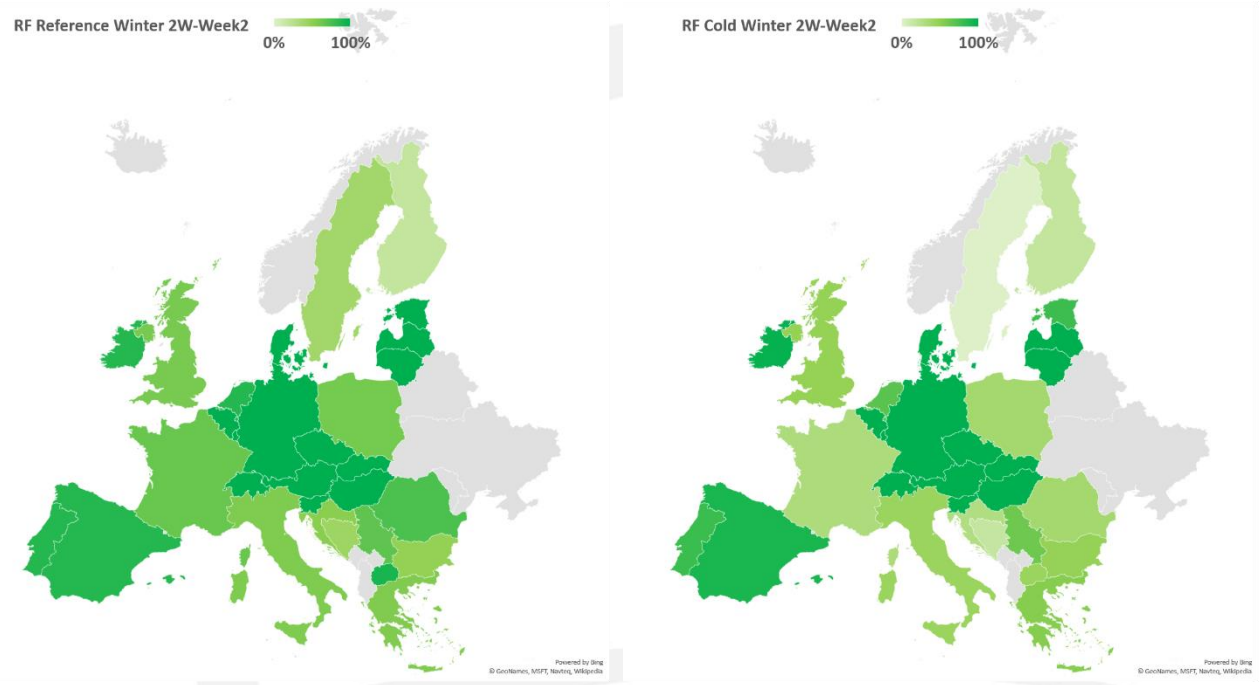
Figures 15.- Peak Day results (Remaining Flexibility and Curtailment Rate) in Reference and Cold Winters[13].

The results show that only Bosnia faces a potential demand curtailment in case of the Cold Winter peak day as the country demand is 2 GWh/d over the entry capacity.

These indicator results are in line with the results obtained in Security of Supply Simulations Report. The main difference is the curtailment in Denmark and Sweden. In the case of SoS report, the demand curtailment is caused by the reduction on the Danish production from December 2019. This reduction doesn't affect to this next winter season.

[13]In all maps, the value of RF for Germany is the weighted average by demand among the different balancing zones of H-gas. Also, the values for France of Belgium are for H-gas. The values for each balancing zone (including L-gas) are included in the Annex D.

5.4. Results for 2-Week Cold spell during a Reference Winter vs. Cold Winter



Figures 16.- 2-Weeks Cold Spell results (Remaining Flexibility) in Reference and Cold Winters[14].

No country faces demand curtailment in the 2-Weeks Cold spell in Reference Winter nor in Cold Winter.

Finland shows low remaining flexibility in all the high demand situation cases, in both Reference and Cold winters, basically due to their dependence on the single capacity connection to Russia. Sweden low remaining flexibility results, especially during cold winter, is a similar case caused by the limited capacity coming from Denmark and their small storage, which is also underutilized.

The lower level of Remaining Flexibility for Finland and Sweden, especially in the Cold Winter case, is consistent with the results shown in Winter Supply Outlook 2017/18 and previous outlooks.

As in the case of Peak Day, the results are in line with SoS report and the main difference is the curtailment in Denmark and Sweden.

As mentioned before, together with the storages, the LNG supply assumptions allow enough flexibility during the 2-week Cold Spell thanks to the LNG tanks.

[14] The results shown are for second week of the 2-Weeks Cold Spell.

6. Results of disruption case event

This section investigates the impact of a supply route disruption during a high demand situation in the Remaining Flexibility and Curtailment Rate. Only the additional effect compared to the result from the situation without the route disruptions are analysed and highlighted in the maps.

This vision is included in ENTSOG's Winter Supply Outlooks since Winter Supply Outlook 2013/14. However, the last year the assessment of the disruptions effects were developed in the Security of Supply Simulations Report. ENTSOG simulated 17 supply and infrastructure disruption scenarios. For this WSO, the purpose is to verify consistency is ensured between the next Cold Winter and the SoS.

Consequently, in this point, the disruption scenarios in Peak Day and 2-Weeks Cold Spell are tested to confirm that the results are in line with the conclusion of SoS report, keeping in mind that the two months disruptions are not considered and the assumptions in SoS was defined for the next four years.

The criteria to choose these disruptions is based on the effects that these disruptions show in SoS report and the risk groups considered are defined according 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.

