entsog

european network
of transmission system operators
for gas

Summer Supply Outlook 2018

ENTSOG – A FAIR PARTNER TO ALL!

Contents

Executive Summary

In line with Art.8(3)(f) of Regulation (EC) 715/2009, ENTSOG has undertaken an assessment of the European gas network for the upcoming summer (April 2018 to September 2018). The analysis investigates the possible evolution of the supplies and the injection in the storages across the season as well as the ability of the gas infrastructures to meet the demand, the exports and the above mentioned storage injection needs during Summer 2018. ENTSOG has used a sensitivy analysis to cover different injection targets and to provide flexibility of injection to reach storage levels.

The **main findings of the Summer Supply Outlook** highlight that the European gas network is sufficiently robust in most parts of Europe to enable:

- At least 90% stock level of the gas storages in preparation of the upcoming Winter,except for the Latvian gas storage;
- maintenance to ensure infrastructure reliability on the long term;
- flexibility for the network users' supply strategy; and
- supply gas to Ukraine with volumes comparable to previous summer seasons.

The report also emphasises:

To achieve the same storage inventory level as the previous season more injection in the storages would be needed (+52 TWh) due to the **storage level on 1st April (17.5%),** the **lowest storage level in seven years** for this date, and also due to the lower National Production expected.

1. Introduction

This edition builds on previous Summer Supply Outlooks as well as on the supply assumptions of the TYNDP 2018 Scenario Report. It aims to assess the ability of the European gas network to provide sufficient flexibility to shippers during their storage injection season.

The summer months (from April to September) provide shippers the opportunity to refill storages in anticipation of the winter months ahead. The level of injection targeted by shippers varies from one country to the other and from one season to the other due to climatic, price and legal parameters.

Modelling has been used to confirm the ability of the European gas network to provide flexibility of injection under different scenarios around a Reference Case targeting a 90% storage level by 30th September 2018. Additional scenarios cover alternative injection targets, to provide flexibility of injection to reach storage levels between 80% and 100%.

Like the previous edition and in order to take into account the latest development since the beginning of the summer, the modelling takes as a starting point the factual storage levels on 1st April 2018.

For an accurate consideration of the reduction of injection capacity when a storage reaches high stock levels, ENTSOG uses injection capacity curves provided by GSE members.

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

- *L-gas modelling:* The L-gas topology has been successfully included in the modelling for France and Germany in the Winter Supply Outlook 2017/18. Belgium L-gas zone was already considered in the modelling before and it still is. In the case of Netherlands, ENTSOG is in close contact with the Dutch TSO regarding Netherlands production and the correct representation of the Dutch system in the network for the simulations. The Netherlands have one cross-quality market without internal bottlenecks in the transmission system but with quality conversion restrictions; such quality conversion restrictions are reflected in the L-gas export capacities.

2. Assumptions and results of the modelling

The simulations consider the existing European gas infrastructure as of 31st March 2018.

The modelling tool for the Summer Supply Outlook is the same as the one used in the TYNDP and the Winter Supply Outlook. It considers the existing gas infrastructureand the maintenance plans to be completed during the upcoming summer [1].

The Summer Supply Outlook 2018 is developed based on assumptions specific to the upcoming summer season as detailed in the annexes and short term trends. In any case actual injection and supply mix will result from shippers' decisions.

The demand data has been provided by TSOs on a monthly level. An averaged daily demand has been considered within each month.

For comparison purposes, **Figure 1** shows the European aggregated demand for the Summer 2018 compared to the historical demand over the last seven summers (from 1st April to 30th September). The demand for this Summer is forecasted to slighty increase around 0.8% in line with the last two Summers due to the increase in the gas demand for power generation.

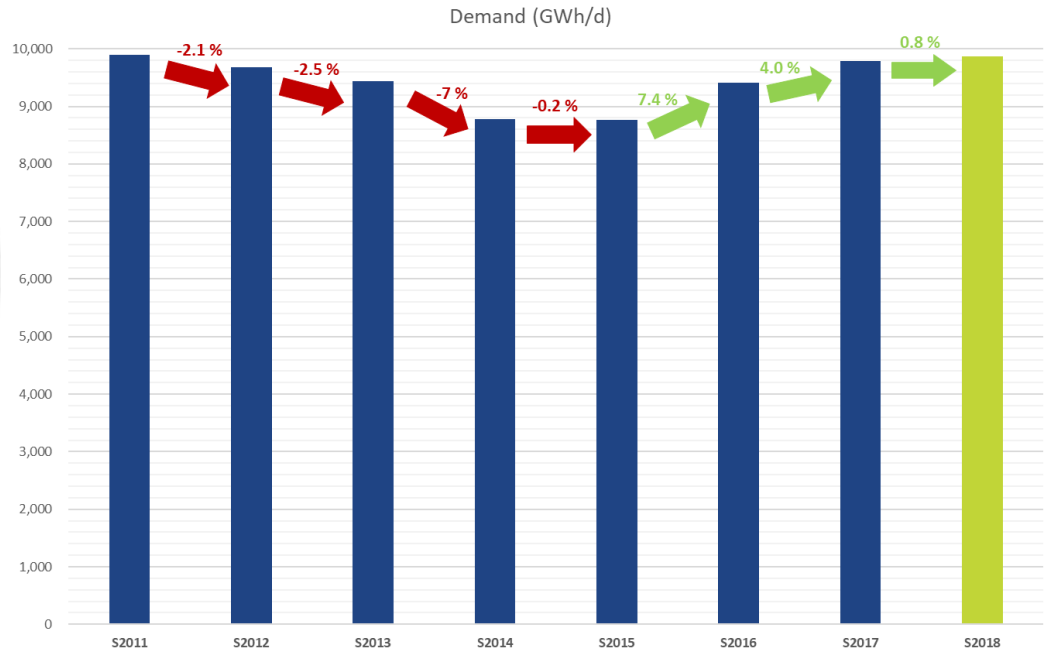


Figure 1.- European daily average demand comparison (Forecast for Summer 2018).

The maximum supply potentials of the different sources providing gas to EU (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 TYNDP 2018. The detailed data is provided in the annexes.

[1] Technical capacities and maintenance plans are updated by TSOs. For the OPAL pipeline a partial availability taking into account the current exemption is considered. For TENP pipeline, the current capacity restrictions as provided by Fluxys TENP and Open Grid Europe were taken into account in the SSO simulations.

3. UGS inventory

a. Cold spell on March

During the second half of February and the first week of March, low temperatures in large parts of Europe increased the use of the gas infrastructure, specially storages, reducing their level up to historical minimums. According to AGSI+, the gas storage 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.

Figures 2 and 3 compares the stock level evolution of the last seven winters, respectively in percentage and volume, highliting the cold spell period during the second half of February and the first week of March.

	1-Oct (%)	31- Mar (%)	UGS Utilisation (% WGV)
W11-12	96.2	49.5	46.7
W12-13	91.5	28.3	63.3
W13-14	82.0	48.8	33.2
W14-15	92.7	28.0	64.7
W15-16	82.2	35.6	46.6
W16-17	90.4	25.8	64.6
W17-18	84.9	18.7	66.2

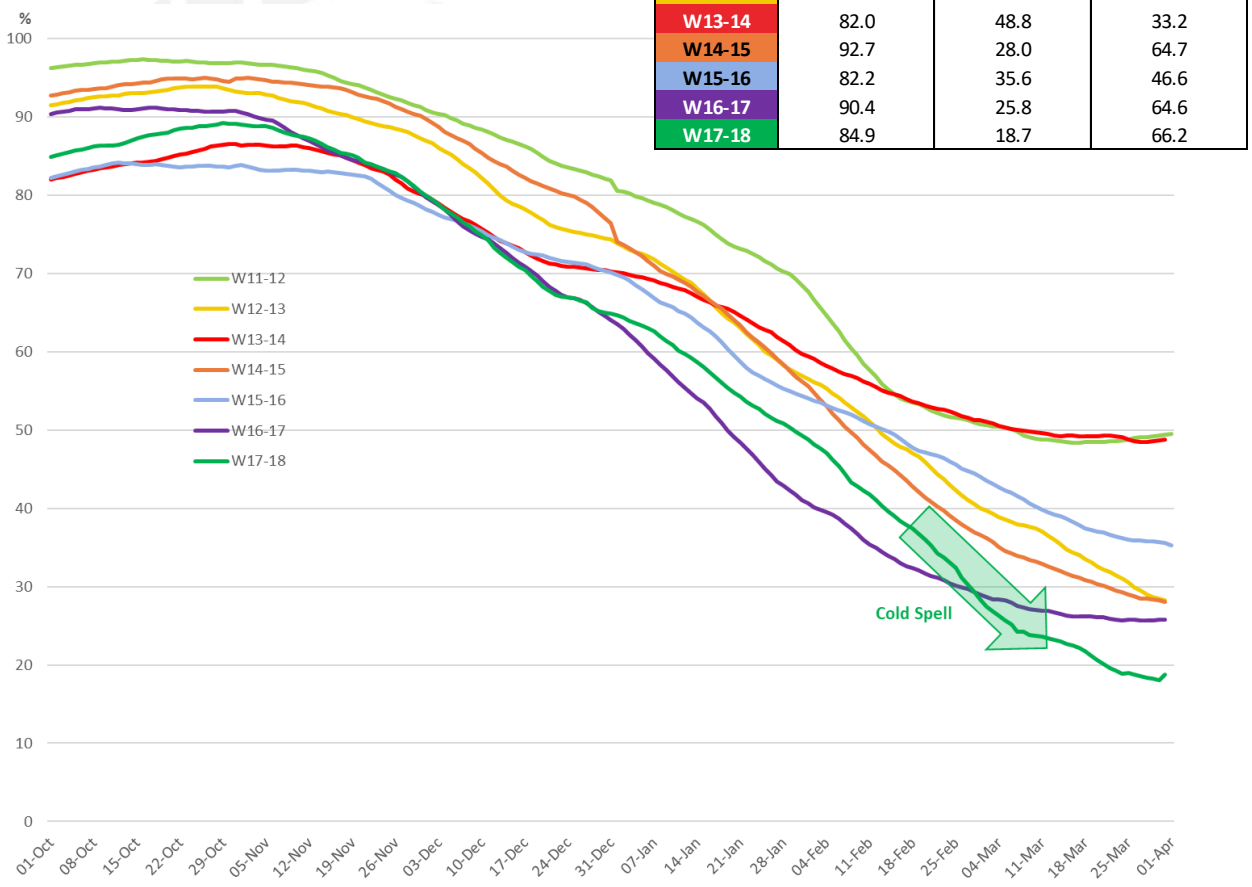


Figure 2.- Evolution of UGS stock level. Winters 2011-2018 (% WGV)(Source: AGSI).

