ENTSOG
UNION-WIDE

SECURITY OF SUPPLY

SIMULATION REPORT

NOVEMBER **2021**

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Union-wide simulation of gas supply and infrastructure disruption scenarios (SoS simulation) 2021

Contents

Executive summary

Regulation 2017/1938 of the European Parliament and of the Council concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010 ("the Regulation") entered into force on 1 November 2017. It assigns to ENTSOG the task to carry out, every 4 years, a Union-wide simulation of gas supply and infrastructure disruptions scenarios in cooperation with the Gas Coordination Group. In accordance with the provisions of the Regulation, this publication is the first full scope revision of the above-mentioned Union wide simulation.

The revision of the methodology with the Gas Coordination Group, led to the introduction of the new 'timestamp approach'. *It* allows to reflect the configuration of the emergency gas corridors at the time of application of the next national plans (by inclusion of the projects that are expected to be commissioned before the year 2023). Consequently, the composition of the risk groups, *as defined in Annex I of the Regulation (EC) 2017/1938,* has been updated.

The main findings of the Union-wide simulation of gas supply and infrastructure disruption scenarios (SoS simulation) 2021 are:

- Even if the infrastructure allows for an efficient European gas market, an unexpected combination of extreme climatic conditions and supply route disruption may nevertheless result in local constraints and market limitations exposing some Member States to demand curtailment.
- The assessment confirms that the European gas infrastructure provides sufficient flexibility for the EU Member States to efficiently apply their cooperation mechanisms and ensure security of gas supply during extreme climatic conditions and individual supply route disruption scenarios.
- Nevertheless, in some scenarios infrastructure limitations and import limitations can prevent the Member States from fully efficient cooperation.
- Gas storages and LNG terminals are essential to ensure seasonal and short-term flexibility. The evolution of the storage levels results from market decisions and can significantly influence the withdrawal capacities and therefore the short-term flexibility gas storages can provide: a too low storage level at the end of the winter can increase the risk of exposure to demand curtailment in some countries and for some scenarios.
- Since 2017 the evolution of the European gas infrastructure considered in the simulation significantly improves the possible cooperation among Member States.
- Gas market evolution, changes in the Member States energy mixes, declining domestic production and coal-to-gas switch explain the evolution of the gas demand compared to the 2017 edition.
- In all scenarios an efficient cooperation between EU Member States can export significant volumes to Energy Community Contracting Parties and other EU neighbouring countries.

Important: *The Security of Supply results should be interpreted as an assessment of the ability of the gas infrastructure to allow for an efficient cooperation of the EU Member States to cope with an unusual cold winter season under different scenarios. The EU-wide simulation is not a forecast of the expected gas supply situation.*

Disruption Scenarios overview				
#	**Disruption scenario**	**Member State can efficiently cooperate and may fully mitigate risks of demand curtailment (Yes/No)**	**Sensitivity impact – efficient cooperation between Member States w/o Nord Stream 2 (Yes/No)**	**2017 SOS Simulation Report**
1	Ukraine	Yes	No; import limitation	No
2	Belarus	Yes	Yes	No
3	Nord Stream	Yes	Yes	Yes
4	Greifswald	Yes	Yes	Yes
5	Baltic states and Finland	No; infrastructure limitation	No change	No
6	Trans-Balkan	Yes	Yes	No
7	Langeled	Yes	Yes	Yes
8	Europipe 2	Yes	Yes	Yes
9	Emden	Yes	Yes	Yes
10	largest L-gas storage	Yes	Yes	Yes
11	L-gas	Yes	Yes	Yes
12	Baltic Pipe	Yes	Yes	No (Ellund)
13	UK (Forties pipelines)	Yes	Yes	Yes
14	Transmed	Yes	Yes	Yes
15	MEG	Yes	Yes	Yes
16	All supplies from Algeria	Yes	Yes	No
17	Libya	Yes	Yes	Yes
18	Turkey	Yes	Yes	Yes
19	TANAP	Yes	Yes	Yes

1. Introduction

Regulation (EU) 2017/1938 of the European Parliament and of the Council concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010 ("the Regulation") entered into force on 1 November 2017.

In its Article 7 “Risk assessment”, the Regulation stipulates:

By 1 November 2017, ENTSOG shall carry out a Union-wide simulation of gas supply and infrastructure disruption scenarios. The simulation shall include the identification and assessment of emergency gas supply corridors and shall also identify which Member States can address identified risks, including in relation to LNG. The gas supply and infrastructure disruption scenarios and the methodology for the simulation shall be defined by ENTSOG in cooperation with the Gas Coordination Group (GCG). ENTSOG shall ensure an appropriate level of transparency and access to the modelling assumptions used in its scenarios. The Union-wide simulation of gas supply and infrastructure disruption scenarios shall be repeated every four years unless circumstances warrant more frequent updates.

ENTSOG’s first Union-wide simulation considered the gas infrastructure in operation along the different gas corridors on 1 October 2017. In October 2020, upon request of the GCG, ENTSOG published an Addendum to the Union-wide simulation 2017 to assess the impact of several major pieces of infrastructure recently commissioned.

This publication is the first full scope revision of the above-mentioned Union wide simulation.

Union-wide simulation of gas supply and infrastructure disruption scenarios (SoS simulation) 2021

On 6 May 2021, the methodology and assumptions for ENTSOG’s Union-wide simulation 2021 have been reviewed by ENTSOG and the GCG. Most of the assumptions from 2017 edition of the report were found to be valid and relevant. Considering the evolution of the gas system foreseen for the next four years, the Gas Coordination Group agreed to implement a new approach regarding the infrastructure to be assessed. The revised Union-wide simulation considers the gas infrastructure existing at the moment of the data collection (May 19th-June 21st, 2021) and also projects that are expected to be commissioned by December 31st, 2022. This new ‘timestamp approach’ allows to reflect the configuration of the emergency gas corridors at the time of application of the next national plans (expected to be in place in preparation for the winter 2023/24). The choice of the relevant projects is based on the technical data submitted to ENTSOG by promoters for TYNDP 2020, (excluding less advanced projects) and verified by national TSOs.

As a consequence of considering a specific timestamp for the simulations the composition of some risk groups, as defined in Annex I of the Regulation, has been updated. Among those changes, the United Kingdom has been removed from the lists of Member States and the Risk Groups have been adapted to consider the enhanced cooperation among Member States enabled by the commissioning of new infrastructure.

Disruption scenarios, duration, and climate conditions configuration agreed in 2017 were found accurate for this edition of the simulation. Only necessary modifications were implemented to follow the timestamp approach. Considering the new infrastructure to be into operation, 2 new disruption scenarios were defined and included the Union-wide simulation 2021 (Scenario 18 and 19). As for the Union-wide

SoS simulation 2017, it was also decided to delegate the treatment of the scenarios concerning L-gas to the Gas Platform[1].

After that meeting, Member states were provided with additional time for review and no further changes were submitted. In parallel, the European Commission asked for feedback regarding the Draft delegated regulation changing Annex 1 to the Regulation (EU) 2017/1938 defining risk group compositions. The methodology and assumptions for the simulations were all approved by the Gas Coordination Group.

The input data for the simulations concerning the gas demand for the different climatic conditions, infrastructure capacities and the estimates for the gas production were submitted by TSOs, Associated Partners and Observers from ENTSOG as part of a specific data collection process in May-June 2021.

The supply and infrastructure disruption scenarios as well as the methodology and assumptions are further detailed in the next chapters.

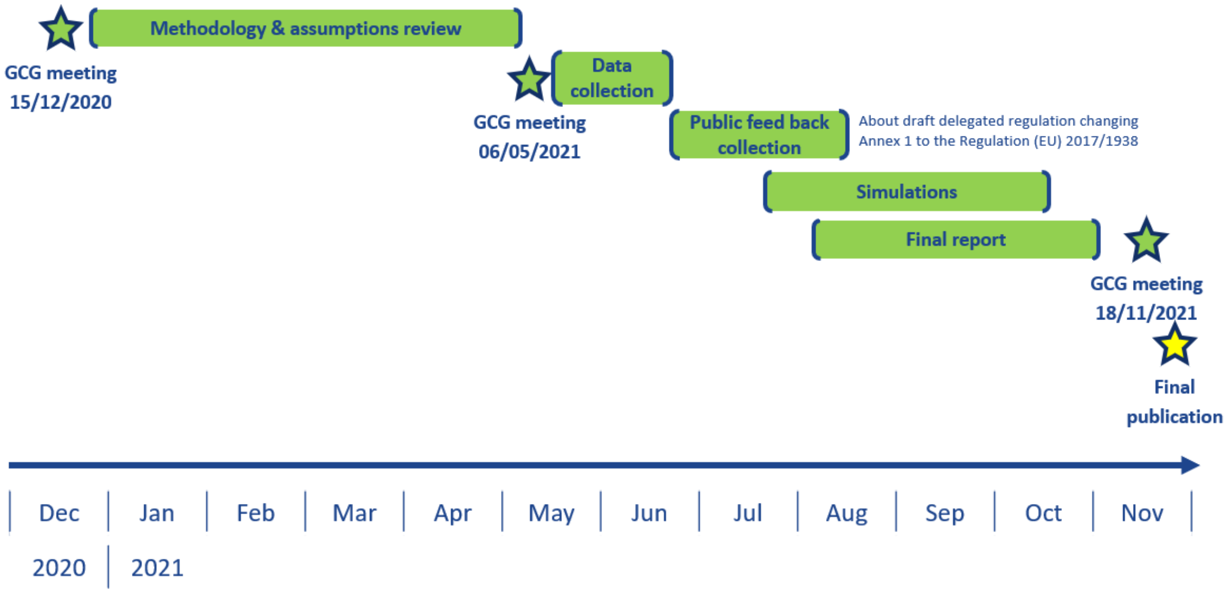


Figure 1. Timeline of 2021 Union wide simulation of supply and infrastructure disruption scenarios.

2. Supply and infrastructure disruption scenarios

The 20 supply and infrastructure disruption scenarios cover all the Emergency Supply Corridors as well as the 13 different Risk Groups of Member States as defined in the amended Annex 1 of the Regulation. They are meant to identify which Member States can address identified risks, including in relation to LNG, against the failures of the main gas supply routes or infrastructures.

Among these scenarios, one is not simulated because no infrastructure exists yet (scenario 20). The scenarios regarding Low Calorific gas are defined and treated within the Gas Platform.

[1] The Gas Platform is the regional cooperation for gas for Belgium, France, Germany, Luxembourg and the Netherlands. It is an intergovernmental initiative where ministries responsible for energy policy discuss issues related to security of supply and market integration, in close cooperation with the National Regulatory Authorities and Transmission System Operators. Ad hoc, the European Commission or other European authorities participate as observer. The Benelux Secretariat provides support.

Table 1. Disruption scenarios Union-wide simulation 2021.