6.1. Indicators

As in the case of high demand situations and no route disruption, modelling indicators results consist in the calculation of:

- The Remaining Flexibility indicator measures resilience at balancing zone level to cope with climatic stress and route disruption (see Annex C for detailed calculation process).
- The potential level of demand curtailment (curtailment rate). The level of curtailment is assessed considering a cooperative behaviour between European countries in order to mitigate its relative impact. This means that countries try to reduce the disrupted rate of other countries by sharing it. The route disruption considered are:
  - Ukraine
  - Belarus.
  - Baltics states and Finland supply.
  - Algerian pipes and LNG.

The approach for demand curtailment allocation is applied according with Security of Supply report:

- **Unified allocation:** All member States within the risk group defined in Annex I of Regulation 2017/1938 cooperate by avoiding a demand curtailment to the extent possible by transporting other supply and furthermore by sharing the curtailment equally in such a way that they try to reach the same curtailment rate.

6.2. 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.

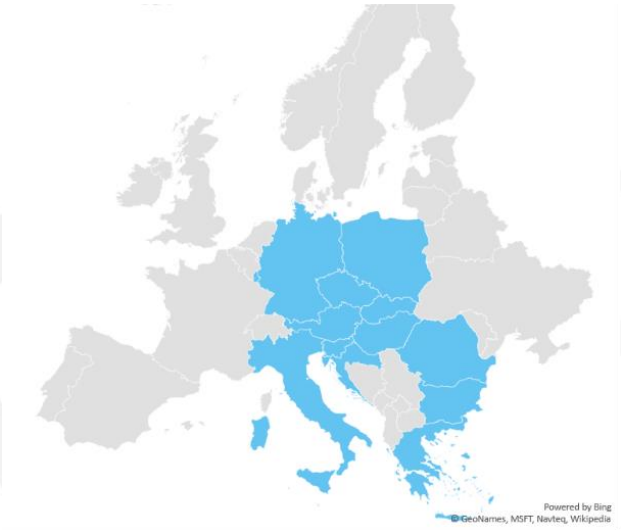


Figure 17.- Risk group for Ukraine transit disruption

Results for a Ukraine transit disruption during a 1-in-20 years Peak day:

The results show that in the case of a Peak Day combined with a disruption of Ukrainian transit, in addition to the countries affected in no route disruption case, some countries in the South-East Europe are facing demand curtailment. At the same time, in Cold Winter Italy and Hungary reduce its Remaining Flexibility.

It is important to highlight that all exports to Ukraine are maintained. Curtailment in the demand of South-East Europe is due to infrastructure limitations. The cease in the exports cannot help to avoid these curtailments.

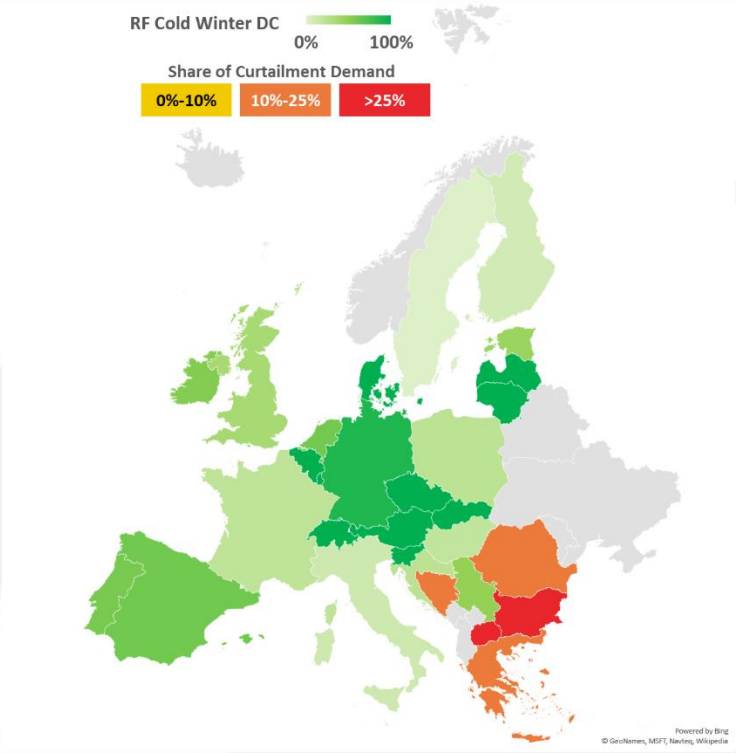


Figure 18.- Peak Day results (Remaining Flexibility and Curtailment Rate) for Ukraine transit disruption[15].

Results for a Ukraine transit disruption during a 1-in-20 years 2-Week Cold Spell:

As in the case of Peak Day, the results show that in case of 2-Week cold spell combined with a disruption of Ukrainian transit, in addition to the countries affected in no route disruption case, some countries in the South-East Europe could face demand curtailment. Also, all exports to Ukraine are maintained.

[15] The maps only show values in the case of new curtailment demand or an important reduction in remaining flexibility compare with no disruption results.