	1-Oct (TWh)	31- Mar (TWh)	UGS Utilisation (TWh)
W11-12	601.7	331.3	270.5
W12-13	716.2	222.8	493.5
W13-14	724.1	433.4	290.7
W14-15	867.4	274.6	592.9
W15-16	838.6	364.1	474.5
W16-17	972.9	278.1	694.8
W17-18	903.8	191.1	712.7

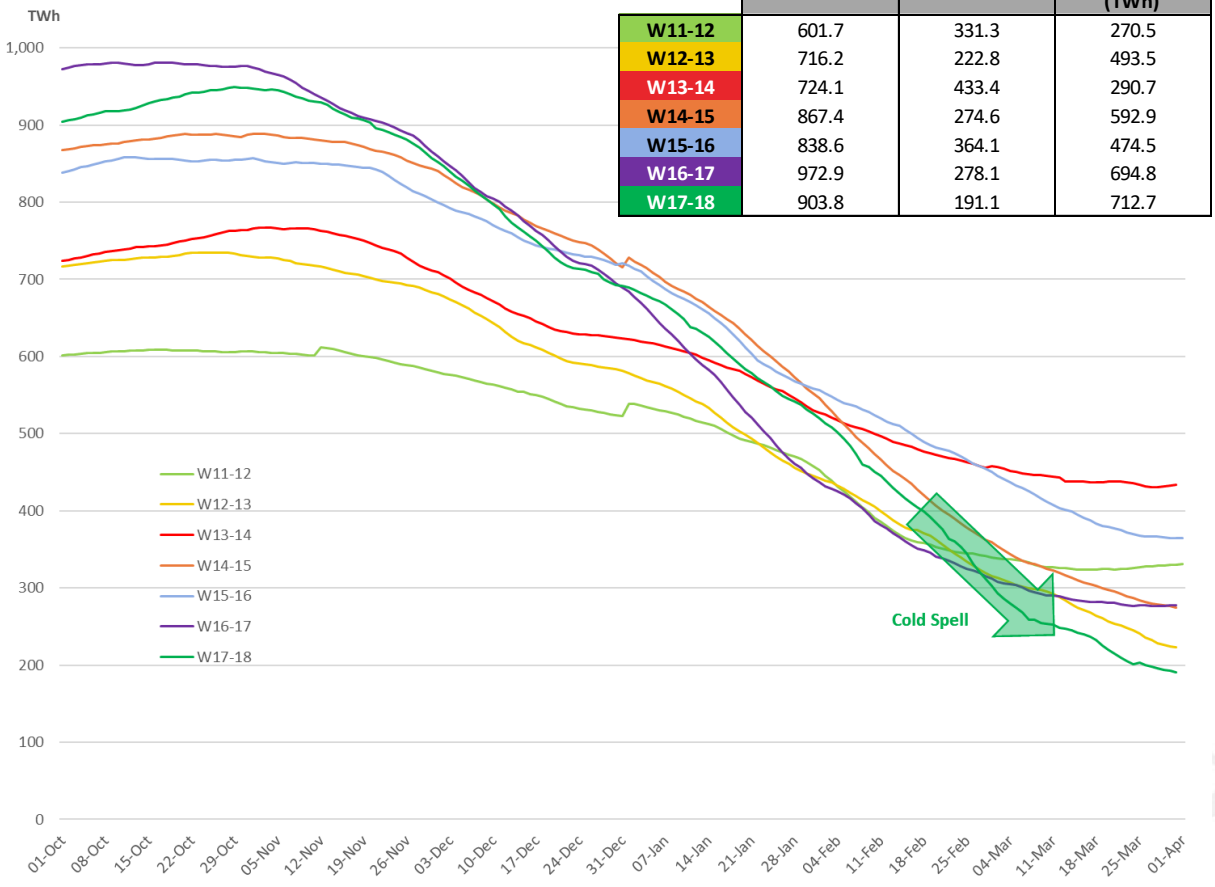


Figure 3.- Evolution of UGS stock level. Winters 2011-2018 (TWh) (Source: AGSI).

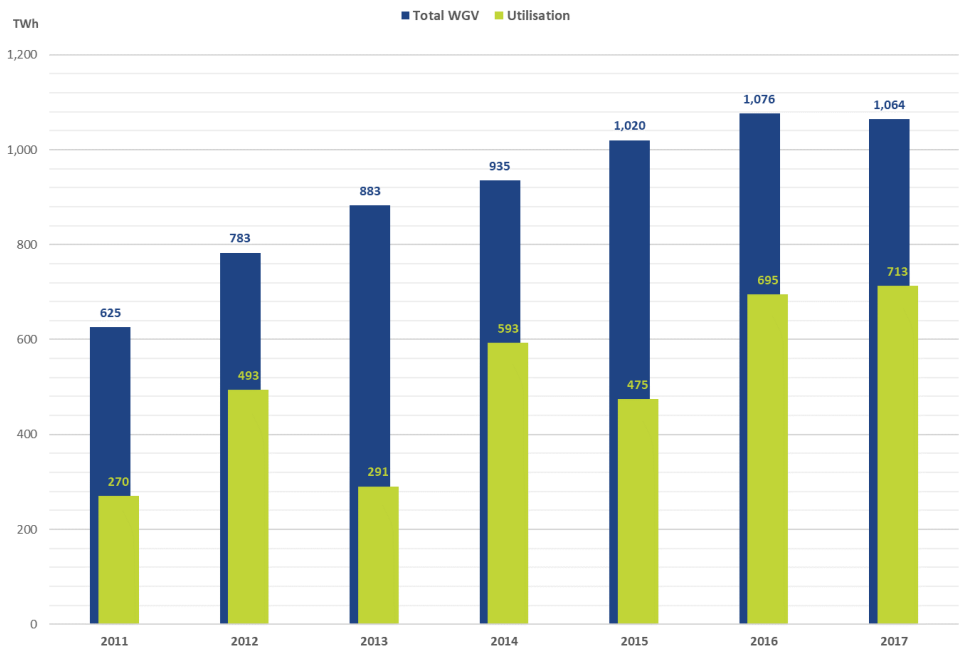


Figure 4.- Evolution of total WGV[2] and Winter Utilisation.

[2] Total WGV in 1st October of each year. Data from AGSI+ platform.

Figure 5 shows the storage inventory level per country on 1st March 2018. This level differs up to 51.2% between the country with the hightest leval and the country with the lowest.