	Risk Group	#	Disruption scenario
Eastern gas supply	Ukraine	1	Disruption of all imports via Ukraine
	Belarus	2	Disruption of all imports via Belarus
	Baltic Sea	3	Disruption of one Nord Stream offshore pipeline (50% NOS)
		4	Disruption of the onshore receiving facility of Nord Stream (Greifswald station, 100% NOS)
	North-Eastern	5	Disruption of all imports to the Baltic states and Finland
	Trans-Balkan	6	Disruption of the largest infrastructure to the Balkan region (Trans-Balkan Pipeline)
North Sea gas supply	Norway	7	Disruption of the largest offshore infrastructure to the UK (Langeled)
		8	Disruption of the largest offshore infrastructure to continental EU (Europipe 2)
		9	Disruption of the largest onshore infrastructure from Norway (Emden station)
	Low calorific gas	10	Disruption of the largest L-gas storage (Gas Platform)
		11	Disruption of the L-gas supply (Gas Platform)
	Denmark	12	Disruption of the largest infrastructure to Denmark (Baltic Pipe)
	United Kingdom	13	Disruption of Forties pipeline system
North-African gas supply	Algeria	14	Disruption of the largest offshore infrastructure to Italy (Transmed)
		15	Disruption of the largest offshore infrastructure to Spain (MEG)
		16	Disruption of all imports from Algeria, including LNG
	Libya	17	Disruption of all imports from Libya
South-East gas supply	Southern Gas Corridor	18	Disruption of all imports from Turkey to Greece (TANAP + Kipi import point)
		19	Disruption of the largest onshore infrastructure to Greece (TANAP)
	Eastern-Mediterranean	20	No existing infrastructure

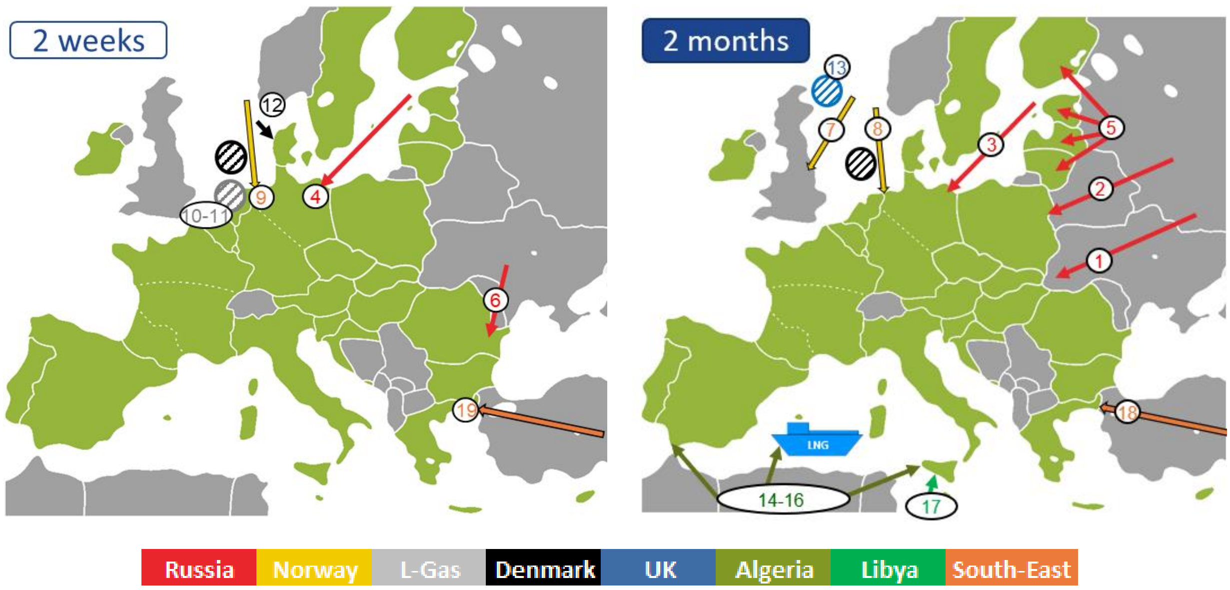


Figure 2. Disruption scenarios allocation Union-wide simulation 2021.

3. Methodology and assumptions

The methodology and assumptions cover:

- Simulation cases along with the corresponding demand assumptions,
- disruption duration,
- supply,
- infrastructure,
- modelling and results interpretation, and
- treatment of storages including the initial inventory levels.

The corresponding data are available in the Annexes.

3.1. Simulation cases and demand assumptions

For every scenario, 3 different cases are simulated to assess the impact of 3 high demand events:

I. A historical high demand winter[2] – country level historical highest gas demand since winter 2009-2010 revised by TSOs.

II. A period of 2 weeks of exceptionally high demand, occurring with a statistical probability of once in 20 years - also called 2-week cold spell.

III. One day (peak day) of exceptionally high demand, occurring with a statistical probability of once in 20 years.

For 2021 edition, TSOs were asked to review and update, when necessary, winter demand values used in 2017 edition, especially under the context of the market evolution and ongoing processes that are taking place in their countries. As shown in Figure 3, an increase of 3% of the total winter demand has been observed from 2017 to 2021 edition mainly driven by the development of the market and infrastructure over the last 10 years. In addition to the demand within the EU member states, the demand of non-EU countries that are only supplied via the European gas infrastructure (UK, BA, CH, MK, RS) have been considered in the simulations.

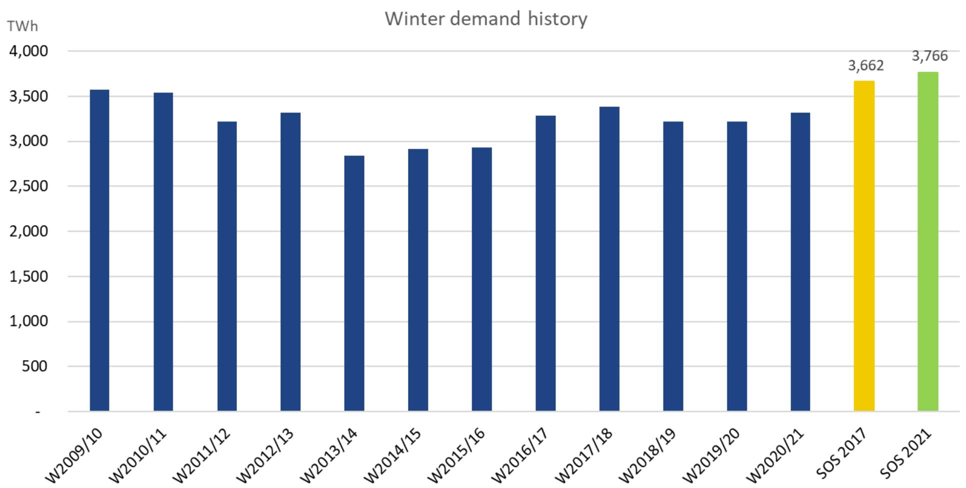


Figure 3. Comparison of demand values for historical winters, SoS 2017 and SoS 2021 assumptions.

[2] Period from 1 October to 31 March, covering the six months in between with 182 days in total.

The sum of the winter demand of the EU countries in this assessment is 5.4% above the demand that has materialised simultaneously across the EU since 2009/10. This deviation is derived from the fact that the historical highest winter demand did not occur simultaneously in every European country.

In specific countries, the application of historical demand figures for the whole winter simulation would not be appropriate without a revision. This applies mainly to following countries:

- Belgium, where there is a clearly observed yearly growth in demand driven by a gas market evolution, decommissioning of the nuclear power plants and an ongoing L-to-H-gas conversion.
- Netherlands, where the gas demand has declined over the past years and is expected to decline further in the upcoming years.
- Poland, where the gas demand has been gradually increasing over the recent years caused by an ongoing coal to gas switch.
- Greece, where the increase of gas demand is attributed to the de-lignification plan of Greece (decommissioning of all lignite-fired power plants by 2025) and to the increase of gas consumption of non-power producers.
- Sweden, where the gas demand has increased in the industrial sector.

The high demand cases are meant to capture the capability of the gas system to cope with the most challenging demand situation (peak day / Design Case) and a long high-demand period (2-week cold spell). Figures 4 and 5 show the 2-week cold spell and peak day demand. The 1-in-20 years approach leads to the sum of the 2-week cold spell demand being 18% and the one for the peak day 26% above the simultaneous demand that could be observed since 2009/10.

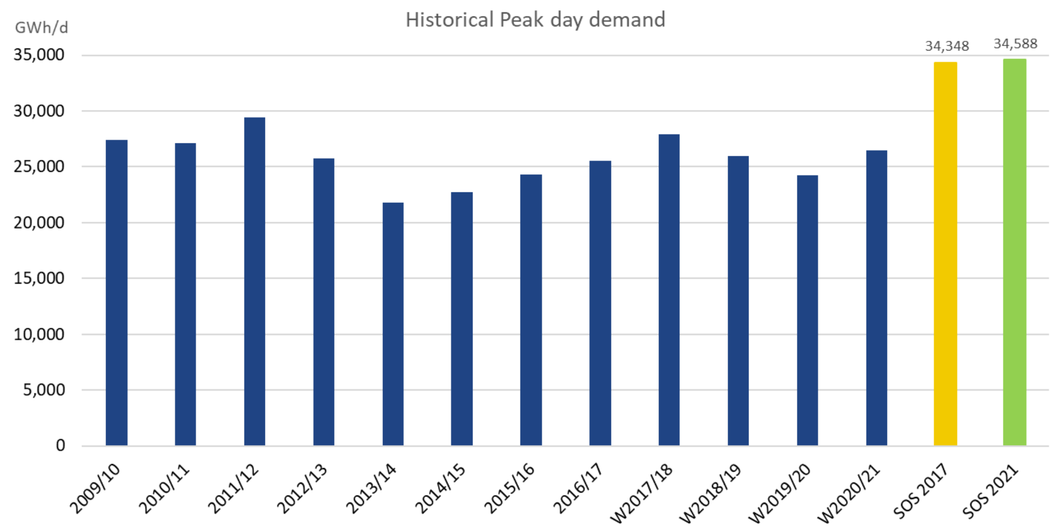


Figure 4. Comparison of peak demand values for historical winters, SoS 2017 and SoS 2021 assumptions.

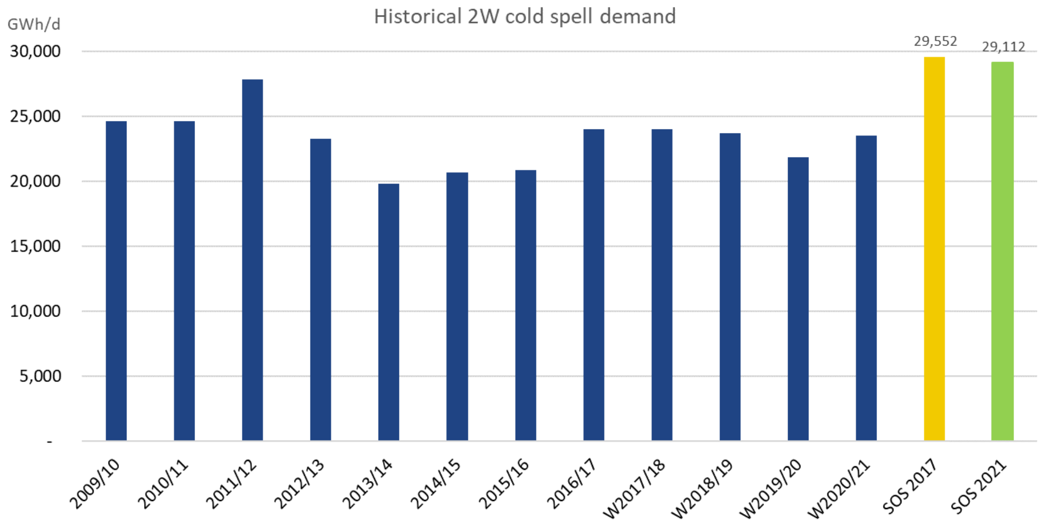


Figure 5. Comparison of 2-week cold spell values for historical winters, SoS 2017 and SoS 2021 assumptions.