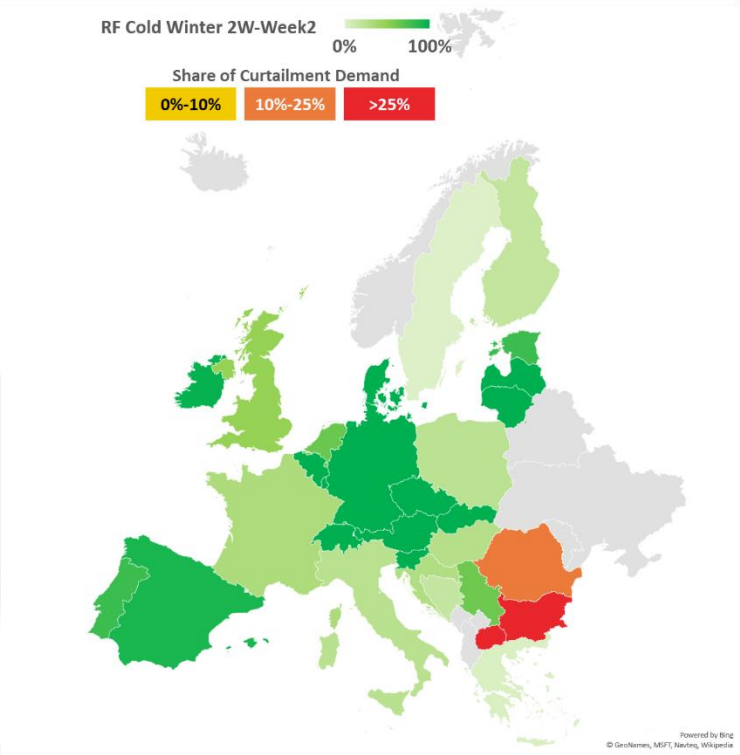


Figure 19.- 2-Weeks cold spell results (Remaining Flexibility and Curtailment Rate) for Ukraine transit disruption.

6.3. 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

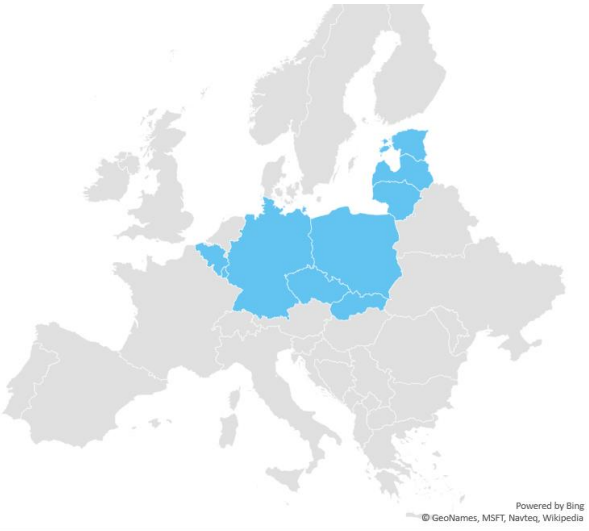


Figure 20.- Risk group for Belarus disruption.

Results for the disruption of Belarus transit during a 1-in-20 years Peak day:

The results show that in the case of a Peak Day combined with Belarus disruption, no country faces demand curtailment apart from Bosnia. As well, Poland, Lithuania and Latvia show a lower level of Remaining flexibility.

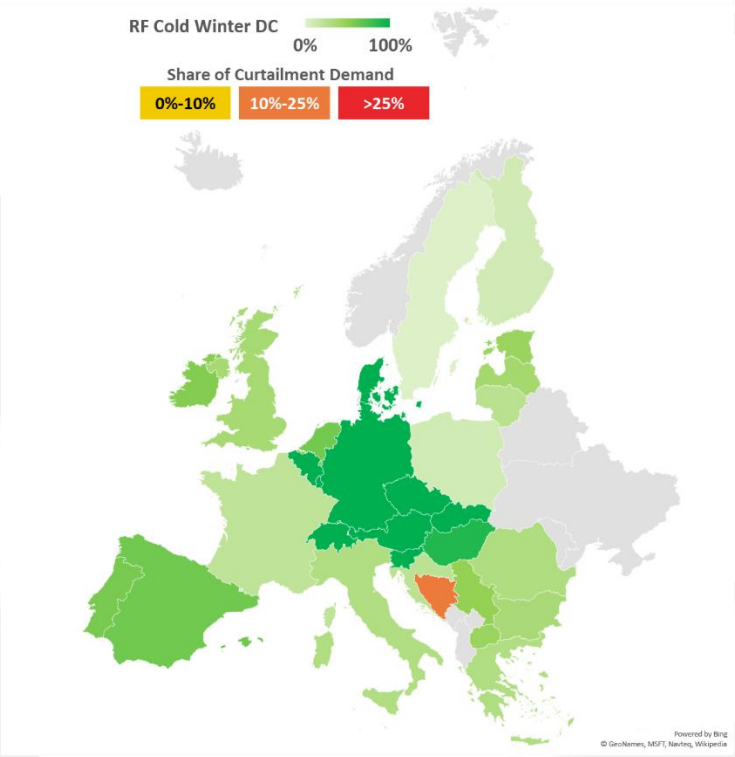


Figure 21.- Peak Day results (Remaining Flexibility) for Belarus disruption.

Results for the disruption of Belarus transit during a 1-in-20 years 2-Week Cold Spell:

As in the Peak Day, the results show that in the case of a 2-Week Cold Spell combined with Belarus disruption, no country faces demand curtailment. Also, Poland shows a lower level of Remaining flexibility.