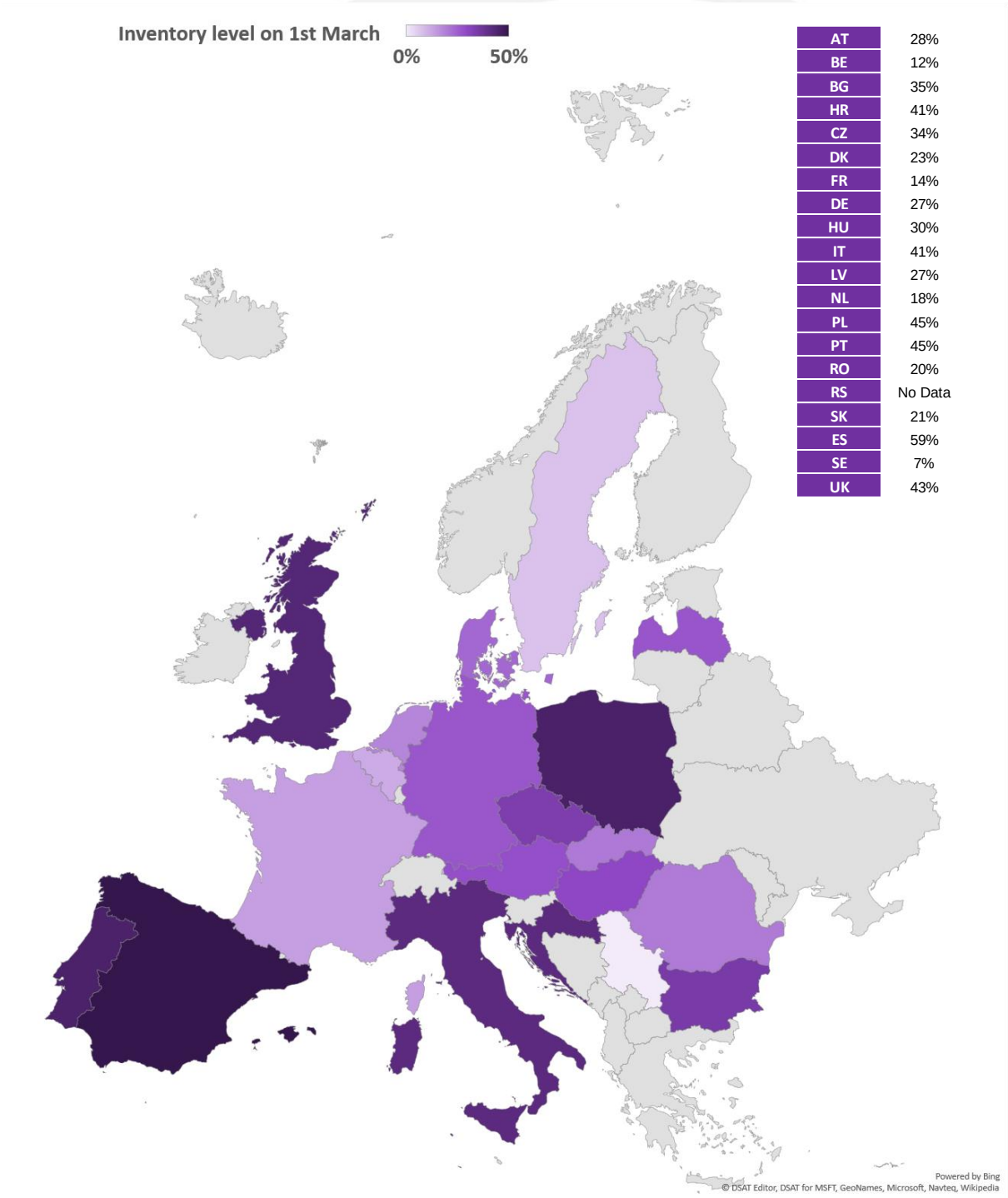


Figure 5.- Storage level per country on 1st March 2018 (For some countries, the initial level includes strategic stocks) [3].

[3] AGSI+ data platform.

During the last week of February and the first week of March, some countries declared early warning situation.

- On 23rd February, Italy declared an early warning situation due to the situation on the TENP pipeline that threatened the flexibility of the Italian gas system and the small but repeated cases of exceeding the storage capacity allowed to shippers. The Italian Ministry invited system operators and regasification terminals to offer to the market all available import capacity where it was not used.
- On 27th February, Denmark declared the crisis level early warning as a result of a tight supply situation together with an increasing negative system imbalance. The tight supply situation was reflected in a narrow flexibility in entries and exits of the network that reflected the need of the market to stay in balance to maintain the system integrity. Accordingly, Energinet took measures to enhance the incentives for the market to stay in balance. Given the supply situation at the time Denmark maintained early warning as a low inventory level combined with a continuous high withdrawal rate from the storage facilities made the risk of a supply shortage critical.
- On 1st March, Sweden declared early warning situation due to a significant imbalance in the Swedish transmission network. The pressure in the transmission network was decreasing since 28th February and, as a preventive measure, Swedegas decided to reduce the range of flexibility for Balance Administrators.
- On 1st March, United Kingdom informed of a tight situation because of the reduction of the supplies from the North Sea and also from the Netherlands and the significant increase of the demand. This situation caused a large imbalance between demand and supply and as a result the linepack was projected to fall below the normal operating range which would put meeting pressure obligations at risk. Therefore, National Grid issued, for the first time, a "Gas Deficit Warning". After 1st March, the market responded to balancing actions with increased supply and and the demand was reduced.
- On 2nd March, Ukraine informed of a tough situation due to problems with delivieries from Russia and the reduction of the pressure at the entry point in the gas transmission system at the Russian-Ukrainian boarder. Additionally, on 16th March, Ukraine declared an early warning level of emergency due to the increased gas demand and expected gas balance deficit during the period from 16th to 21 th March.

At the same time, it is important to note that this situation had a significant impact in the European gas markets with a large increase in prices during the mentioned period.

In the following figure, the daily prices at European hubs from 1st February until 6th March are shown. The highest prices were reached on 1st March in all markets.

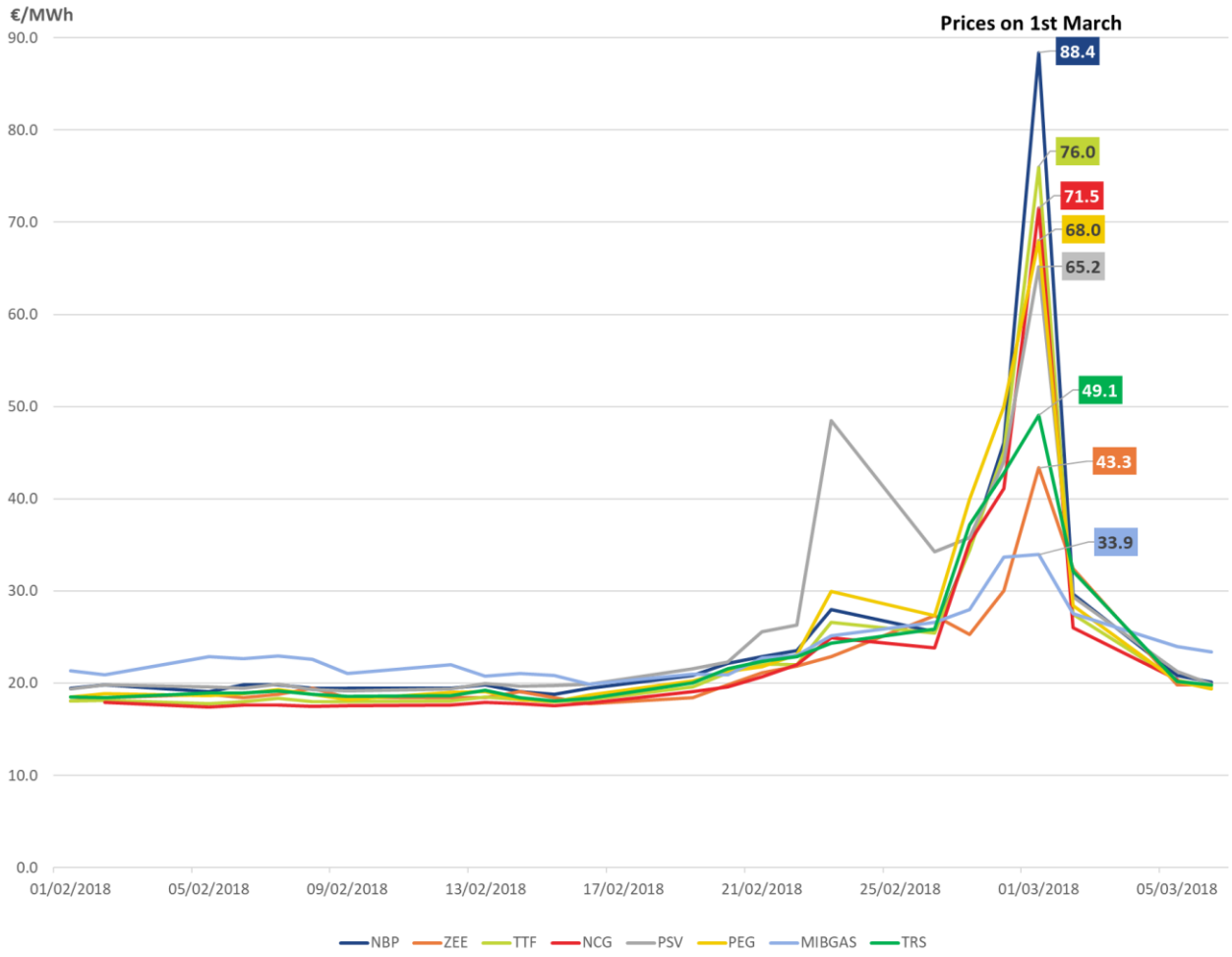


Figure 6.- Day-ahead daily prices at selected European hubs from 1st February until 6th March in €/MWh (Source: Bloomberg).

Compared with the gas prices on 1st February, the most affected markets on 1st March were the NBP (+354%), the TTF (+320%), the NCG (+300%) and PEG (+268%). The less affected hub was MIBGAS (+59%).

b. Initial storage level on 1st April

The Summer Supply Outlook takes into account the actual storage inventory level per country as of 1st April 2018[4] as the initial situation exposed in **Figure 7**. As shown on the map the storage inventory levels differ depending on the country.

[4] The initial storage level on 1st April 2018 for each country is based the AGSI platform captured on 1st April 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. For Serbia, the initial storage is consider 0% due to no availability of data.