3.2. Exports

In addition to the EU member states and non-EU countries demand, the exports to Ukraine (based on the last five winters historical flows), and the transits towards Kaliningrad (based on the last five winters historical flows) have been considered in the simulations. The transits to Kaliningrad are not maintained in the scenarios 2 and 5. In general, exports to Ukraine and Kaliningrad represent around 2% of the EU winter demand. No exports to Turkey are considered.

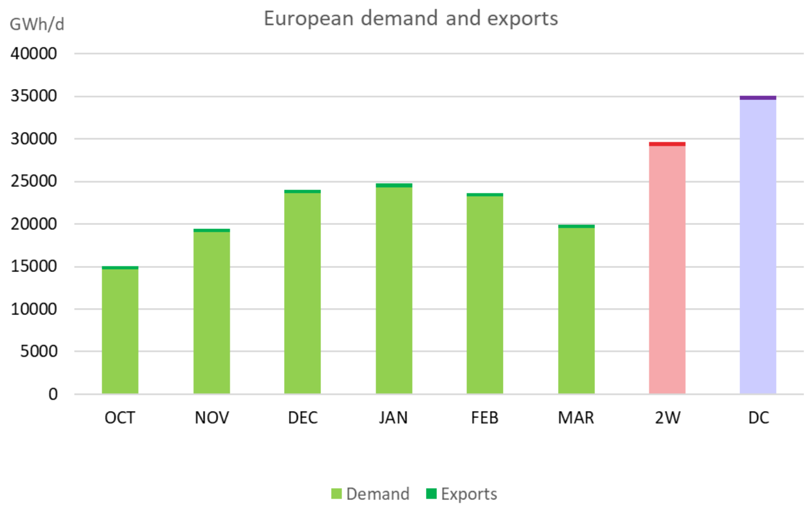


Figure 6. Monthly, 2-week and peak day EU demand and exports from EU.

3.3. Demand and disruption timelines

The disruption periods are defined to assess the impact of the various scenarios along with a low initial storage level during these exceptionally high demand events. They are not defined based on their probability of occurrence but based on agreed periods instead. The 2-month disruptions are simulated during January and February and the 2-week disruptions from 15 February to 28 February.

During the disruption periods, exceptionally high demand periods are considered with an occurrence probability of once in 20 years: 2-week cold spell and peak day. For these exceptional cases, storage levels and LNG import flows considered on 15 February are resulting from the whole winter simulation or the 2-month disruption depending on the scenario (see also chapter 3.6 for further information).

Table 2. Simulation cases timeframes.

Simulation case	**Historical high demand winter**	**2-week in 20 years**	**Peak day in 20 years**
Simulation period	From 1 October to 31 March	From 15 February to 28 February	On 15 February
Gas demand	Highest winter demand since 2009/10 (at country level and then aggregated for EU)[3]	Exceptionally high demand, occurring with a statistical probability of once in 20 years.	Exceptionally high demand, occurring with a statistical probability of once in 20 years.

Figure 7. Demand assumption and disruption timeframes.

[3] TSOs were asked to review and update (when necessary) winter demand assumptions values, especially under the context of the market evolution and ongoing processes that are taking place in their countries. In specific countries the application of historical demand figures without any adjustments for the whole winter simulation was not appropriate.

> *Specificity of scenario 16 - Algerian disruption:*

- Disruption scenario #16 considers the disruption of the imports from Algeria via both pipelines and LNG cargos. Regarding the LNG supply, it is assumed that a period of 3 weeks, starting from 1 January, is necessary to attract more LNG cargos to substitute the Algerian LNG (see Figure 8).

Figure 8. Demand assumption and disruption timeframes for scenario 16.

3.4. Supply

Supply limitations are set for different time scales (winter season, monthly, 2-weeks and daily) so that the maximum flow of each source cannot exceed reasonable levels based on historical observations.

The maximum supply potentials of the different sources providing gas to EU via pipeline (Algeria, Libya, Norway, Russia) are based on a 10 year historical data (daily and 2-week maximum supply potential are based on the available data - 8 years range). Differing from SoS 2017, Caspian (CA) imports are considered for the first time in this edition. Caspian supply is covering part of EU demand since December 2020; therefore, in order to reflect the real potential of the source, summer 2021 flows have been considered to calculate the maximum supply potential.

Figures 9 and 10 show historical supply since winter 2011/12 for pipeline and LNG imports. Figures 11 and 12 show the historical 2-week cold spell and daily peak demand since winter 2013/14.

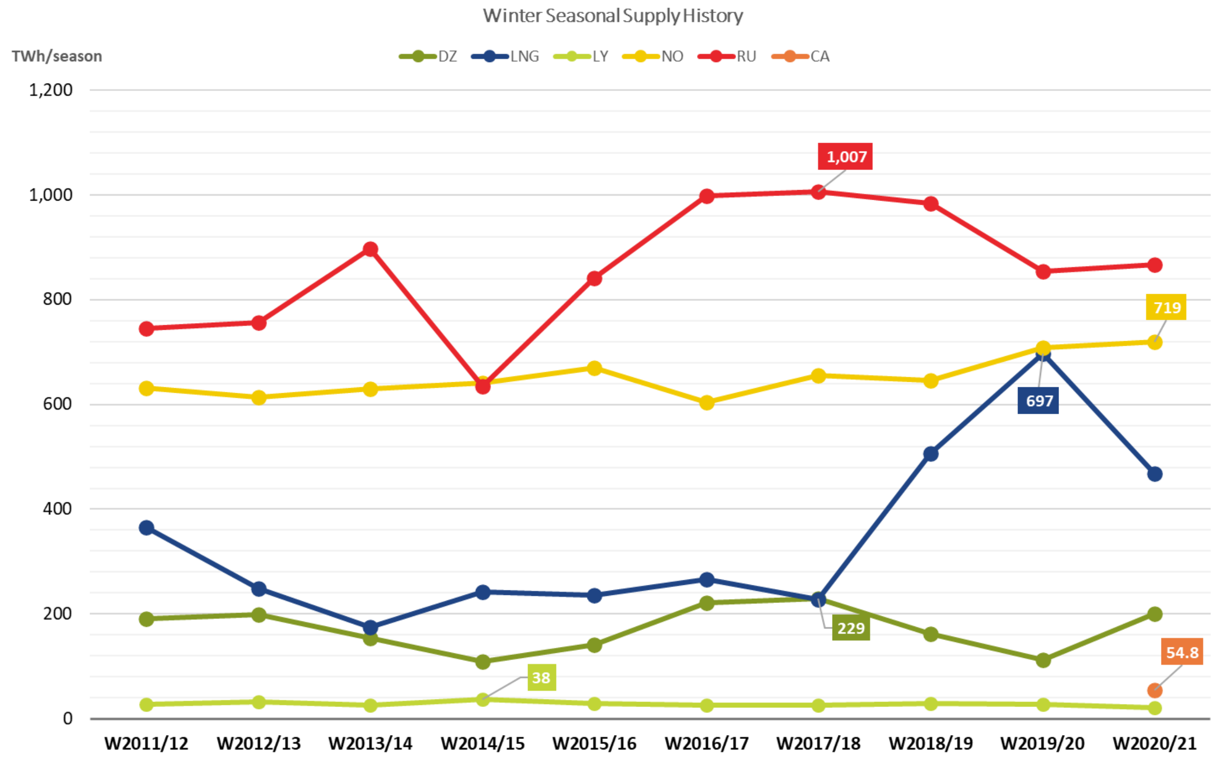


Figure 9. Winter supply history.

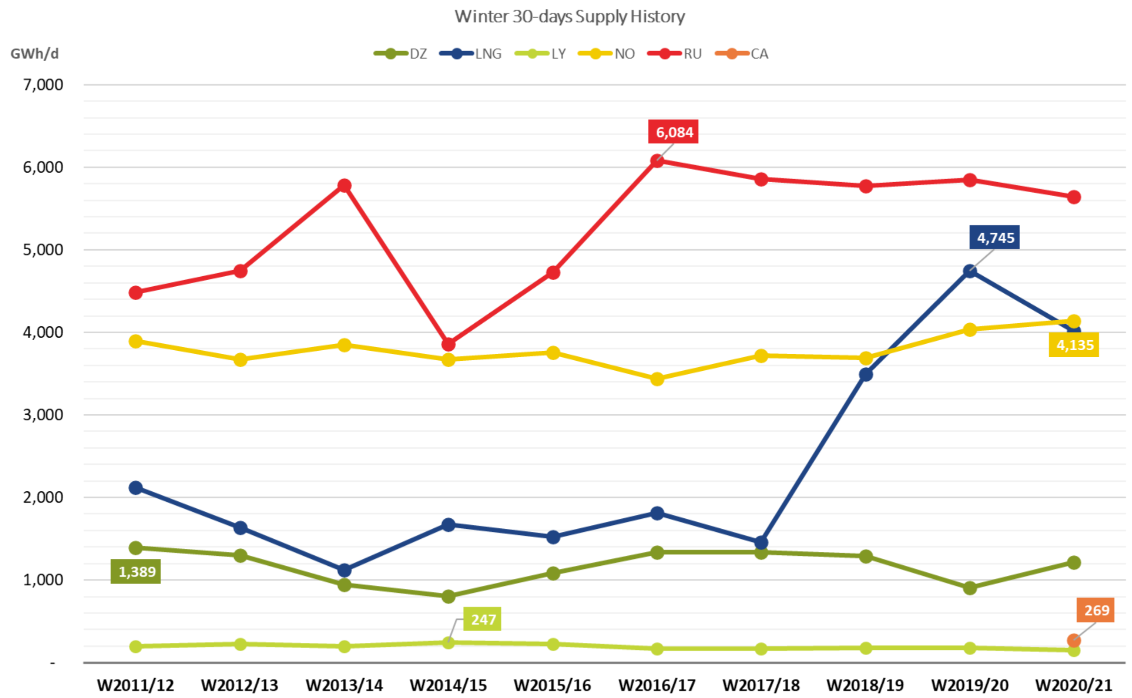


Figure 10. Winter 30-days supply history.