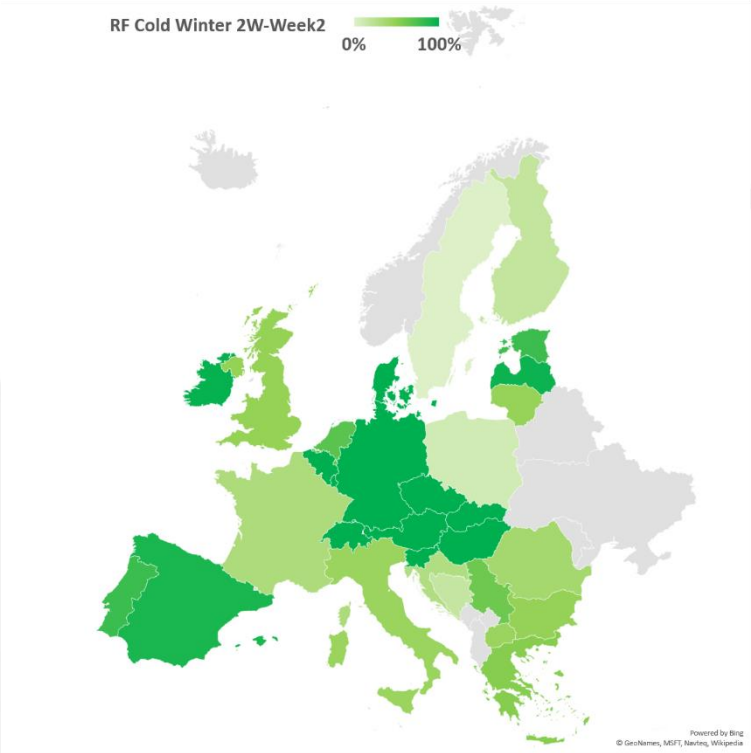


Figure 22.- 2-Weeks Cold Spell results (Remaining Flexibility) for Belarus disruption.

6.4. Baltics 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 23.- Risk group for Baltic states and Finland disruption

Results for a disruption of all pipeline imports to the Baltic states and Finland during a 1-in-20 years Peak day:

The results show that in the case of a Peak Day combined with a disruption of the imports to Baltic states and Finland, in addition to the countries affected in no route disruption case, Estonia and Finland are facing demand curtailment due to infrastructure limitations in the connection with other countries. In the case of Finland, the demand curtailment is 100% because of the no connection to any other country.

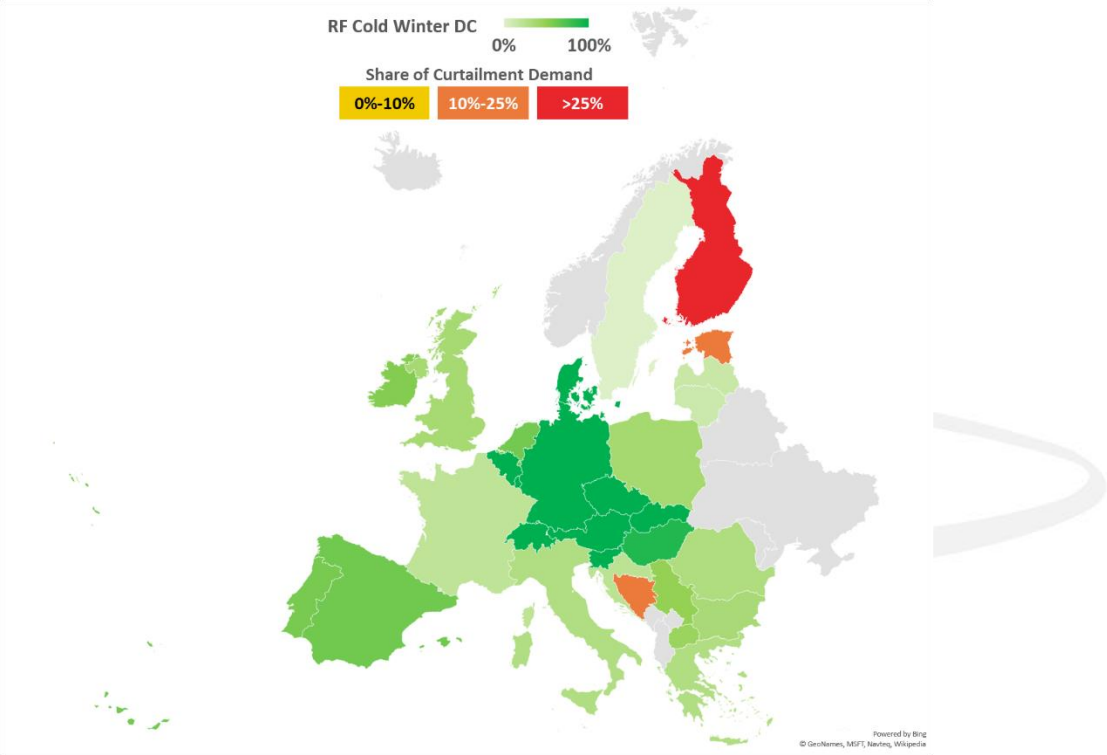


Figure 24.- Peak Day results (Remaining Flexibility and Curtailment Rate) for Baltic states and Finland disruption.

Results for a disruption of all pipeline imports to the Baltic states and Finland during a 1-in-20 2-Week Cold Spell:

The results show that in the case of a 2-Weeks Cold Spell combined with a disruption of the imports to Baltic states and Finland, in addition to the countries affected in no route disruption case, Finland are facing demand curtailment of 100% because of the no connection to any other country. Also, there is a reduction in Remaining Flexibility in Estonia.