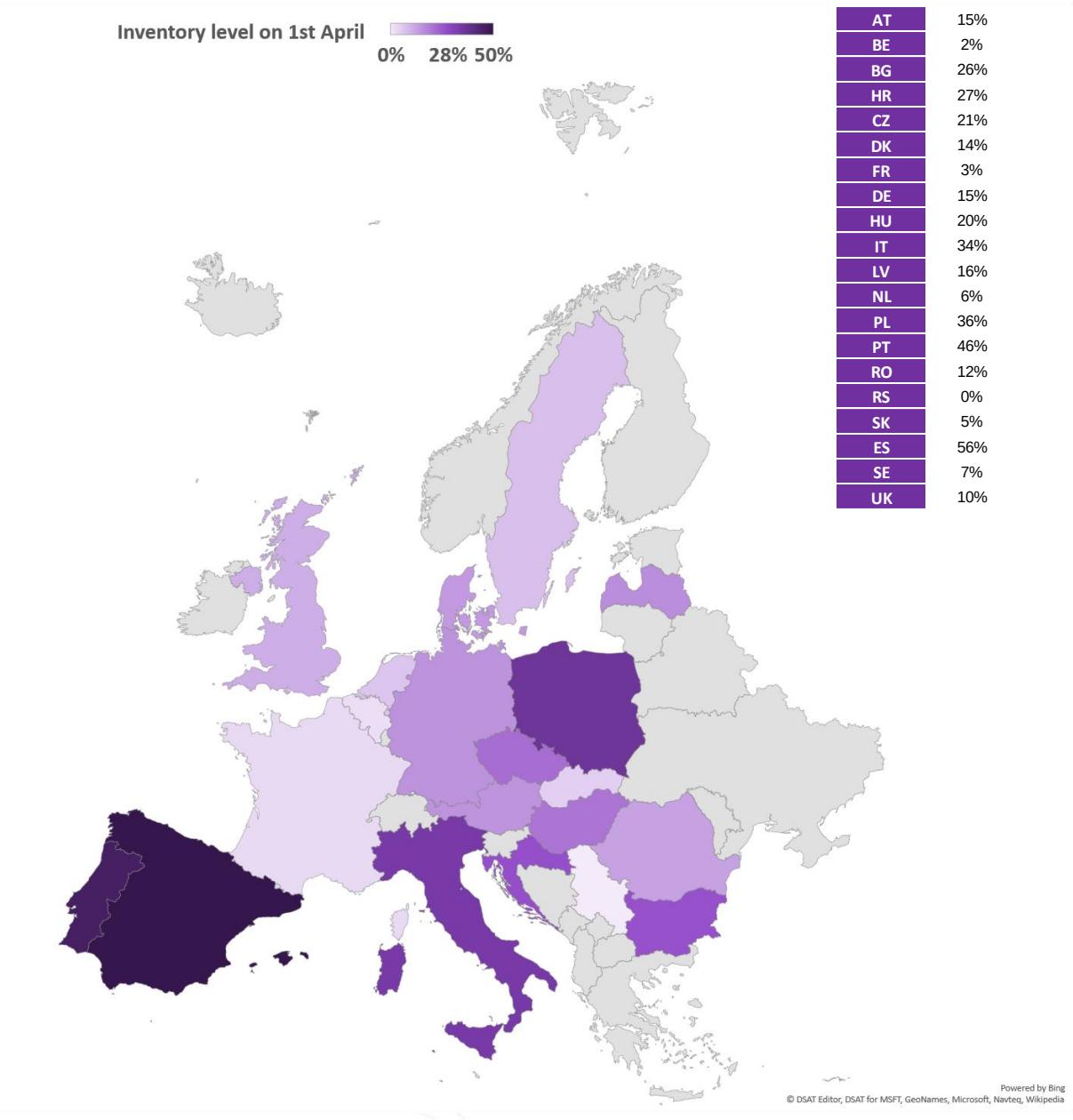


Figure 7.- Actual storage inventory levels on 1st April 2018 (For some countries, the initial level includes strategic stocks) [5].

In terms of **absolute volumes** in gas storages, the largest volumes on 1st April are located in Italy, Germany and Spain. The initial average UGS inventory is lower than the one from the previous year (17.5%[6]. vs. 26%). In particular, Belgium, France, the Netherlands, Slovakia and Sweden face an inventory level on the 1st April below 10%.

[5] AGSI data platform except for LV (data from Latvian INČUKALNS UGS UTILISATION https://capacity.conexus.lv/?lang=eng).

[6] The WGV of the UGS with no firm injection capacity isn't consider, but still they can be used by the market participants and would increase the total volume of gas stored in EU.

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 Summer Supply Outlook 2018.

4. Reference Case (90% storage target)

The overall "Summer injection" is defined as the quantity of gas necessary to reach a 90% stock level at each storage of EU on 30th September 2018 starting from above mentioned actual stock level of 17.5% on 1st April 2018.

The repartition of injection and supply along the summer months result from the modelling and the following assumptions (further detailed in Annex A and B):

- The monthly gas demand forecast by TSOs;
- The monthly national gas production forecast by TSOs;
- Exports towards Ukraine[7];and
- The overall summer injection as defined above.

The flexibility given to the model for the definition of the supply patterns derives from the supply mix of the last five summers (See Annex B-Supply assumptions).

Based on these assumptions, modelling has been used to check if any physical congestion or dependence on an import source may limit the injection.

The simulations show that a 90% stock level may be achieved by 30th September 2018 in all the balancing zones except for the storage in Latvia.

In the specific case of Latvian storage, the 90% of WGV is not achieved due to the limited entry capacity[8] in the country and the assumption that no gas coming from NW Russia will be injected. This assumption stems from the fact that in the summers of 2016 and 2017, mainly volumes of gas intended for customers in Latvia were injected into the storage. This resulted from the decision of Gazprom not to use Incukalns UGS for customers in Russia since, after enhancement of gas transmission network in the Russian NW region, there are enough capacities in the network to supply customers directly by pipeline. The final level in this storage is 35%[9] (8.8 TWh) on 30th September, starting from 15.9% (4.0 TWh) on 1st April.

[7] The exports to Ukraine were assumed to be on the summer 2015, 2016 and 2017 average levels.

[8] Technically, the capacity of the interconnection between Lithuania and Latvia is not enough to fill the storage during Summer. In order to reach the 90% of WGV level in this storage, imports from Russian route would be necessary.

[9] At this level of inventory in the storage of Latvia, the daily withdrawal capacity will be limited to cope with the peak demand during Winter.

Table 1 shows the evolution of the stock level per country as a result of the model.

Table 1.- Storage Evolution Reference Case . (*Actual stock level on AGSI platform, complemented by other information sources for storages not reported on AGSI. For some countries, the initial level includes strategic stocks)

Country	01/04/2017*	01/05/2017	01/06/2017	01/07/2017	01/08/2017	01/09/2017	30/09/2017
AT	15%	21%	35%	49%	63%	80%	90%
BE	2%	2%	18%	39%	60%	80%	90%
BG	26%	26%	39%	51%	64%	78%	90%
CZ	8%	12%	23%	40%	60%	80%	90%
CZd	87%	87%	87%	87%	87%	87%	90%
DE	14%	15%	28%	44%	60%	77%	90%
DK	14%	14%	29%	44%	60%	77%	90%
ES	56%	56%	56%	60%	70%	80%	90%
FR	3%	13%	28%	44%	60%	77%	90%
FRs	4%	16%	30%	45%	60%	75%	90%
FRt	4%	10%	25%	42%	60%	78%	90%
HR	27%	31%	42%	54%	67%	80%	90%
HU	20%	29%	40%	52%	65%	78%	90%
IT	34%	34%	42%	54%	65%	80%	90%
LV	16%	16%	16%	16%	23%	29%	35%
NL	6%	19%	32%	46%	61%	77%	90%
PL	36%	36%	38%	48%	63%	80%	90%
PT	46%	46%	53%	60%	68%	80%	90%
RO	12%	25%	37%	50%	64%	77%	90%
RS	0%	11%	24%	41%	60%	79%	90%
SE	7%	20%	34%	48%	62%	77%	90%
SK	5%	5%	23%	41%	60%	77%	90%
UK	10%	10%	10%	34%	77%	80%	90%

Figure 8 shows the breakdown of transported gas for each month (average daily values for each month including exports) for the **Reference Case**.