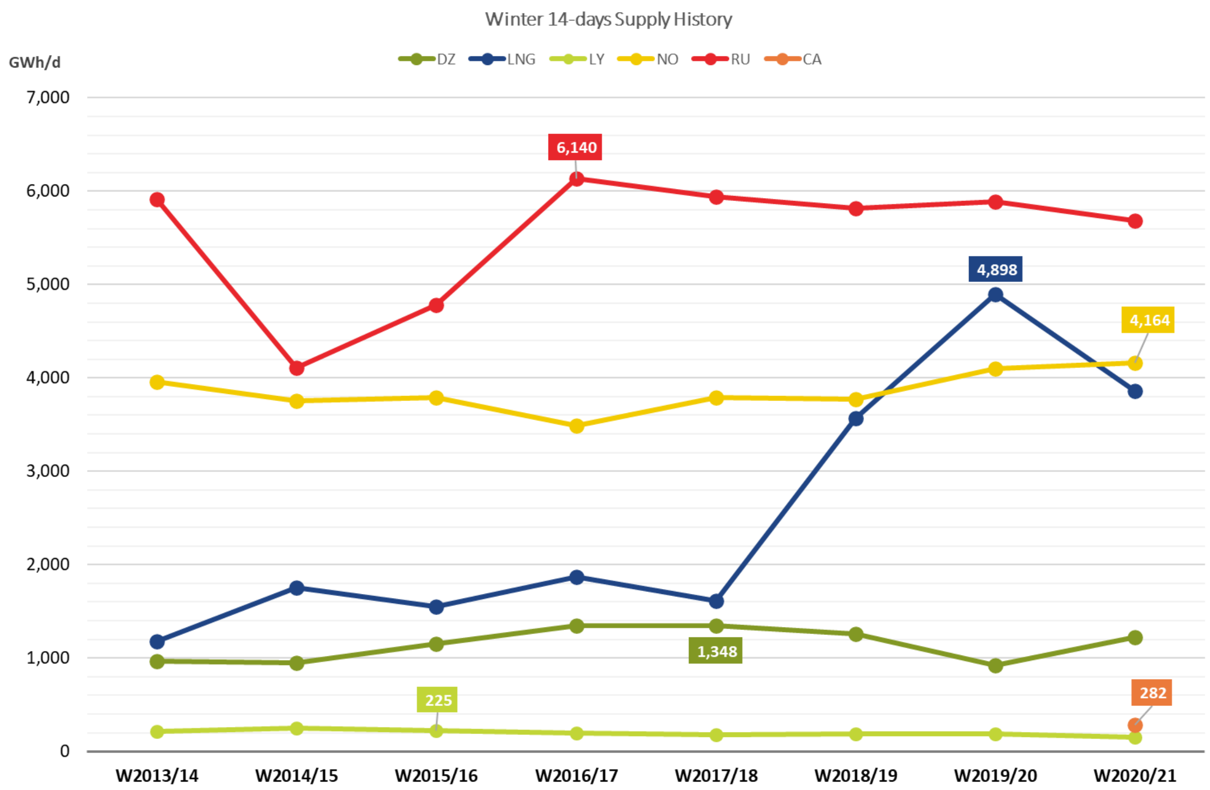


Figure 11. 2-week supply history.

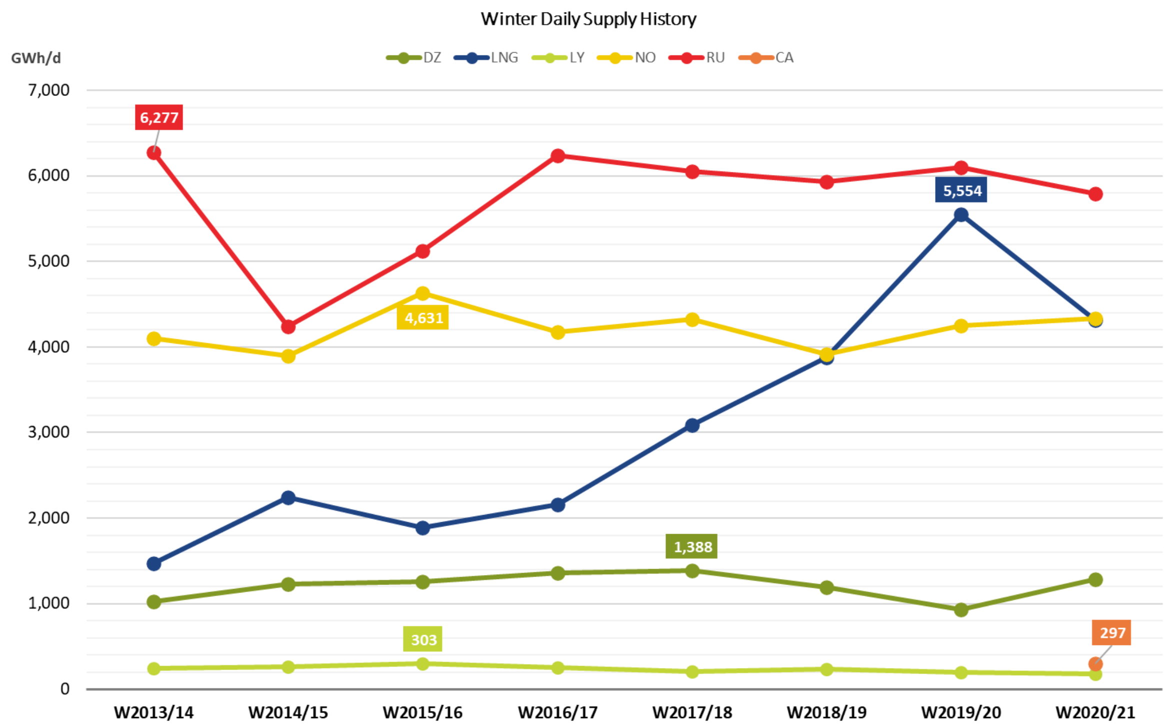


Figure 12. Daily supply[4] history.

[4] For LNG maximum supply potential, the maximum send-out capacity from GLE map has been considered (see further explanation below).

As an example, Figure 13 shows Norwegian maximum winter supply. Over the whole simulated winter period, gas imports from Norway do not exceed 719 TWh and for each month, the average import flows do not exceed 4,135 GWh/d. However, during some days, import flows go up to the daily limit (4,631 GWh/d). The supply potential limitation ensures that the monthly average flow remains below the 4,135 GWh/d limit, and the winter average flows remains below 3,953 GWh/d limit.

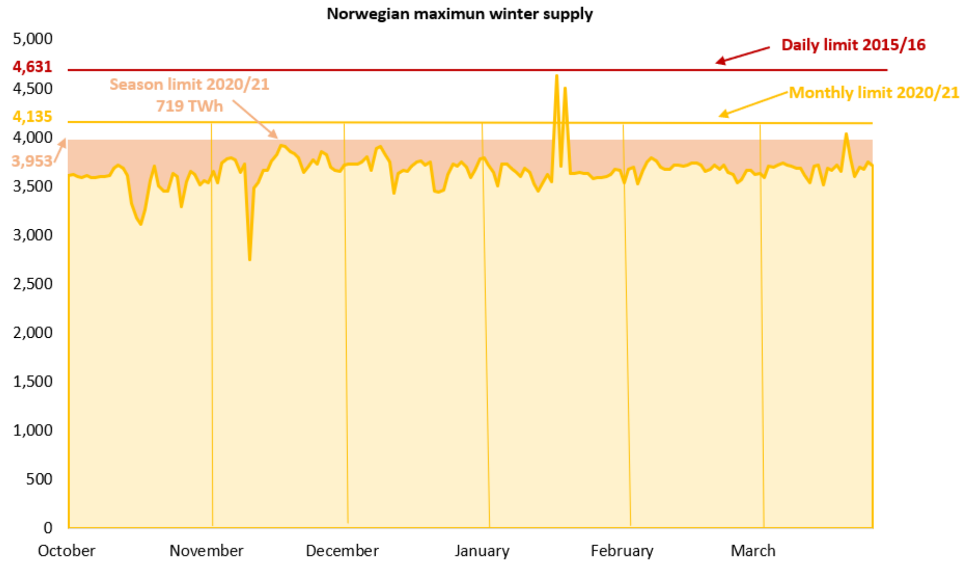


Figure 13. Winter supply history and modelling assumptions.

In case of LNG supply, additional assumptions are made:

- During the peak day, the LNG supply is allowed to go up to the total send-out capacities of the terminals (6,803 GWh/d).
- LNG flows during the first week of the 2-week cold spell simulations (15 to 21 February) are limited by the LNG flows resulting from the whole winter simulation.
- For scenario #16 (disruption of all Algerian imports), the model considers that the flows to the different LNG terminals are reduced by the share of Algerian LNG in their LNG mix in 2019.

Table 3. Share of Algerian LNG in the LNG mix per country in 2019 – Cf Source GIIGNL report 2020[5].

Share of Algeria in LNG supply mix			
Belgium	0%	**Netherlands**	23%
Finland	0%	**Poland**	0%
France	43%	**Portugal**	2%
Greece	20%	**Spain**	19%
Italy	23%	**Sweden**	0%
Lithuania	0%	**UK**	56%
Croatia	0%		

[5] The actual share of Algerian LNG on the total Italian and Greek LNG imports has been updated under request of TSOs (Source for Italian data: IHS).

In addition to the pipeline supply and LNG supply, the assessment takes into consideration indigenous gas production, the gas coming from the underground storages and the LNG tanks flexibility:

> *EU Production:*

The EU production levels are based on the best TSOs estimates for the monthly average production expected to flow from the production facilities in January 2023.

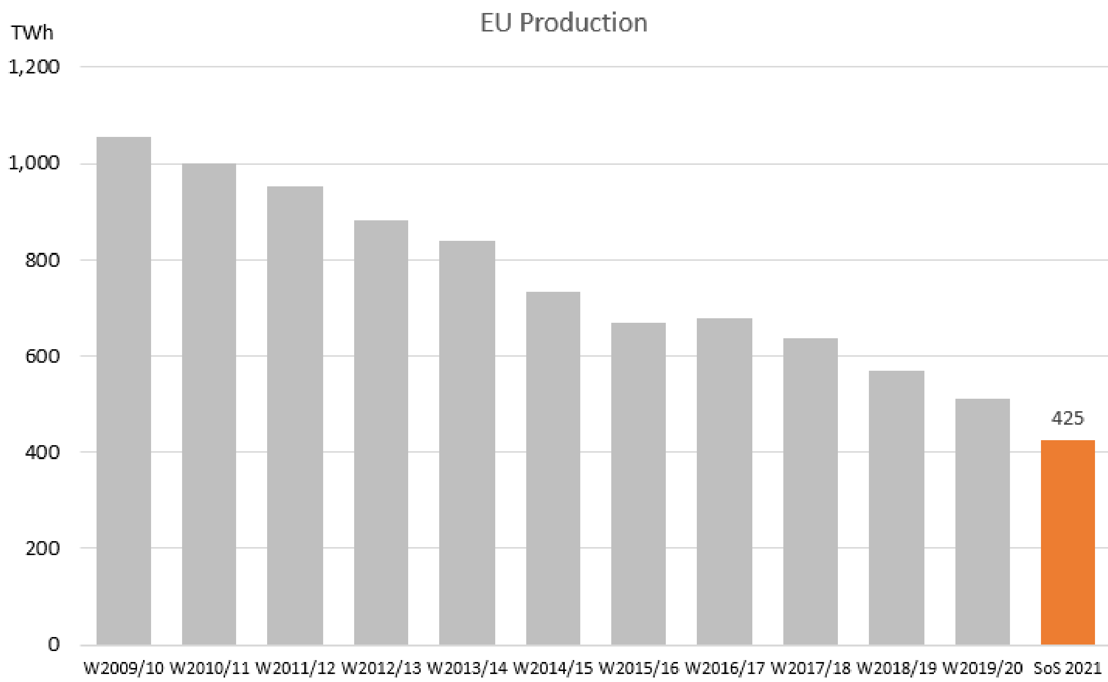


Figure 14. EU production history and SoS assumption.