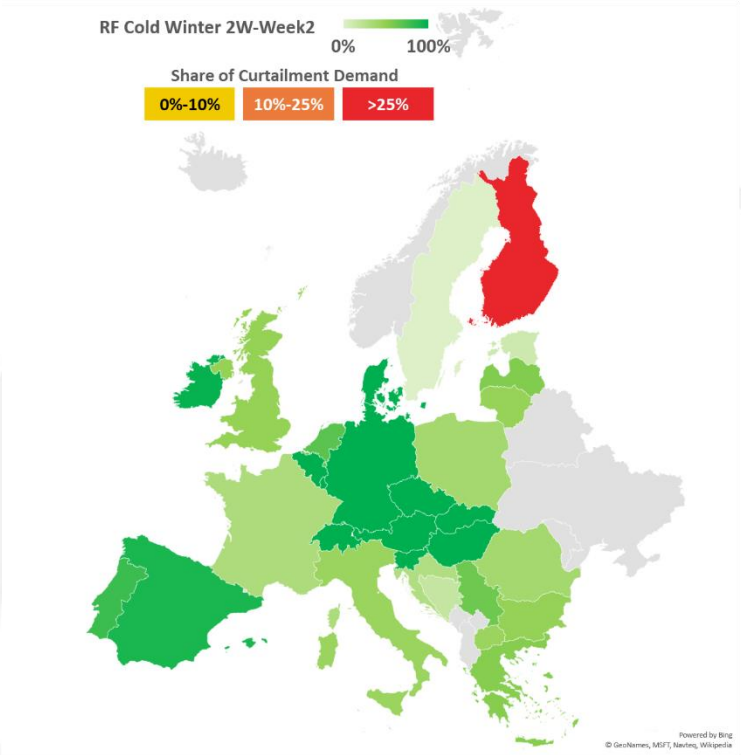


Figure 25.- 2-Weeks Cold Spell results (Remaining Flexibility and Curtailment Rate) for Baltic states and Finland disruption.

6.5. Algerian Pipes and LNG Disruption

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

Figure 26.- Risk group for Algerian pipes and LNG disruption.

Results for a disruption of all pipeline imports and LNG from Algeria during a 1-in-20 years Peak day:

The results show that in the case of a Peak Day combined with Algerian disruption, no country faces demand curtailment apart from Bosnia. The lower level of Remaining flexibility for Italy is consistent with the results in SoS report.

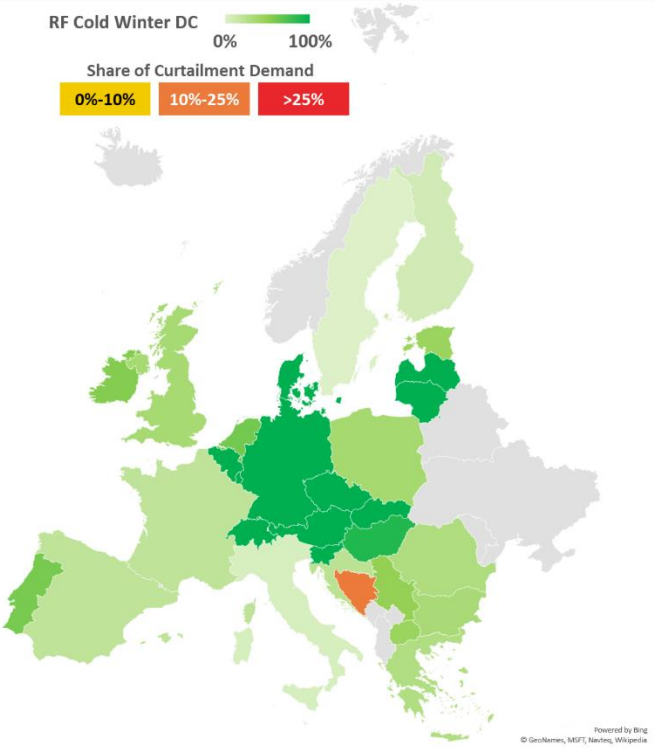


Figure 27.- Peak Day results (Remaining Flexibility and Curtailment Rate) for Algerian disruption[16].

Results for a disruption of all pipeline imports and LNG from Algeria during a 1-in-20 years 2-Week Cold Spell:

As in Peak Day, the results show that in the case of a 2-Week Cold Spell combined with Algerian disruption, no country faces demand curtailment. The lower level of Remaining flexibility for Italy is consistent with the results in SoS report.

[16] The results for Unified allocation and Distance-Based are equal.

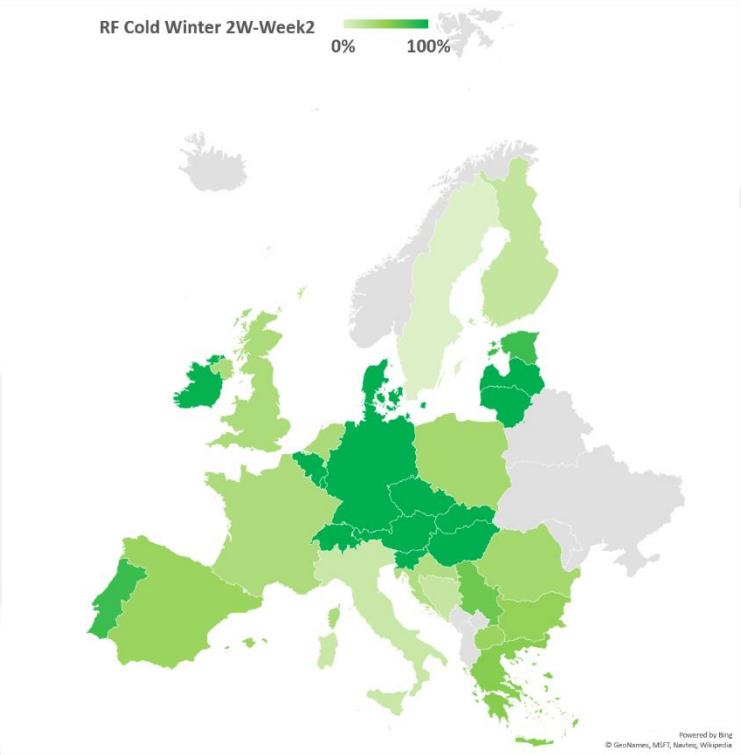


Figure 28.- 2-Weeks Cold Spell results (Remaining Flexibility) for Algerian disruption.