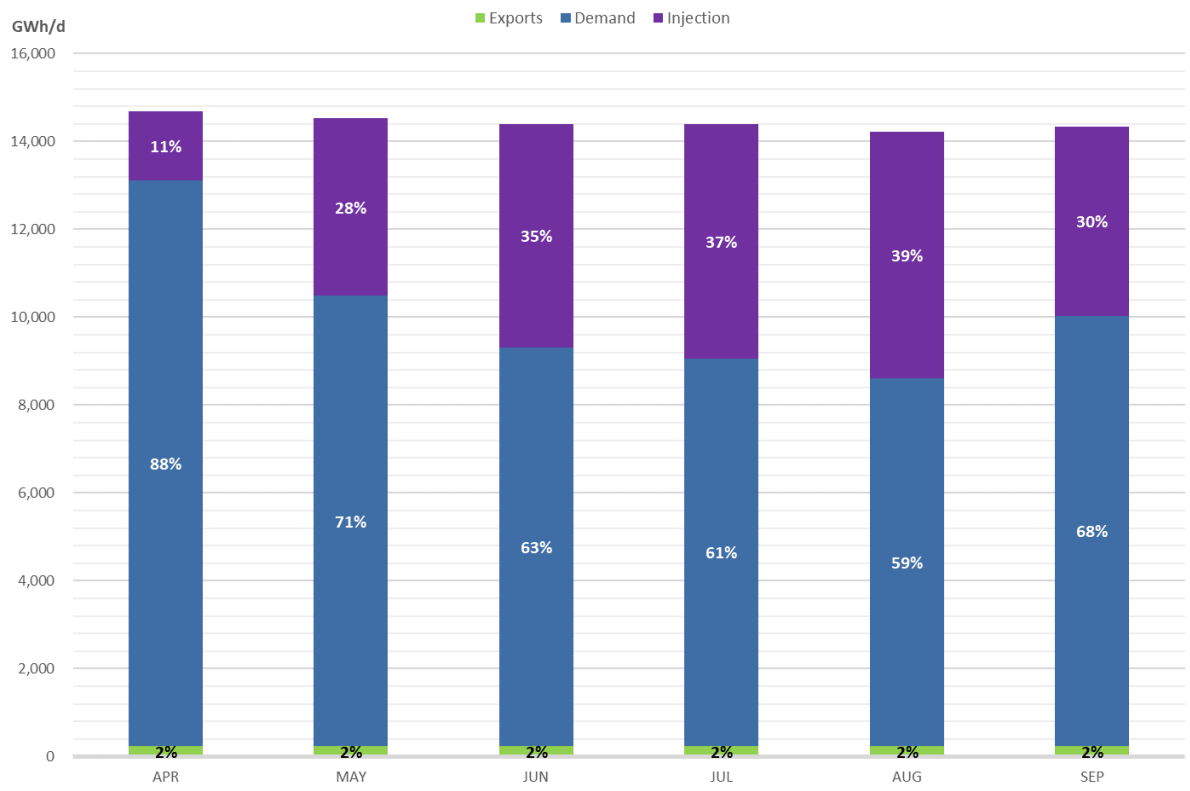


Figure 8.- Transported Gas on Reference Case.

Figure 9 shows the level and composition of the supply mix for every month in the Reference (90%) case.

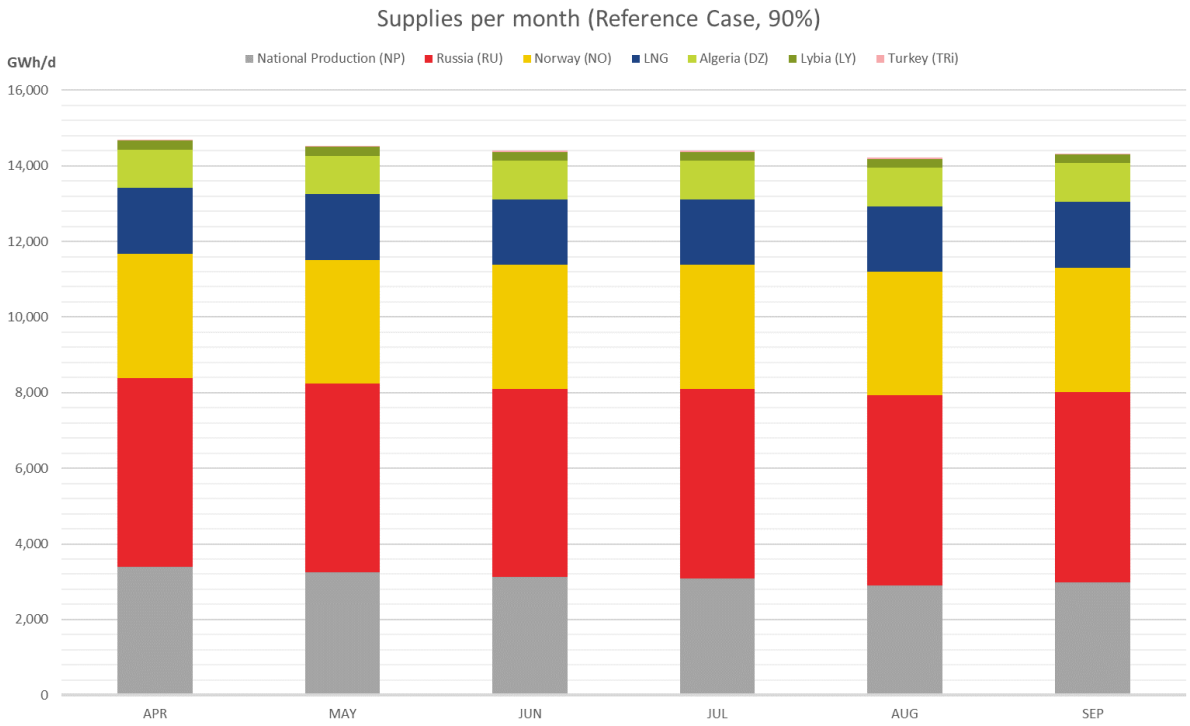


Figure 9.- Monthly supply mix.

5. Sensitivity-analysis – Alternative injection targets (80% and 100% targets)

Given the uncertainty on the level of stock at the end of the season resulting from the behaviour of market participants, two alternative targeted levels of storage have been considered: 80% and 100% on 30th September 2018.

The definition of the monthly injection and supply is following the same rules as for the Reference Case. The assumptions for the demand, export and indigenous productions are kept on the exact same level as in the Reference Case.

Figure 10 provides the stock level evolution curve as resulting from the modelling of Summer Supply Outlook 2018 (actual injection curve will derive from shippers' behaviour) and actual curves of last three summers.

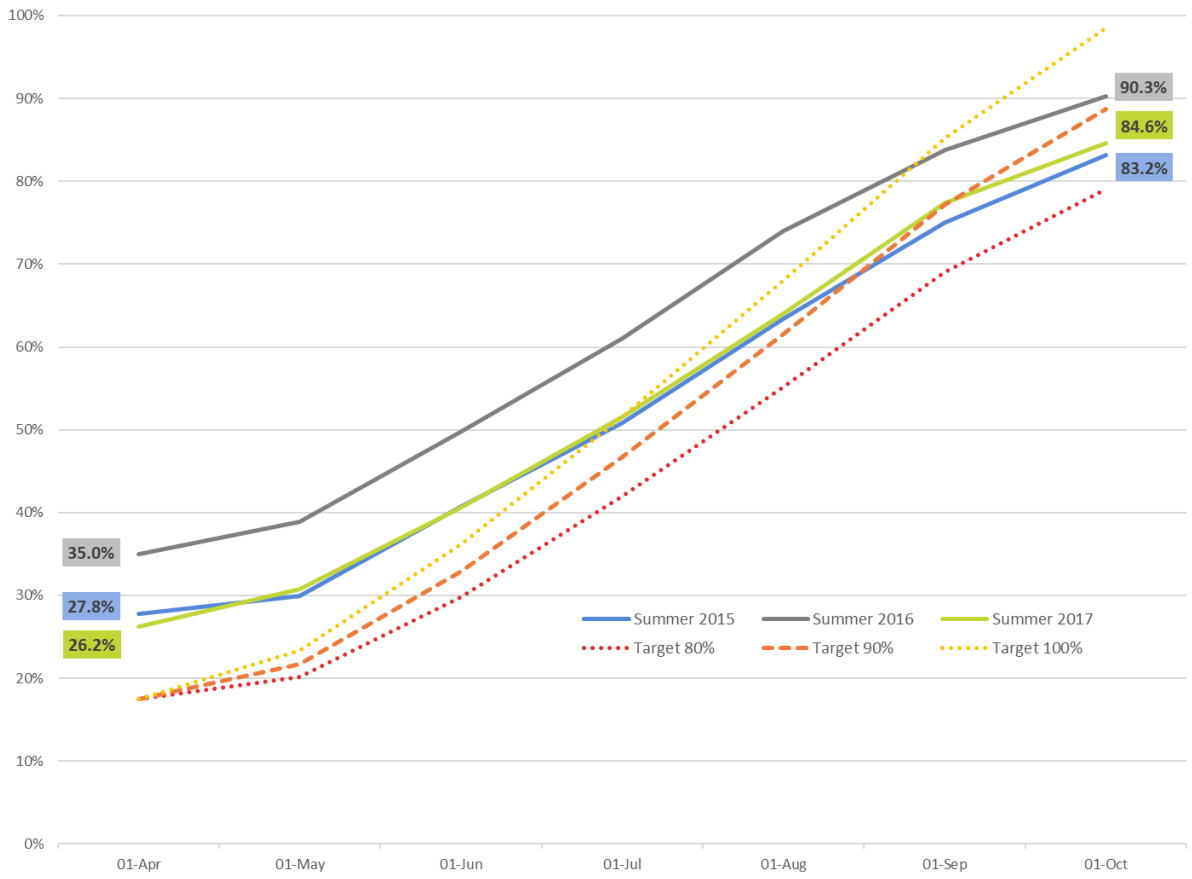


Figure 10.- Stock level development curve (% WGV).

In absolute terms, the target level of 90% represents a quantity of 989 TWh of gas in the storages at the end of the Summer. By comparing this value with the result of the previous Summer Outlook (1,021 TWh), we observed that is lower due to the reduction in the total

WGV in Europe. Nevertheless, this result of 989 TWh is higher compared with the final historical level in the storage over the last seven summers[10].

Considering the two alternative targeted levels of storage, all the European gas storages can achieve the 80% of the WGV and also the 100% of WGV at the end of the summer. The only exception continues to be the Latvian storage with a 35% of WGV level. Yet, achieving a target level beyond 80% will require injection levels significantly exceeding those observed over the three last summers.

Still, for many operators the injection season continues in October enabling a full injection if decided by market players.

Given the supply constraints detailed in Annex A, the different injection targets are reached through fluctuation of the supply levels. Some additional flexibility has been considered for LNG, Russia and Norway to be able to reach the highest stock levels targets.