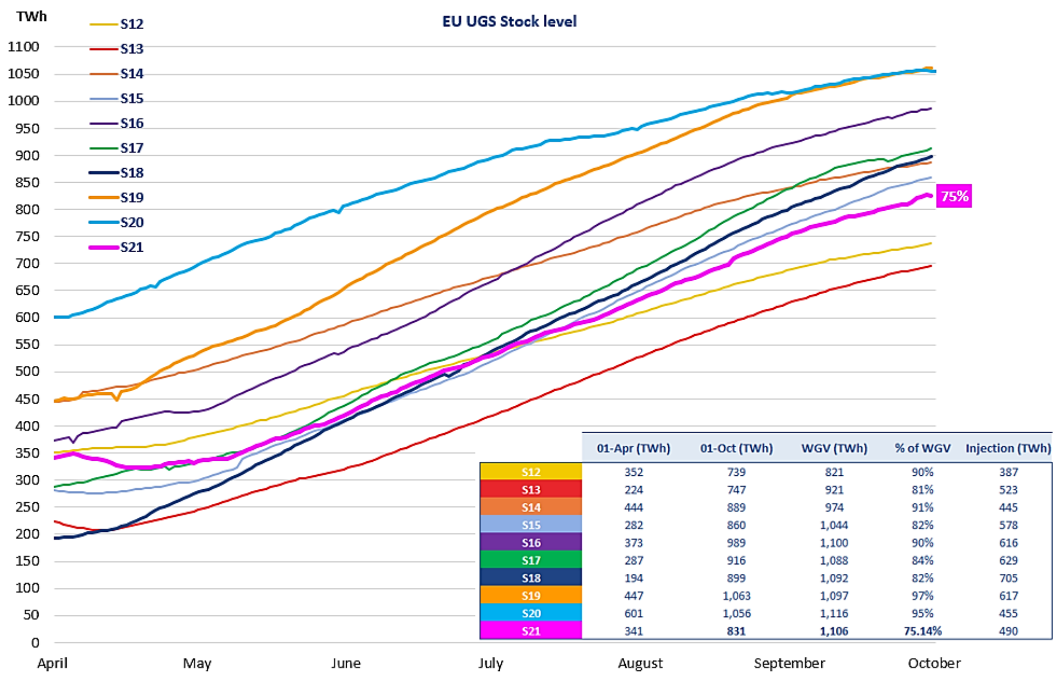
The EU Production level considered in the simulations is 60% lower than the EU Production observed during the high demand winter of 2009/10. National production value submitted by TSOs for the 2021 edition of this report is 30% lower than production considered in 2017 simulations. Differing from SoS 2017 edition, the renovation of the Danish production gas field (Tyra) is considered as completed and the associated production increased. In the simulations, the Danish national production represents 103.3 GWh/d plus 306.8 GWh/d of Norwegian supply thanks to the commissioning of the Norwegian tie-in to Danish upstream system. Additionally, a minimum flow of 1.5 bcm is expected to continue from the Groningen field from October 2022 to March 2023.

> *Underground Gas Storages:*

In winter, the supply flexibility in the European gas system is largely ensured by the gas storages. Storages are essential assets to cope with the high demand variation during the winter season. The capability of the gas system to cope with the winter demand variation depends on the storage filling levels at the beginning of the winter and is reported every year by ENTSOG in its Winter Supply Outlook.

For this edition of the Security of Supply simulation, the lowest historical storage filling level was considered (in percentages): 75%[6] on 1st October 2021. Therefore, for all EU storage, 75% of their WGV is assumed on 1 October. As shown in Figure 15, when comparing absolute values, winter 2012/13 and 2013/14 started the injection season with lower gas in the storages but the total WGV was lower than in 2021 and the EU indigenous production was significantly higher. For further information, see Annex III. For 2-week cold spell and peak day simulations, the model considers the storage levels resulting from the simulations of the entire winter. The storage level of 15 February is then considered as an input.

[6] Under request of TSO, a lower storage level was kept for Latvia in line with AGSI historical data of 50.05%.



	01-Apr (TWh)	01-Oct (TWh)	WGV (TWh)	% of WGV	Injection (TWh)
S12	352	739	821	90%	387
S13	224	747	921	81%	523
S14	444	889	974	91%	445
S15	282	860	1,044	82%	578
S16	373	989	1,100	90%	616
S17	287	916	1,088	84%	629
S18	194	899	1,092	82%	705
S19	447	1,063	1,097	97%	617
S20	601	1,056	1,116	95%	455
S21	341	831	1,106	75.14%	490

Figure 15. EU injection history and SoS assumption (Source: AGSI+).

ENTSOG model considers injection and withdraw capacities provided by SSOs and TSOs. In addition to the withdrawal and injection capacities, withdrawal and injection curves for storages are considered. These curves define the abilities of storages to withdraw or inject gas depending on the filling level. The lower the storage level, the lower the withdraw capacity. The curves are provided by Storage System Operators via GSE (available in Annex III).

> *<u>LNG terminals tank flexibility:</u>*

LNG infrastructure is characterised by the regasification capacity available along the winter season and the peak send out capacity available during high demand situations. The LNG tank volumes have operational characteristics specific for each terminal. LNG stored in the tanks fluctuates within a normal operating range and a minimum amount of LNG that must be kept in the tanks for a safe operation. In case of high demand events such as cold spells or peak days, this minimum amount can be lowered and part of the tanks can be used as a buffer volume, waiting for more LNG carriers to unload. This flexibility is modelled based on information provided by the LNG System Operators via GLE (available in Annex IV).

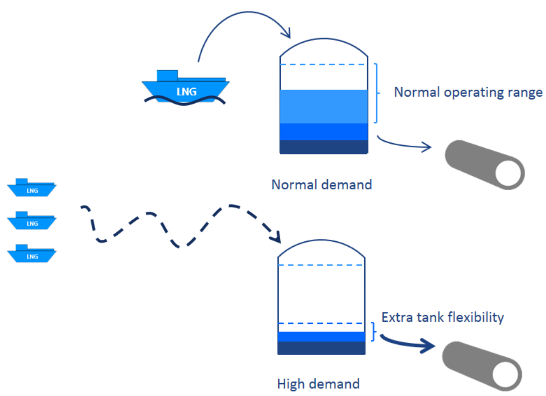


Figure 16. LNG tank flexibility.

3.5. Infrastructure

ENTSOG uses Plexos modelling tool since spring 2021. ENTSOG model builds on TSO expertise and hydraulic modelling of national infrastructure to model the European gas infrastructure with the most relevant accuracy. This enables the national assessments to benefit from the Union wide simulation of supply and infrastructure disruption scenarios.

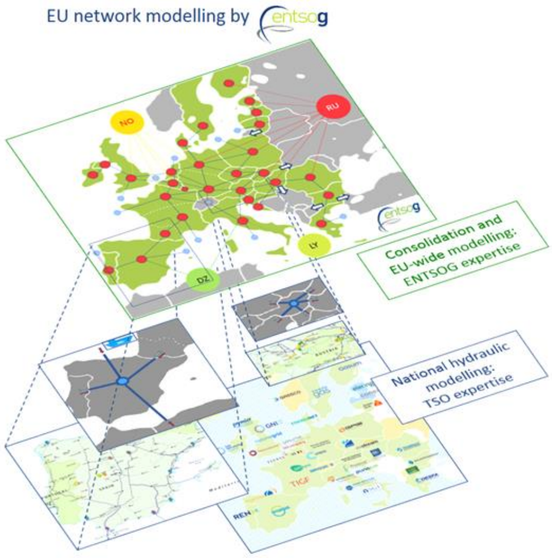


Figure 17. ENTSOG model overview.

The simulations consider the existing European gas infrastructure and projects to be commissioned before January 2023. This assumption is made to reflect the configuration of the emergency gas corridors at the time of application of the next national plans (expected to be in place in preparation for the winter 2023/24). The choice of the relevant projects is based on the technical data submitted to ENTSOG by promoters for TYNDP 2020, (excluding less advanced projects) and verified by national TSOs (see Table 4). Capacities used in the simulation can be found in Annex I.

Table 4. TYNDP2020 projects included for the SoS assessment.

Project Name	Code
NTS developments in North-East Romania	TRA-F-357
Upgrading GMS Isaccea 1 and GMS Negru Voda 1	TRA-F-1277
Upgrade of LNG terminal in Świnoujście (first stage)	LNG-F-272
Poland - Slovakia interconnection	TRA-F-190
Poland - Slovakia Gas Interconnection (PL section)	TRA-F-275
Gas Interconnection Poland-Lithuania (GIPL) - PL section	TRA-F-212
Gas Interconnection Poland-Lithuania (GIPL) (Lithuania's section)	TRA-F-341
Poland - Denmark interconnection (Baltic Pipe) – onshore section in Poland	TRA-A-1173
Poland - Denmark interconnection (Baltic Pipe) - offshore section	TRA-A-271
Baltic Pipe project – onshore section in Denmark	TRA-A-780
Norwegian tie-in to Danish upstream system	TRA-A-394
GUD: Complete conversion to H-gas	TRA-N-955
Capacity4Gas – DE/CZ	TRA-F-752
EUGAL - Europaeische Gasanbindungsleitung (European Gaslink)	TRA-F-763
Necessary expansion of the Bulgarian gas transmission system	TRA-F-592
Interconnector Greece-Bulgaria (IGB Project)	TRA-F-378
Modernization and rehabilitation of the Bulgarian GTS	TRA-F-298

3.6. *Modelling results interpretation*

The Security of Supply results should be interpreted as an assessment of the ability of the gas infrastructure to allow for an efficient cooperation of the EU Member States to cope with an unusual cold winter season under different scenarios. The EU-wide simulation is not a forecast of the expected gas supply situation. The actual utilisation of the gas infrastructure, supply directions and the development of the gas storage levels, will be also determined by the decisions of the market participants.

The simulations identify situations where a country can receive some help from its neighbouring countries in order to avoid or mitigate the exposure to demand curtailment. An infrastructure limitation can be observed when the capacities between countries are completely used, and no additional gas can flow to the country with the highest exposure to demand curtailment.

> *Comparison with reference case*

For the purpose of giving more insight to the flows during the disruption scenarios, a reference case without disruption has been defined (reference scenario). The comparison of the scenarios' results with the reference case is described in the results analysis and gives more information on the reaction to the disruption scenarios. Demand-side response and demand-side measures are not simulated so that the results can be interpreted and compared to the reference scenario without pre-empting any reaction or possible solution to the identified situations.

> *Demand curtailment allocation*

Whenever a simulation result indicates possible exposure to demand curtailment, the actual allocation of this curtailed demand between the countries depends on several factors amongst which the cooperation of member states and contractual arrangements are most relevant. In some instances, infrastructure limitations can limit the cooperation possibility. It is assumed in the simulation that all member States within a risk group cooperate to avoid demand curtailment to the extent possible and by sharing the curtailment equally.