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 2018/19 with sufficient flexibility in most parts of Europe. This assessment is valid throughout the season and under high demand situations.

Winter Supply Outlook 2018/2019 assessment highlights:

- the national production keeps on following a decreasing trend;
- the storage level on 1st October is in the average of the last 5 years;
- in case of cold winter, the LNG terminals utilization would need to be significantly higher than observed over the last 5 years and comparable to 2009-2011 period, prior to the Fukushima nuclear disaster, otherwise the storages at the end of the season could fall to historical low levels;
- shippers keeping on filling storages by 1 November could secure higher flexibility;
- nevertheless, the European gas system offers sufficient flexibility across the season in Europe, provided gas is available;
- the European gas system is also capable of supplying Energy Community Contracting Parties and other EU neighbouring countries with significant volumes of gas;
- limited entry capacity in Bosnia could expose it to demand curtailment during the peak demand day;
- South-East Europe would be significantly exposed in case of a transit disruption through Ukraine under high demand situations.

Please note that the level of storages across Europe significantly contributes to the balance of demand across the season and also to the ability to physically send gas to neighbouring countries.

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 2019 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	Injection 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%	98%	97%	96%	90%	84%	74%	64%	56%	0%
BE	100%	100%	100%	100%	100%	100%	100%	100%	35%	35%	24%	0%
BG	74%	74%	100%	100%	100%	100%	89%	79%	79%	60%	40%	0%
HR	100%	100%	100%	100%	100%	96%	80%	65%	48%	32%	14%	0%
CY												
CZ	100%	100%	100%	100%	100%	97%	80%	70%	50%	40%	40%	0%
CZd*	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
DK	100%	100%	100%	100%	100%	100%	100%	100%	85%	40%	30%	0%
EE												
FI												
FRan	100%	95%	90%	85%	80%	75%	66%	57%	48%	39%	30%	0%
FRas	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%	98%	96%	95%	93%	91%	88%	83%	79%	67%	25%	0%
FRt	100%	100%	100%	100%	100%	100%	91%	74%	57%	39%	22%	0%
DE	100%	99%	99%	98%	97%	97%	86%	75%	63%	49%	36%	0%
GR												
HU	100%	100%	100%	100%	100%	97%	95%	84%	73%	50%	38%	0%
IE												
IT	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
LV	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
LT												
NL	100%	97%	95%	92%	90%	87%	80%	73%	64%	55%	46%	0%
PL	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
PT	100%	100%	99%	98%	97%	92%	86%	79%	74%	63%	39%	0%
RO	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
RS	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
SK	100%	99%	97%	96%	93%	88%	82%	74%	65%	55%	44%	0%
SI												
ES	100%	80%	72%	67%	63%	60%	55%	50%	45%	40%	40%	0%
SE	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%
UK	100%	98%	96%	95%	94%	91%	83%	75%	64%	52%	40%	0%

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

Figure 29 - UGS deliverability curves

Annex B - Data for Winter Supply Outlook 2018/19

Indigenous Production

GWh/d	OCT	NOV	DEC	JAN	FEB	MAR	2W-Week1	2W-Week2	DC
National Poduction	3,343.2	3,613.0	3,382.8	3,626.5	3,898.9	3,367.0	4,564.5	4,564.5	4,666.0

Figure 30. – Supply assumptions indigenous production

Supply assumptions (maximum per period)

GWh/d			DZ	LY	NO	RU	LNG	LNG*
Winter Period	Max on Whole Winter		1,261	208	3,677	5,530	1,463	2,500
	Max per 30 days		1,336	247	3,854	6,084	1,816	2,500
High Demand	2-week Cold Spell	Week 1	1,348	250	3,959	6,140	***	***
		Week2	1,348	250	3,959	6,140	1,871	6,318
	1-day Design Case		1,388	303	4,631	6,277	3,086	6,318

** LNG sensitivity for Cold Winter*

Figure 31.– 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	41%
FRn	73%
FRs	58%
GR	40%
IT	15%
LT	3%
NL	35%
PL	38%
PT	44%
UK	38%

Figure 32.-LNG tank flexibility

Reference Winter Demand

Country	October	November	December	January	February	March	2W-Week1	2W-Week2	DC
AT	264	359	399	459	435	337	459	459	459
BA	4	7	8	8	9	7	10	10	14
BEh	464	528	571	575	548	486	903	903	1,001
BEl	165	222	259	260	260	228	374	374	460
BGn	85	107	127	137	128	102	157	157	173
CH	92	134	164	174	164	130	225	225	230
CZ	250	324	409	419	452	323	592	592	727
DEg	1,001	1,198	1,328	1,360	1,353	1,183	1,694	1,694	2,086
DEgL	193	247	282	290	288	243	1,895	1,895	2,460
DEn	896	1,180	1,368	1,413	1,403	1,159	380	380	486
DEnL	379	492	567	585	581	483	777	777	1,003
DK	78	104	119	125	121	107	140	140	236
EE	15	18	20	27	23	20	40	40	53
ES	876	1,073	1,131	1,214	1,216	1,089	1,591	1,591	1,872
FI	51	68	84	107	110	89	220	220	240
FR	1,080	1,678	1,974	2,179	2,250	1,702	2,780	2,780	3,621
FRnL	109	155	195	202	193	153	263	263	358
GR	134	136	173	184	147	117	192	192	222
HR	87	110	112	113	129	105	140	140	174
HU	295	405	520	660	510	360	540	540	780
IE	145	143	184	170	192	151	233	233	291
IT	1,798	2,485	3,138	2,891	3,256	2,704	3,972	3,972	4,933
LT	67	76	80	84	74	73	109	109	119
LU	22	30	33	35	38	32	50	50	53
LV	39	37	46	61	79	64	94	94	114
MK	5	5	10	10	9	5	14	14	17
NL	972	1,246	1,361	1,538	1,524	1,281	3,269	3,269	3,867
PL	527	613	677	706	672	631	825	825	950
PT	170	198	170	197	186	143	213	213	263
RO	324	440	508	528	545	483	581	581	697
RS	62	62	62	62	62	62	95	95	104
SE	23	30	36	40	39	33	63	63	79
SI	25	34	37	36	43	37	46	46	61
SK	136	175	200	226	204	165	285	285	343
UK	2,563	3,035	2,827	3,105	2,893	2,660	4,167	4,167	5,076
UKn	47	53	52	54	59	46	69	69	69
TOTAL	13,442	17,206	19,230	20,235	20,197	16,991	27,455	27,455	33,692