As shown in **Figure 10**, the flexibility of the European transmission system is high enough to allow for different supply patterns while reaching 80% and 90% stock level at the end of September 2018. On the other hand, reaching a 100% storage level would imply an increase in the imports from LNG, Russia and Norway compare with the supplies for target 90%.

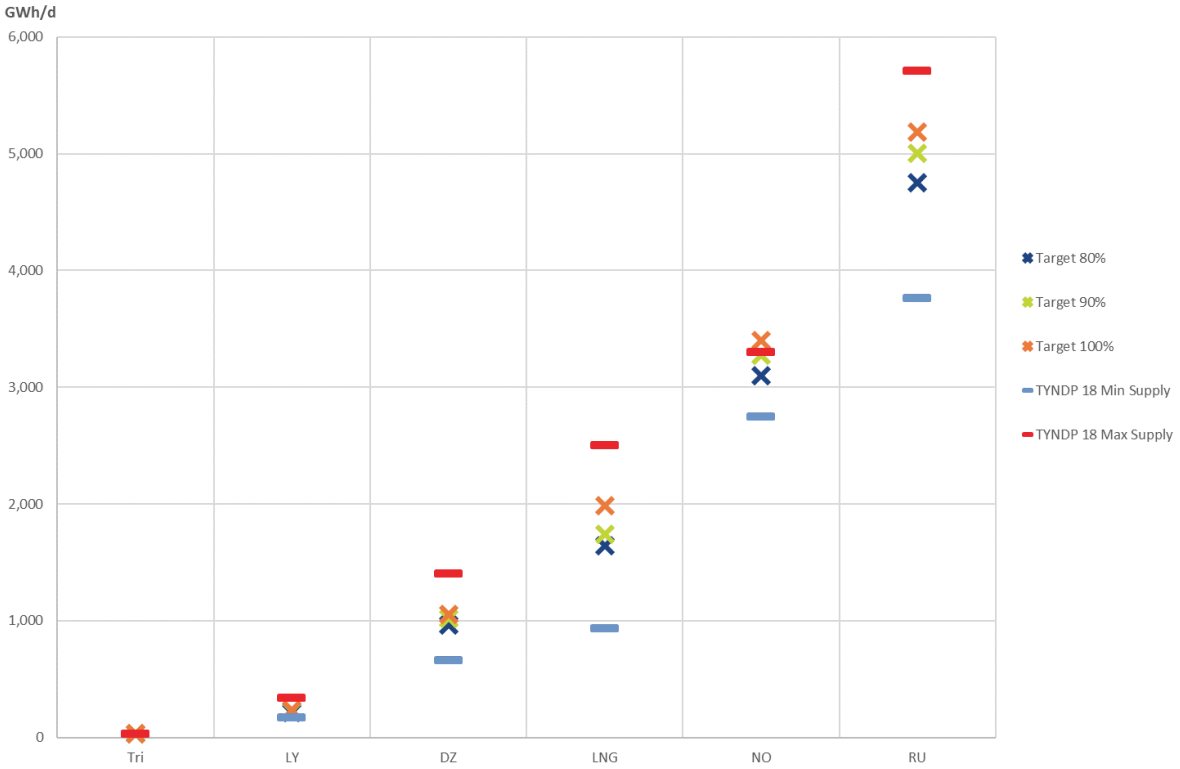


Figure 11.- Fluctuation of the supply patterns in the sensitivity analysis on the stock level

[10] The gas in the storages on 1st October for each year could be check in the Table 1 of this report.

Figure 11 compares the the maximum and minimum supply per source of **TYNDP18** Scenario Report[11], , with the results of the supply shares modelled for Summer 2018 .

Figure 12 shows a comparison between the supply shares in the Reference and the two alternative stock level targets (on a daily average basis) compared with historical supplies for three previous seasons.

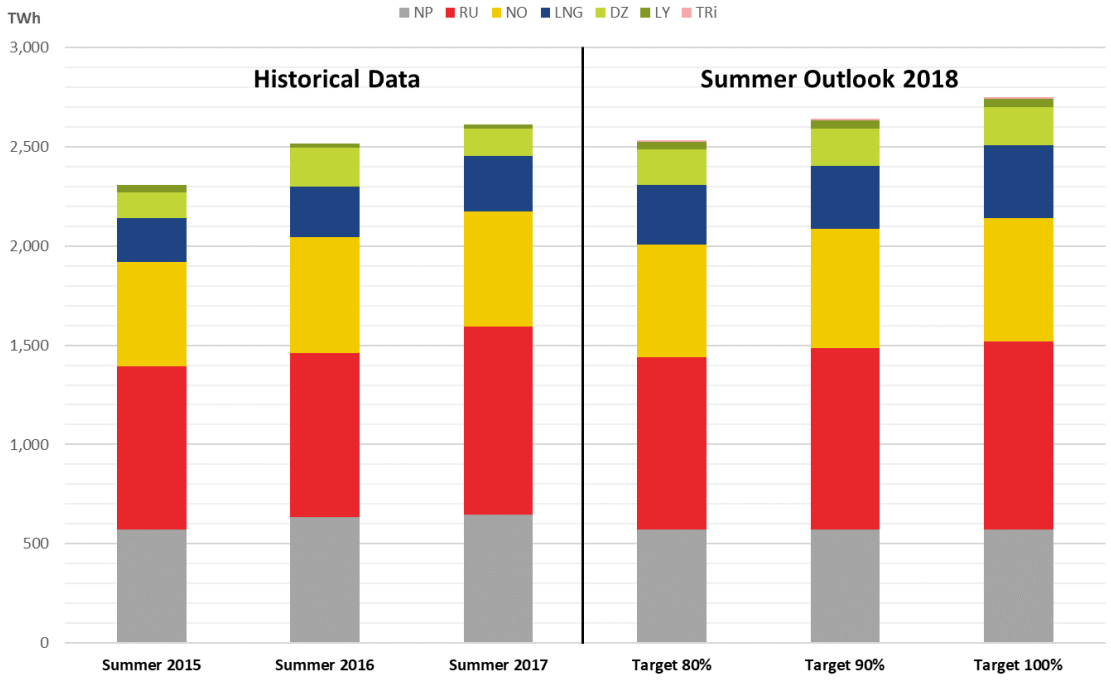


Figure 12.- Comparison between the summer supplies in the Reference and the two alternative stock level targets with historical data (TWh).

Regarding the National Production, **Figure 13** provides a comparison between the last three seasons and the National Production anticpated by TSO for Summer 2018. The reduction in the National Production is around 12% (2018 vs.2017).

[11] Supply potentials forecasted for year 2018.

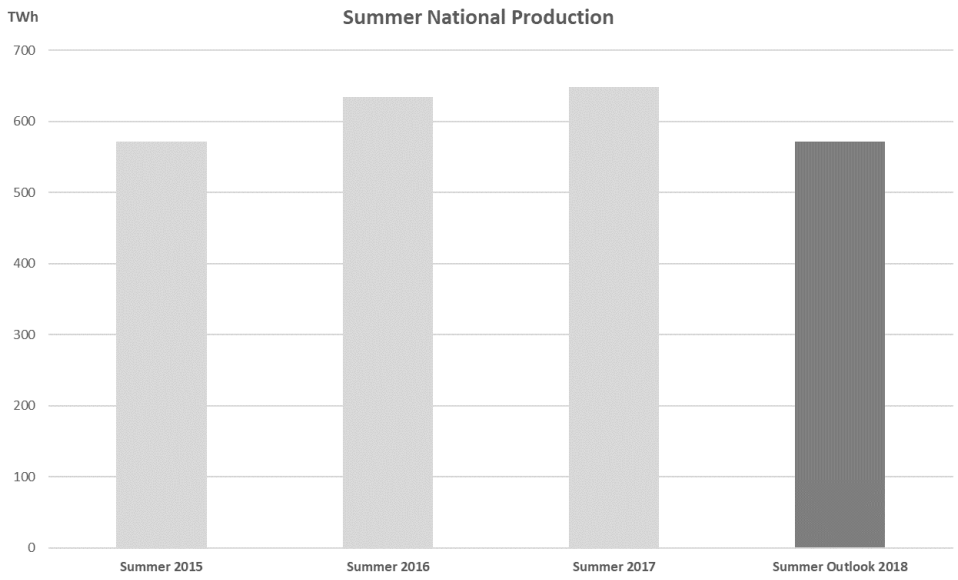


Figure 13.- National Production comparison (TWh).

Finally, **Figure 14** shows the difference between the supply shares in the Reference and the two alternative stock level targets.