The allocation of the demand curtailment within the member states can be further investigated as part of the national and regional risk assessments.

> *Storage use*

Simulations of the whole winter season assess the capability and the flexibility of the gas infrastructure and supply to cope with a high winter demand. The model prepares for this high demand level by injecting in the UGS as long as the import flows allow for it. High demand cases (2-week cold spell and peak day) consider the storage levels at the start of the events resulting from the whole winter simulation.

> *Nord Stream 2 sensitivity*

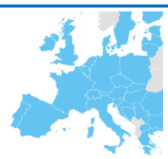
Nord Stream 2 is included in all scenarios as an existing infrastructure. Due to some uncertainty on the commissioning of the project, the Gas Coordination Group decided to include a sensitivity assessment for all disruption scenarios. All disruption scenarios and specific demand events are additionally simulated without Nord Stream 2. Results of this sensitivity are presented in this report when changes in terms of exposure to demand curtailment are observed.

> *Units*

All the data used in the simulation are expressed in energy (TWh or GWh). For better readability of the results analysis, ENTSOG presents the results in both energy and volumes. ENTSOG derives volumes from energy by applying a single conversion factor of 11 kWh/m^3.

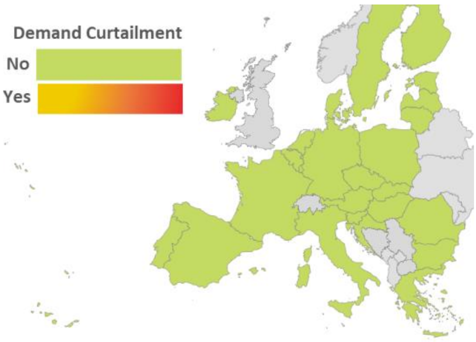
4. Results analysis

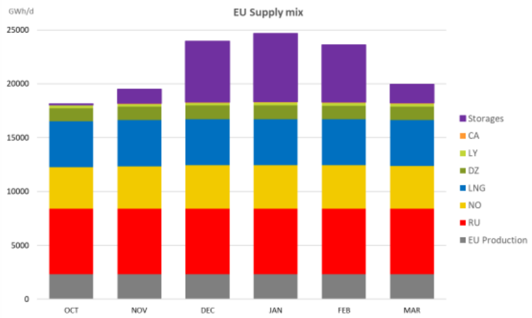
REFERENCE SCENARIO	Reference case
Risk group:	Not applicable
Disruption duration:	No disruption

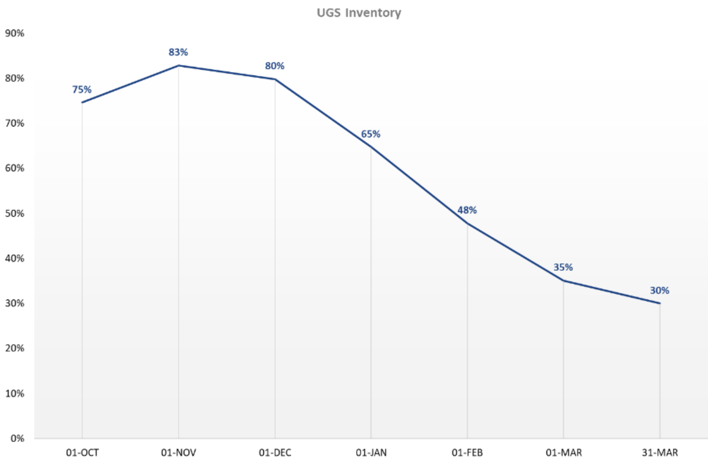


Simulation results

Whole winter







Supply

Storages: The EU storage level ends around 30%[7] on 31st of March, which means that all EU countries reach the target of their working gas volume (WGV). Gas is still injected in the storages in October up to 83% of WGV and withdrawal is observed in all countries from November to March. Higher withdrawal is observed during the months of highest demand: December, January, and February.

Pipeline and LNG supplies: Supplies are not used at their maximum supply potential during the whole winter, only RU and LY supply reach the maximum.

CA	LY	DZ	LNG	NO	RU	EU production
269 GWh/d	247 GWh/d	1,389 GWh/d	4,746 GWh/d	4,135 GWh/d	6,084 GWh/d	2,333 GWh/d
24 mcm/d	22 mcm/d	126 mcm/d	431 mcm/d	376 mcm/d	553 mcm/d	212 mcm/d

[7] Spain has strategic storages usage, UGS should not be used below 55% for the reference case simulations. The level of the storages could go below 55% in particularly stressful situations as in the case of Algerian Disruption.

REFERENCE SCENARIO Reference case

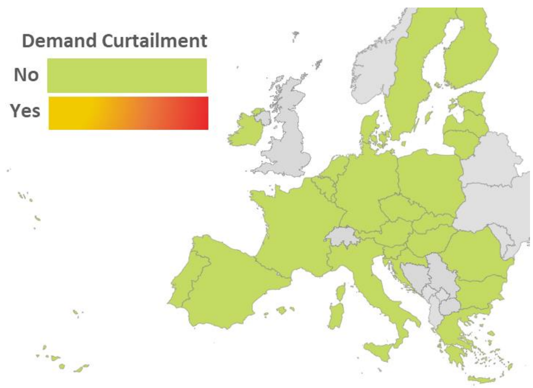
Demand

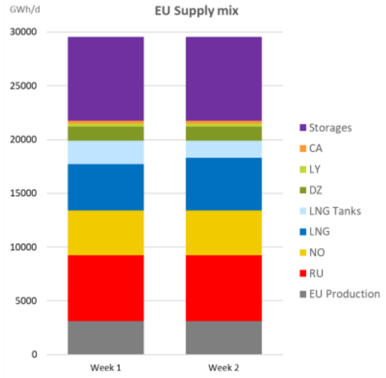
No country is exposed to demand curtailment.

Exports to Ukraine (UA) and transit to Kaliningrad can be maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storages are mostly used up to their maximum withdraw potential set by the SSOs.

Pipeline and LNG supplies: Supplies are used at the maximum level defined at supply potential for whole winter.

CA	LY	DZ	LNG	NO	RU	EU production
282 GWh/d	250 GWh/d	1,348 GWh/d	4,898 GWh/d	4,164 GWh/d	6,140 GWh/d	3,111 GWh/d
26 mcm/d	23 mcm/d	123 mcm/d	445 mcm/d	379 mcm/d	558 mcm/d	283 mcm/d

LNG tanks: In total LNG tanks can provide up to 39 TWh of flexibility that can be used within the limits of the capacities from the individual LNG terminals (at EU level around 6 TWh/d in total).

Demand

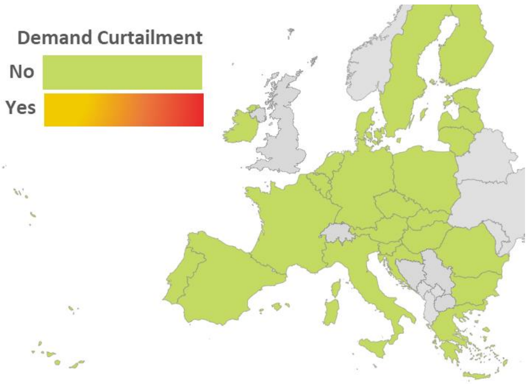
No country is exposed to risk of demand curtailment. Compared to 2017 SoS edition, Denmark and Sweden improve their situation being no longer exposed to risk of demand curtailment. The renovation of the offshore production of Tyra is considered completed in 2023 - increasing the Danish national production - as well as the Norwegian tie-in to Danish upstream system project and the Baltic pipe project.

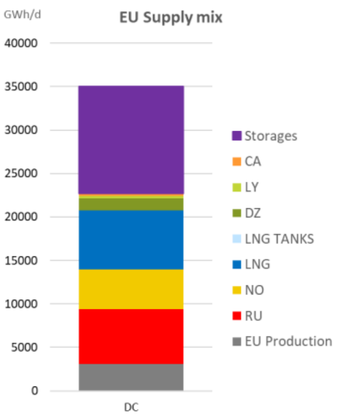
Exports to Ukraine (UA) and transit to Kaliningrad can be maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

REFERENCE SCENARIO Reference case

Peak day/ 20 years: 15 February





Supply

Storages: Storages are mostly used up to their maximum withdraw potential set by the SSOs.

Pipeline and LNG supplies: Supplies are used at the maximum level defined at supply potential for whole winter except for NO that used up to the maximum import capacity and LNG.

CA	LY	DZ	LNG	NO	RU	EU production
297 GWh/d	303 GWh/d	1,388 GWh/d	6,803 GWh/d	4,631 GWh/d	6,277 GWh/d	3,111 GWh/d
27 mcm/d	28 mcm/d	126 mcm/d	618 mcm/d	421 mcm/d	571 mcm/d	283 mcm/d

Demand

No country is exposed to risk of demand curtailment compared to 2017 SoS edition, Denmark and Sweden improve their situation being no longer exposed to risk of demand curtailment. The renovation of the offshore production of Tyra is considered completed in 2023 - increasing the Danish national production - as well as the Norwegian tie-in to Danish upstream system project and the Baltic pipe project.

Exports to Ukraine (UA) and transit to Kaliningrad can be maintained.

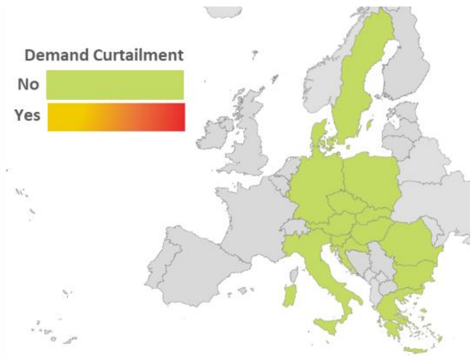
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

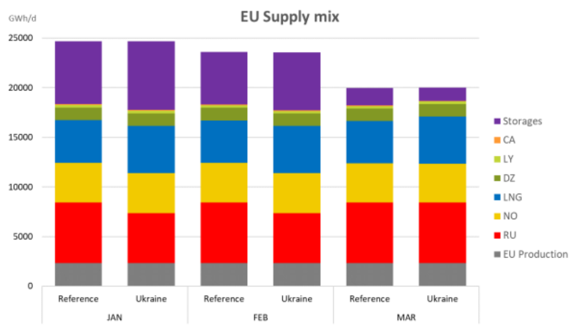
SCENARIO #1 - Disruption of all imports to EU via Ukraine

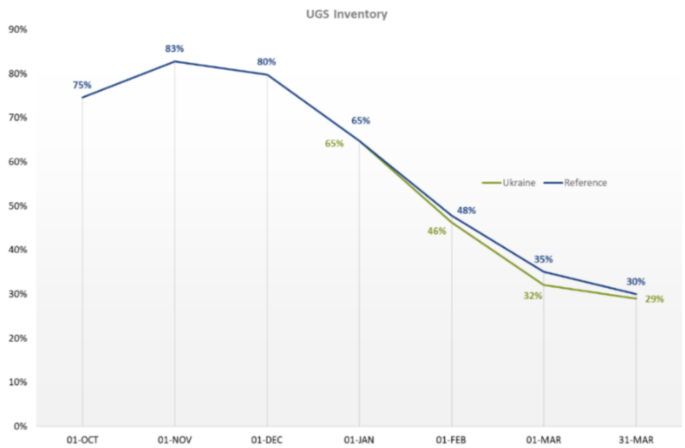
Risk group: Eastern gas supply – Ukraine	Bulgaria, Czech Republic, Germany, Greece, Croatia, Denmark, Italy, Luxembourg, Hungary, Austria, Poland, Romania, Slovenia, Slovakia, Sweden
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage increases during January and February by 33 TWh to compensate the decrease of Russian supply through Ukraine.