Note: Germany and France balancing zones (DEg: GASPOOL, DEn: NCG, DEgL: GASPOOL L-gas, DEnL: NCG L-gas, FRnL: GRTgaz Nord L-gas).

Figure 33. – Demand and exports forecasts in reference winter

Cold Winter Demand

Country	October	November	December	January	February	March	2W-Week1	2W-Week2	DC
AT	302	335	441	414	412	339	471	471	471
BA	4	6	9	11	7	5	12	12	16
BEh	404	483	614	718	663	527	883	883	964
BEl	113	135	171	200	185	147	378	378	454
BGn	87	107	127	150	128	101	157	157	173
CH	109	151	184	219	162	119	225	225	230
CZ	259	303	479	421	432	315	592	592	727
DEg	990	1,180	1,367	1,522	1,380	1,205	1,694	1,694	2,086
DEgL	191	242	292	334	296	249	380	380	486
DEn	881	1,155	1,424	1,647	1,443	1,191	1,895	1,895	2,460
DEnL	373	482	589	678	597	496	777	777	1,003
DK	66	93	115	126	122	106	190	190	230
EE	16	22	39	38	31	36	57	57	70
ES	1,031	1,257	1,281	1,292	1,269	1,135	1,549	1,549	1,823
FI	103	114	148	152	131	140	220	220	240
FR	1,197	1,845	2,465	2,243	2,088	1,711	3,278	3,278	3,893
FRnL	143	206	265	223	187	150	336	336	391
GR	125	158	152	186	191	149	191	191	228
HR	91	121	107	107	145	93	161	161	175
HU	314	425	539	623	574	443	780	780	820
IE	146	166	193	202	201	188	220	220	282
IT	2,139	2,718	3,618	3,590	3,373	2,885	4,122	4,122	4,825
LT	76	74	82	98	68	76	128	128	151
LU	43	46	57	54	53	47	59	59	72
LV	49	60	89	79	95	70	104	104	135
MK	8	11	14	17	13	4	19	19	19
NL	1,189	1,297	1,742	2,058	1,921	1,496	3,454	3,454	3,706
PL	460	588	647	746	669	550	929	929	973
PT	160	180	176	198	181	176	221	221	252
RO	353	538	528	561	638	458	719	719	776
RS	62	62	62	62	62	62	95	95	104
SE	23	31	37	43	41	34	86	86	86
SI	33	40	42	47	46	39	56	56	62
SK	156	205	269	281	253	229	441	441	496
UK	2,450	3,165	3,969	4,325	4,107	3,551	416	416	416
UKn	61	66	68	74	72	68	4,403	4,403	5,144
TOTAL	**14,208**	**18,065**	**22,399**	**23,738**	**22,238**	**18,592**	**29,698**	**29,698**	**34,439**

Note: Germany and France balancing zones (DEg: GASPOOL, DEn: NCG, DEgL: GASPOOL L-gas, DEnL: NCG L-gas, FRnL: GRTgaz Nord L-gas).

Figure 34.– Demand and exports forecasts in SoS Cold Winter

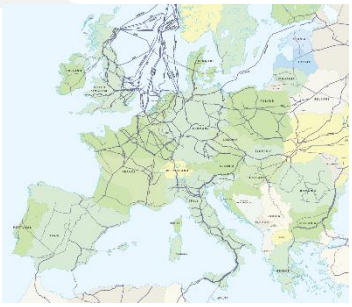
Exports to Ukraine

Country	October	November	December	January	February	March
UAe	364	364	364	364	364	364

Annex C – Modelling approach

The simulations consider the existing European gas infrastructure as of 1st October 2018.

ENTSOG modelling tool (NeMo) builds on TSO expertise and hydraulic modelling of national infrastructure to model the European 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.