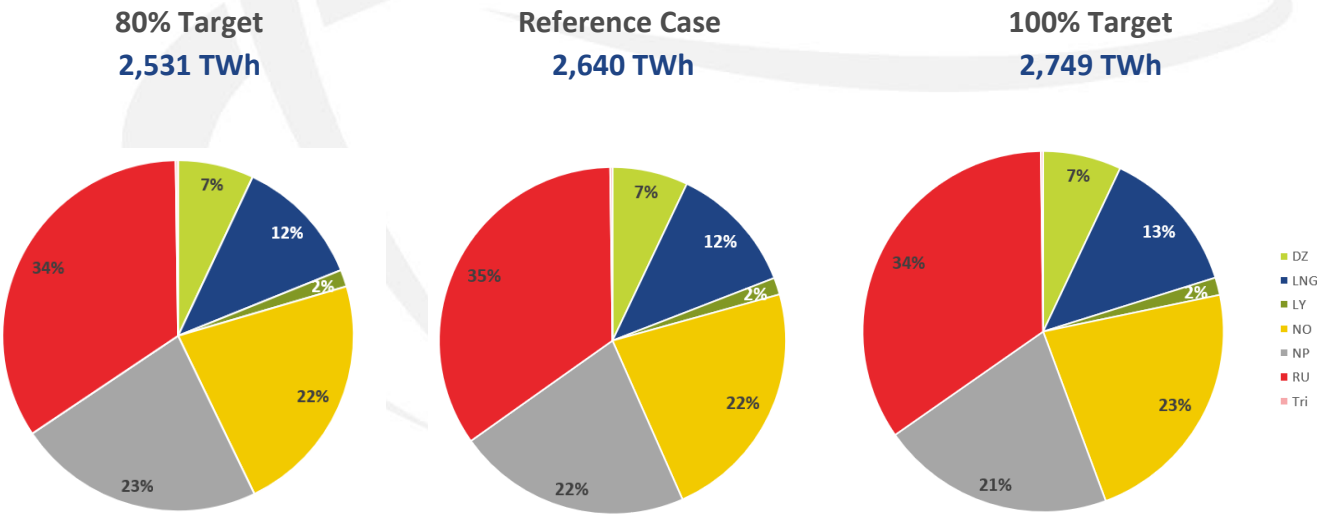


Figure 14.- Summer supply average share.

6. Conclusion

According to the ENTSOG modelling, under the given supply assumptions, this Summer Supply Outlook confirms the capability of the European gas network to enable shippers to reach at least a 90% stock level in all but one underground gas storages by the end of this Summer 2018 while ensuring the proper maintenance of the system, although this will require increased injection compared to past summers.

The sensitivity analysis shows that also a 100% stock level could be achieved in almost all of the countries.

The only exception in both cases is the storage in Latvia due to the limited entry capacity in the country and the assumption that no gas coming from NW Russia will be injected.

Legal Notice

The current analysis is developed specifically for this Summer 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 30th September 2018 will depend on market behaviour and global factors.

ENTSOG has prepared this Summer 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

The total quantity of gas to be injected from 1st April to 30th September 2018 is defined as the difference between:

- the sum of the working volume of all European UGS times the targeted stock level, and
- the stock level of European UGS on 1st April 2018 (source: AGSI platform).

This quantity will be split per month by the model on the basis of the temporal optimisation, considering the limits set by the linearisation of the injection curves.

Figure 15 shows the average injection curve, based on the storage profiles provided by GSE members. Default values are used in case specific country profiles are not available, calculated based on the WGV-weighted average of the provided ones. The detail of the curves defined at country level is included in Annex D.

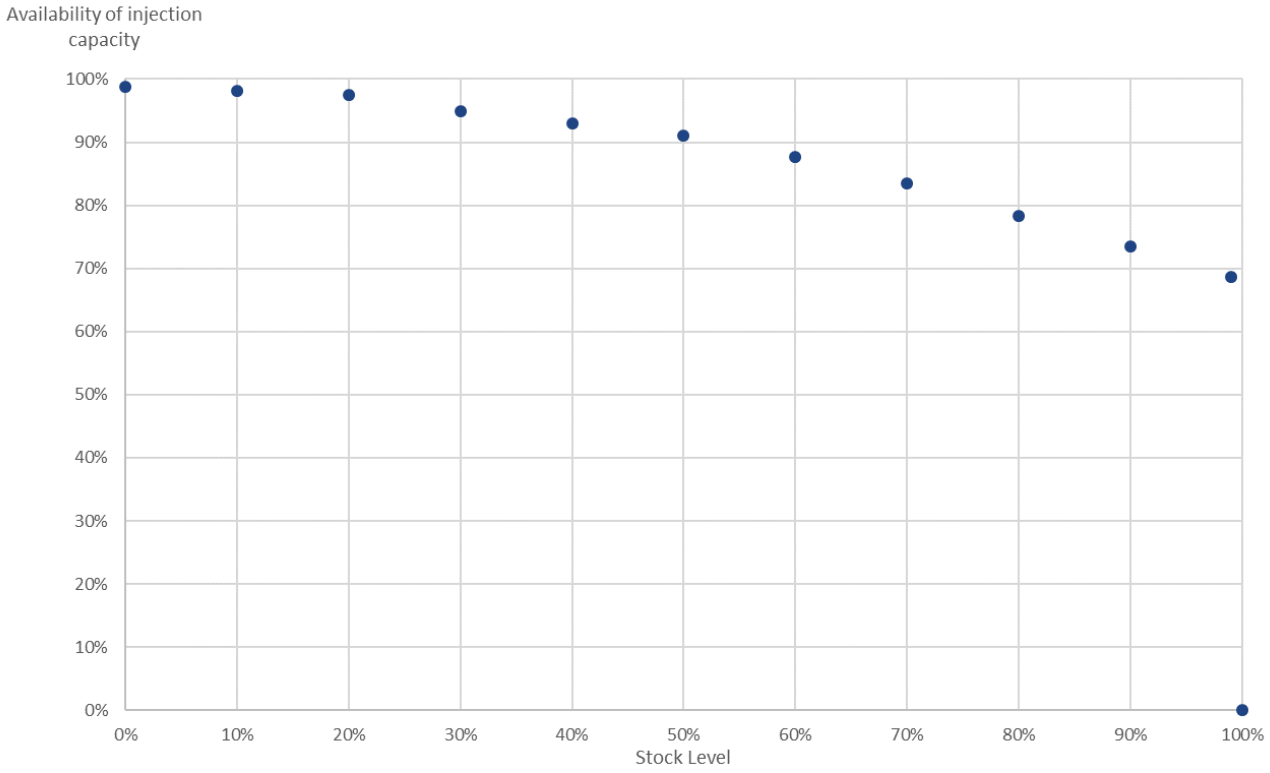


Figure 15.- Injection average curve

Annex B – Supply assumptions

Minimum supply per source: The minimum supply per source, on daily average, is set as the average of minimum monthly supply of the last 5 summers (April to September for years 2013, 2014, 2015, 2016 and 2017) for each supply source.

Maximum supply per source: The maximum supply per source, on daily average, is set as the average of maximum monthly supply of the last 5 summers (April to September for years 2013, 2014, 2015, 2016 and 2017) for each supply source.

Use of Supplies: Modelling is handled as to ensure use of the different supply sources pro-rata of their maximum.

The model can access additional flexibility on LNG, Russia and Norway only once all sources have reached their maximum. This way, the access to higher levels than these maximums will imply they will only be used by the model when it is necessary to avoid demand disruptions.

Additional Flexibility: The additional flexibility is based on the difference between the maximum supply per source (calculated as noted above) and the maximum of the maximum monthly supply of the last 30 summer months. We allow this flexibility only for the sources that have a difference higher than 150 GWh/d between the average of maximum monthly supply and the maximum of the maximum monthly supply.

Table 2.- Minimum, maximum and additional flexibility per supply source.

Sources (GWh/d)	Minimum	Maximum	Maximum + Additional Flex.
Algeria	478.95	1,123.49	
Libya	72.58	250.87	
LNG	827.73	1,914.60	2,111.22
Norway	2,002.10	3,624.97	4,084.58
Russia	3,267.41	5,526.84	6,009.60
Turkey	30.14	30.14	

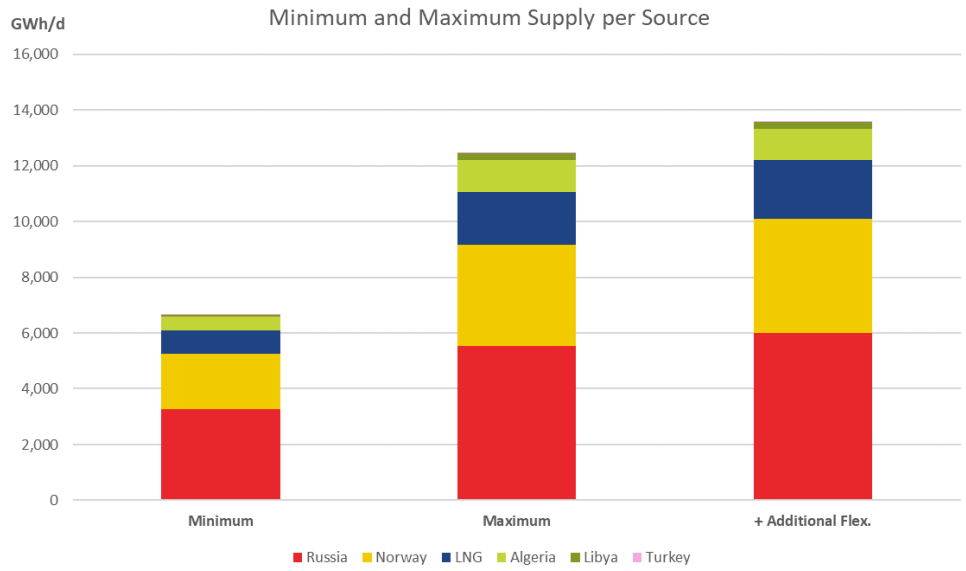


Figure 16.- Minimum, maximum and additional flexibility per supply source.

LNG basins: LNG is traded in a global market by giving access to a large variety of sources and routes, and LNG makes gas reserves around the world accessible to the EU market. The ranges defined for the LNG import potentials reflect the particularly high uncertainty in the level of LNG supplies to Europe.The share of the different LNG basins is based on the supply assumptions considered in the TYNDP 2018 Scenario Report[12] for year 2018.