Pipeline and LNG supplies: Imports from Russia though Ukraine can be partly re-routed thanks to other available routes (Belarus, Nord Stream 1 and 2 and Turk Stream). Supplies shows some potential flexibility. The decrease in Russian imports could be replaced by Norwegian and LNG supplies, as well as storage utilisation.

Demand

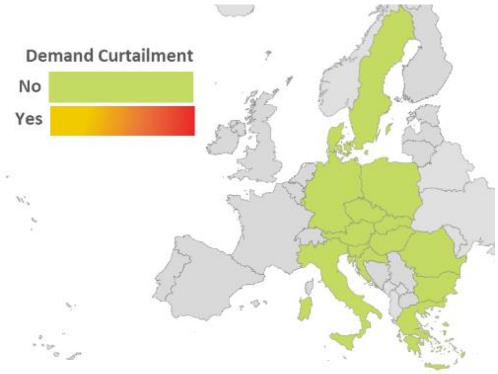
No country is exposed to demand curtailment. The situation in this Risk Group has improved with the commissioning of Turk Stream and other investments in the region.

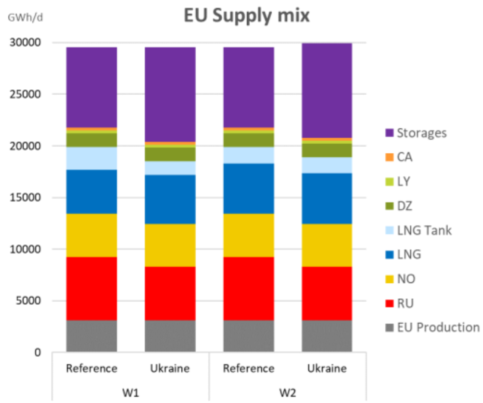
Exports to Ukraine (UA) and transit to Kaliningrad can be maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #1 - Disruption of all imports to EU via Ukraine

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage increases during both weeks by 19 TWh to compensate the decrease of Russian supply through Ukraine.

Pipeline and LNG supplies: Supplies are used at the maximum potential for the 2-week cold spell. The overall flows of Russian gas are limited by capacities via Belarus to Poland (reduced capacities as of 2023), Nord Stream 1 and 2 (used up to the technical maximum), Turk Stream (all routes are used up to the technical maximum). Nevertheless, the decrease in Russian imports could be replace by LNG supply as well as storage utilisation.

LNG tanks: Necessary to provide extra LNG capacity during both weeks.

Demand

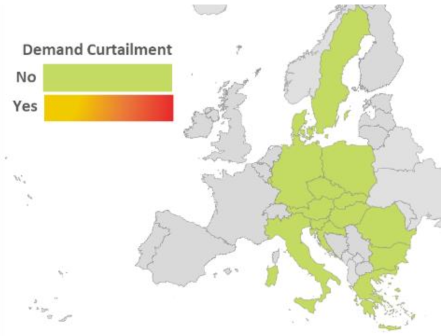
No country is exposed to demand curtailment. The situation in this Risk Group has improved with the commissioning of Turk Stream and other investments in the region. Additionally, following the re-location of capacities for IP Isaccea 1/Orlovka and IP Negru Vodă 1 / Kardam (from Romania transit balancing zone to Romanian National balancing zone), Romania is not exposed to demand curtailment since the capacity from Bulgaria to Romania national increased.

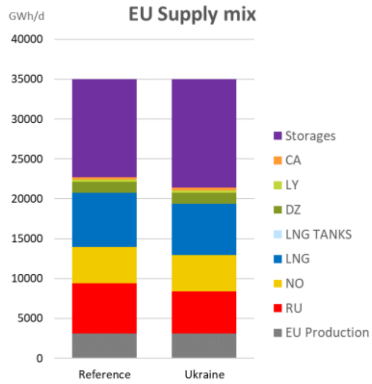
Exports to Ukraine (UA) and transit to Kaliningrad can be maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #1 - Disruption of all imports to EU via Ukraine

Peak day / 20 years: 15 February





Supply

Storages: Storage usage increases during both weeks by 1.3 TWh to compensate the decrease of Russian supply through Ukraine.

Pipeline and LNG supplies: Supplies are used at their maximum potential apart from LNG and RU supply. The overall flows of Russian gas are reduced to around 1,000 GWh/d which is limited by the capacities of the transit via Belarus (reduced as of 2023), Nord Stream 1 and 2, Turk Stream (all routes are used to the technical maximum). Nevertheless, the decrease in Russian imports could be also replaced by storage utilisation (storages are used up to their maximum withdrawal potential set by SSOs in BE, CZ, HR, IT and RO in other countries, additional usage still possible).

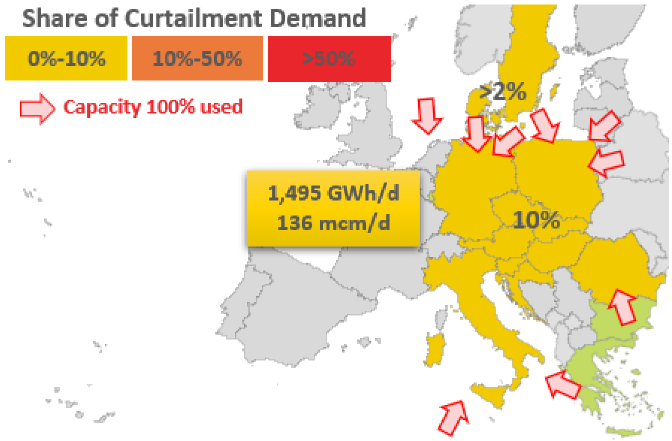
Demand

No country is exposed to demand curtailment. Situation in this risk group has improved by the implementation of Turk Stream and other investments in the region. Additionally, following the re-location of capacities for IP Isaccea 1/Orlovka and IP Negru Vodă 1 / Kardam (from Romania transit balancing zone to Romanian National balancing zone). Romania is not exposed to demand curtailment since the capacity from Bulgaria to Romania national increased.

Exports to Ukraine (UA) and transit to Kaliningrad can be maintained.

SCENARIO #1 - Disruption of all imports to EU via Ukraine

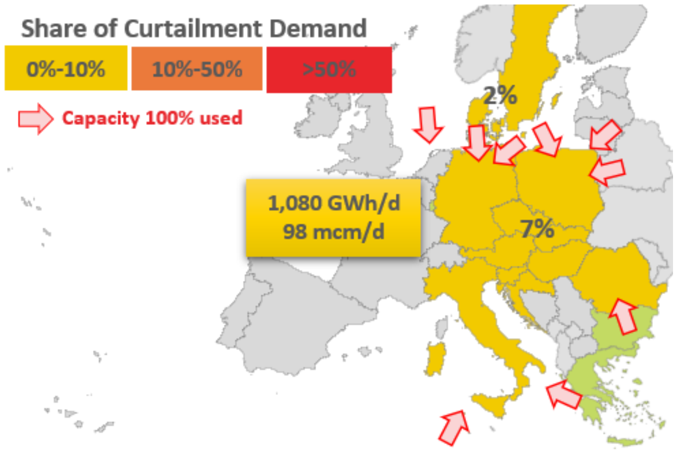
<u>Nord Stream 2 sensitivity (without Nord Stream 2)</u>:



With exports to Ukraine (UA) and transit to Kaliningrad.

All countries within the risk group, but GR and BG, can efficiently cooperate to mitigate the situation by sharing around 10% of demand curtailment. Infrastructure limitations prevent BG and GR to further cooperate with RO and IT.

Risk group demand: 16,507 GWh/d.



Without exports to Ukraine (UA) and with transit to Kaliningrad.

All countries within the risk group, but GR and BG, can help mitigating the situation by sharing around 7% of demand curtailment. Infrastructure limitations prevent BG and GR to further cooperate with RO and IT.

Conclusions:

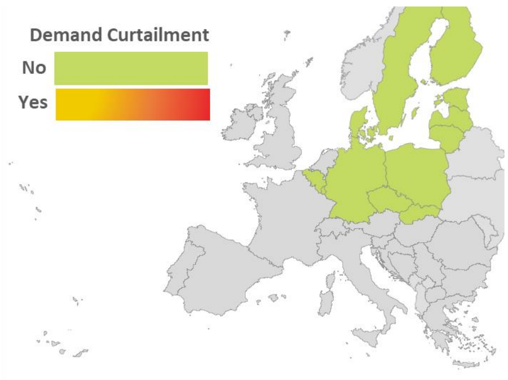
- Lower storage level at the beginning of the 2-month disruption and a critically low level in the high demand situation mid-February (peak day).
- At the start of the peak day, storage levels are around 30% of WGV. In this situation the withdraw capacity is limited (on average 70% of the withdraw capacity can be used) (see Annex III).
- Storages are used up to their maximum withdrawal potential set by SSOs in most of the countries within the Risk Group (AT, CZ, DK, HR, PL, IT, RO, SE) with a utilization of239 GWh/d higher than peak day simulations with NOS2.
- Capacities from BG towards RO are fully used.
- Demand curtailment caused by import limitations to the region. Import flows from DZ, LY and CA are used up to their maximum supply potential. While NO supply is used up to the maximum import capacity.
- BE, FR, HR, IT, NL, PL & UK LNG regasification capacities are fully used.
- The overall flow of Russian gas is limited by the transit capacities via Belarus, Nord Stream 1, Turk Stream.