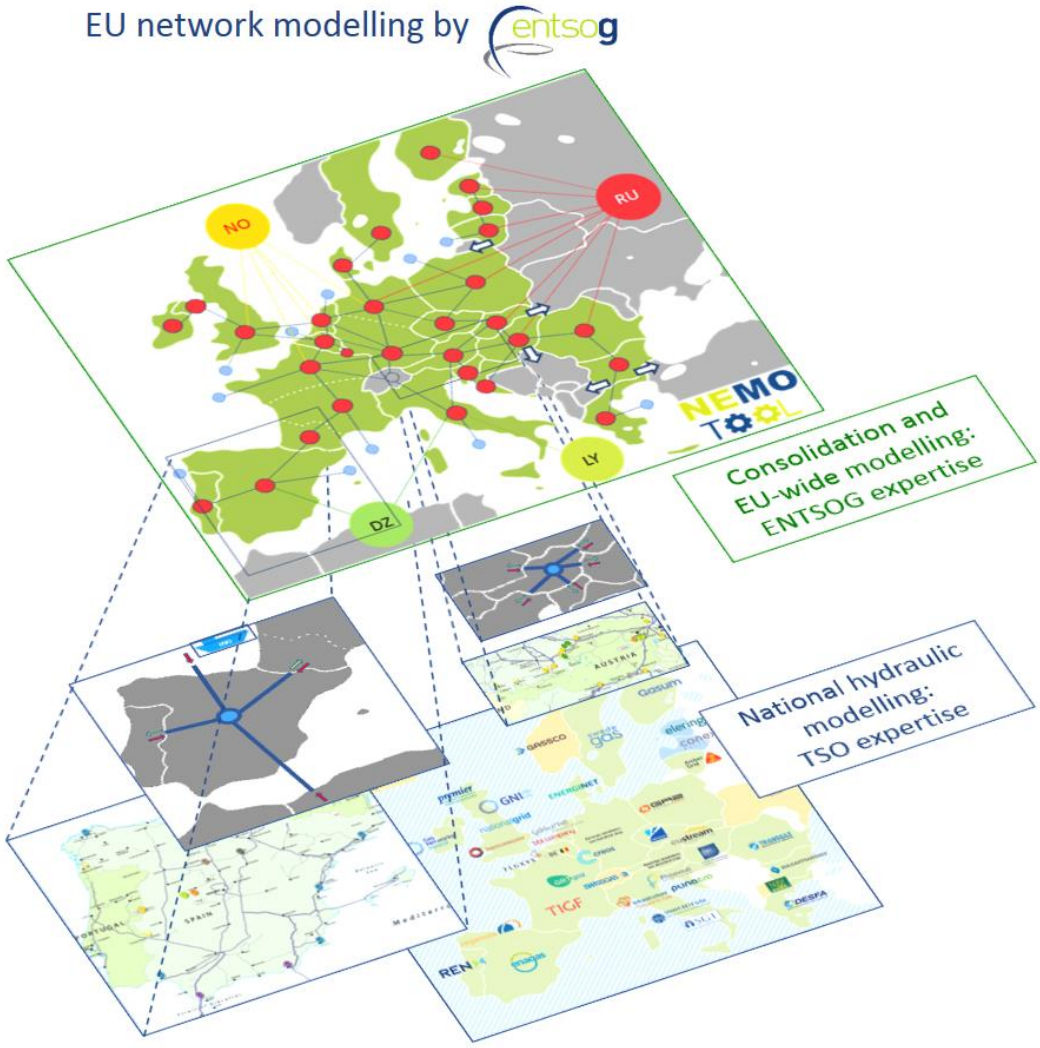


Illustration 1: NeMo tool simplistic overview

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[17] 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-Weeks 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.

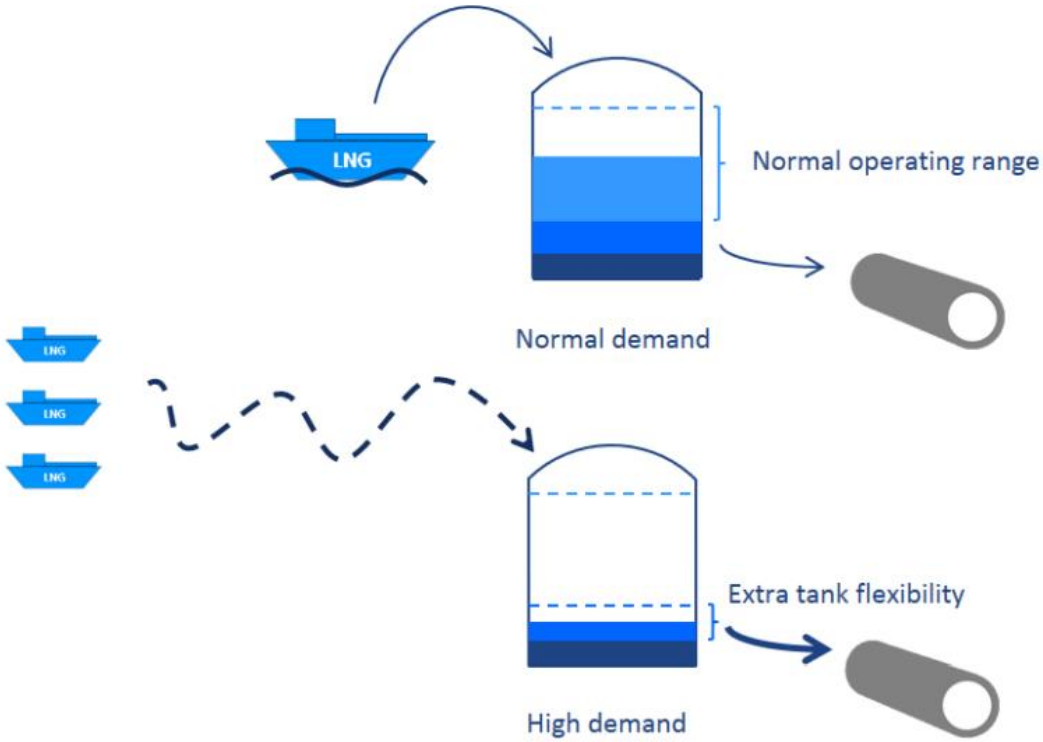
LNG terminals tank flexibility

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).

[17] 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
DC	Design Case
LSO	LNG System Operator
PEG	Gas exchange point (Point d'échange de gaz, in French)
RF	Remaining Flexibility
SO	Supply Outlook
TRF	Trading Region France
TRS	Trading Region South
TSO	Transmission System Operator
UAe	Exports to Ukraine
UGS	Underground Storage
WGV	Working Gas Volume
WSO	Winter Supply Outlook

> Supplies

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

> Countries

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

ENTSOG AISBL

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

info@entsog.eu
www.entsog.eu