Table 3.- Minimum, maximum and additional flexibility per LNG basin.

LNG basins (GWh/d)	Minimum	Maximum	Maximum + Additional Flex.	%
Middle East	434.81	1,005.75	1,109.03	52.5%
North Africa	165.70	383.29	422.65	20.0%
SubSaharian Africa	141.97	328.39	362.11	17.2%
S. America	57.16	132.21	145.78	6.9%
N. America	2.73	6.31	6.96	0.3%
Australia	0.00	0.00	0.00	0.0%
Other	25.36	58.66	64.69	3.1%
TOTAL	**827.73**	**1,914.60**	**2,111.22**	

[12] Source: The LNG export capacity was based on WEO 2017 New Policies.

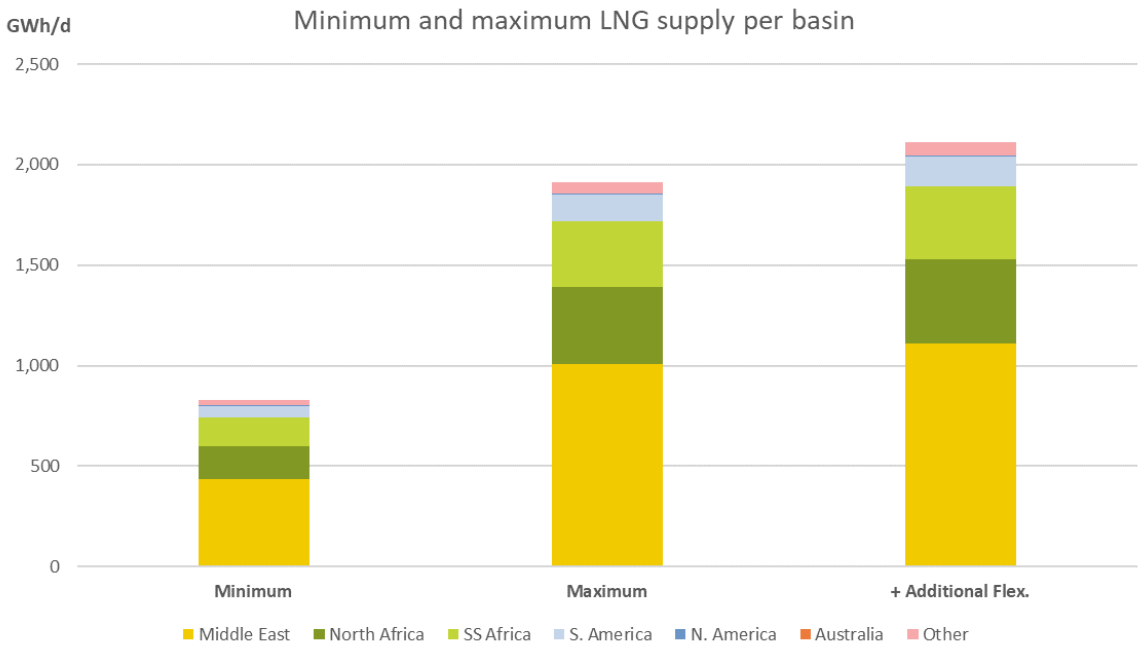


Figure 17.- Minimum, maximum and additional flexibility per LNG basin.

Note: The gas supplies are a modelling result that depends on the supply assumptions, which are derived from the Summer Reviews.

Annex C – Summary of Summer Supply Outlook 2018 assumptions

Assumptions	Reference case
Demand and National Production	Average monthly demand and production anticipated by TSOs.
Monthly injection	> European aggregated injection over the Summer: quantity necessary to reach injection target (80%, 90% or 100%) on 30th September 2018. > Monthly injection (aggregated and per Zone) is a result of the modelling.
Overall supply	Sum of demand and injection for the whole summer.
Supply shares	Supply shares is a result of the modelling.
Import routes	Split between import routes is a result of the modelling.
Cross-border capacity	Firm technical capacity as provided by TSOs considering reductions due to maintenance.
Exports towards Ukraine	236 GWh/d (average of three previous Summer seasons).

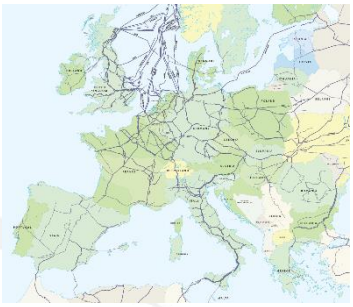
Annex D – Data for Summer Supply Outlook 2018

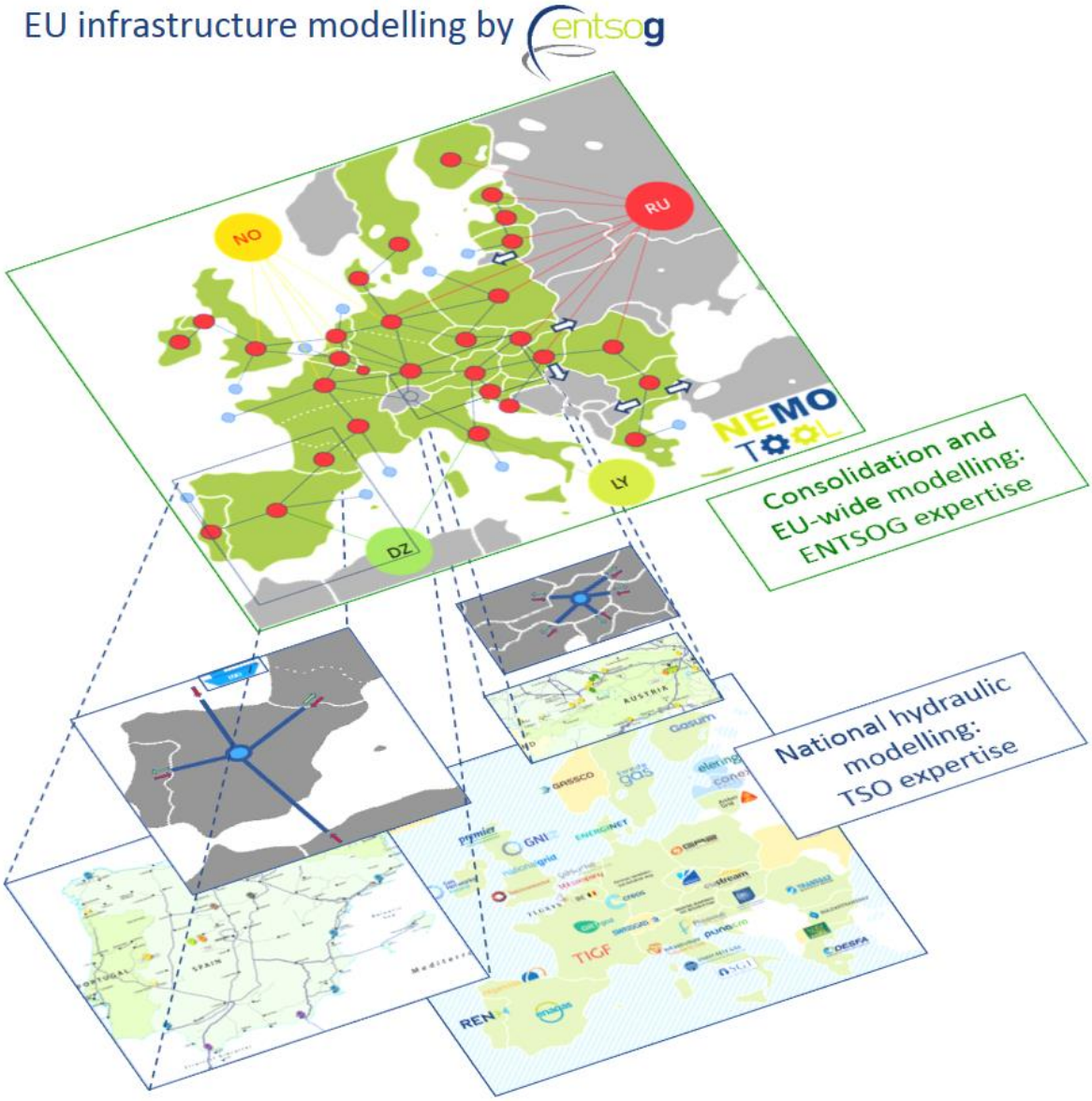
The data for Summer Suply Outlook 2018 is available online as an annex of this report. The data available is specifically:

- Linearisarion curves of the injection in the storages (source GSE members).
- Average monthly national production forecast.
- Average monthly demand forecast.
- Average monthly final and power demand forescast.

Annex E – Modelling approach

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.





The network used in this report is the same to the one used in the Winter Outlook 2017-2018.

The following elements are part of the modelling:

- Definition of six temporal periods, representing the months from April to September.
- Temporal optimization means the optimisation of the summer as a whole period in a single simulation. This implies that the model anticipates an event, adapting the flows in the previous months and mitigating its impact.
- Use of linearisation curves for storage injection capacities, as provided by GSE Members, to consider the reduction of injection capacity when the stock level increases.

Modelling enables the identification of potential capacity and supply limitations, if any, preventing the targeted stock level in each European storage by 30th September 2018 being reached.

Annex F – List of Figures and Tables

> **Figures:**

> **Tables:**

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