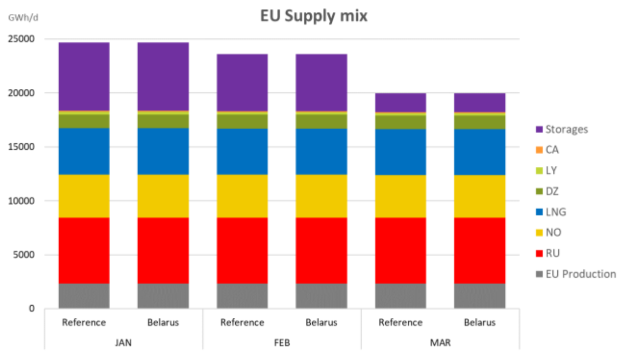
SCENARIO #2 - Disruption of all imports to EU via Belarus

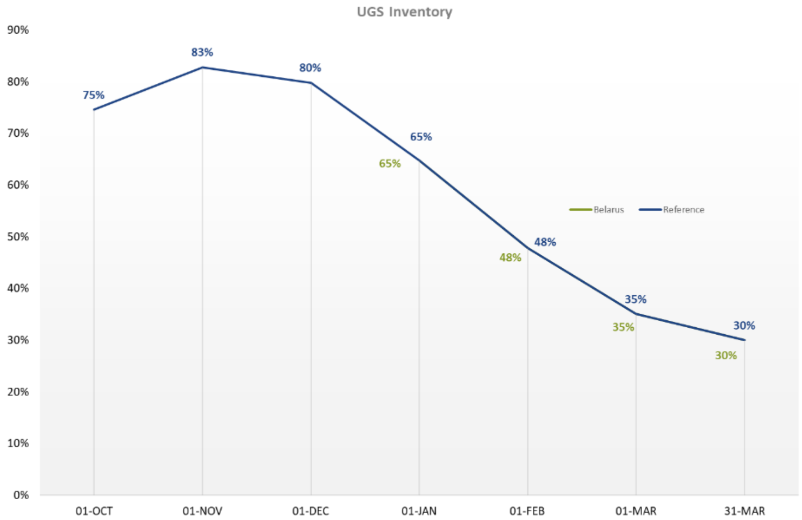
Risk group: Eastern gas supply – Belarus	Belgium, Czech Republic, Denmark, Germany, Estonia, Finland, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Slovakia, Sweden
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: Russian gas stays on a similar level reaching the maximum supply potential. Transits through BY are re-directed through other Russian supply routes.

Demand

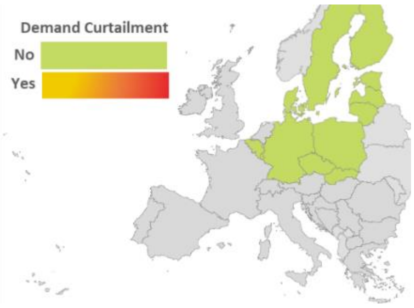
No country is exposed to demand curtailment.

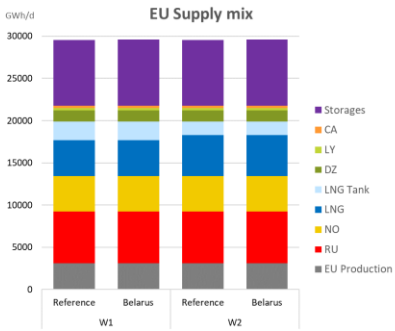
Exports to Ukraine are maintained while transit to Kaliningrad is interrupted in line with the considered assumptions.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #2 - Disruption of all imports to EU via Belarus

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage slightly increases during both weeks by 0.40 TWh to compensate for the decrease of Russian supply through Belarus.

<u>Pipeline and LNG supplies</u>: The overall flows of Russian gas stay on a similar level, reaching the maximum supply potential. Transits through BY are re-directed through other Russian supply routes.

<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

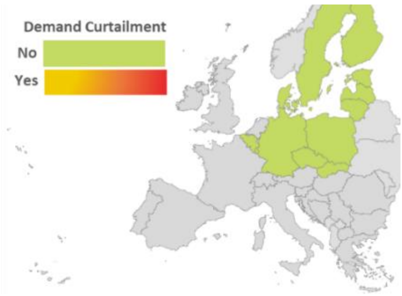
Demand

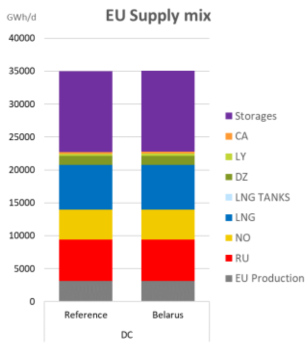
No country is exposed to risk of demand curtailment.

Exports to Ukraine are maintained while transit to Kaliningrad is interrupted in line with the considered assumptions.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages:</u> The storages are used up to the same level as in the reference case.

<u>Pipeline and LNG supplies:</u> The overall flows of Russian gas stays on a similar level, reaching the maximum supply potential. Transits through BY are re-directed through other Russian supply routes.

<u>LNG tanks:</u> LNG supply does not reach its maximum supply potential; therefore, LNG tanks are not used.

Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Exports to Ukraine are maintained while transit to Kaliningrad is interrupted in line with the considered assumptions.

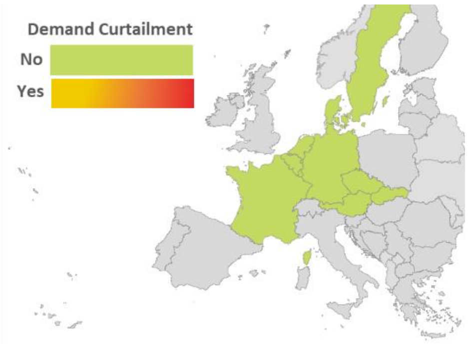
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

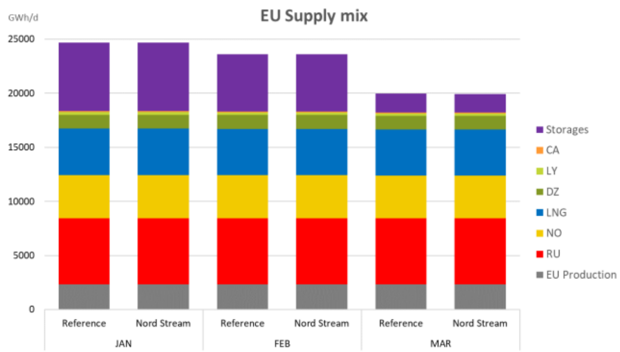
SCENARIO #3 - Disruption of one offshore pipeline of Nord Stream (50% of Nord Stream capacity)

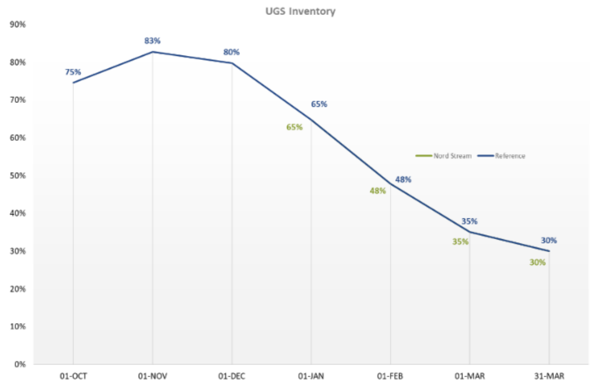
Risk group: Eastern gas supply – Baltic Sea	Belgium, Czech Republic, Denmark, Germany, France, Luxembourg, Netherlands, Austria, Slovakia, Sweden
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: The overall flows of Russian gas stay on a similar level, reaching the maximum supply potential. Nord Stream import flows are re-routed through UA, BY, TR/STR and NOS2.

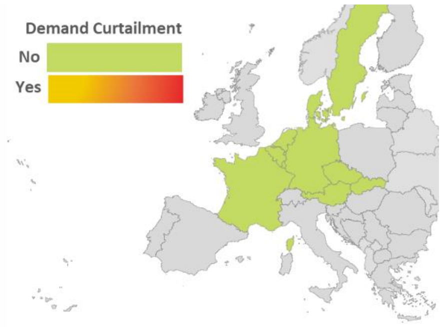
Demand

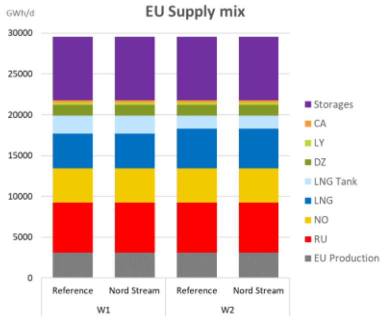
No country is exposed to demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #3 - Disruption of one offshore pipeline of Nord Stream (50% of Nord Stream capacity)

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage is the same as in the reference situation.

<u>Pipeline and LNG supplies</u>: The overall flows of Russian gas stays on a similar level, reaching the maximum supply potential. Nord Stream import flows are re-routed through UA, BY, TR/STR and NOS2.

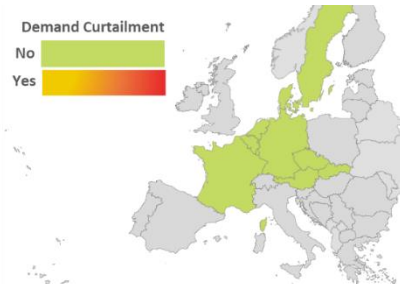
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

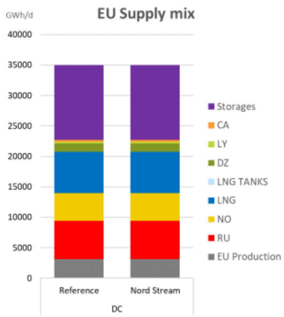
Demand

No country is exposed to risk of demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages:</u> Storage usage is the same as in the reference situation.

<u>Pipeline and LNG supplies:</u> The overall flows of Russian gas stays on a similar level, reaching the maximum supply potential. Nord Stream import flows are re-routed through UA, BY, TR/STR and NOS2.

Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to risk of demand curtailment as explained in the reference case.

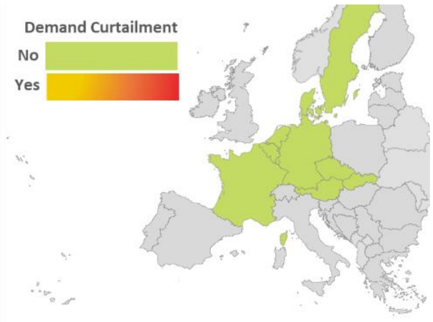
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

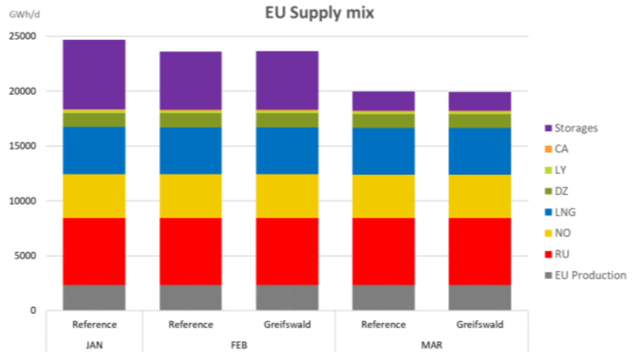
SCENARIO #4 - Disruption of the onshore receiving facility of Nord Stream (Greifswald station)

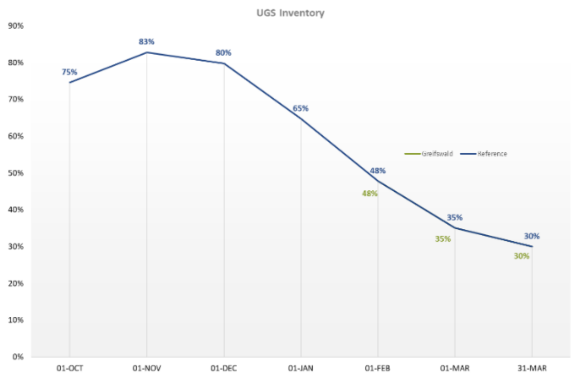
Risk group: Eastern gas supply – Baltic Sea	Belgium, Czech Republic, Denmark, Germany, France, Luxembourg, Netherlands, Austria, Slovakia, Sweden
Disruption duration:	2 weeks (15 February – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage slightly increases during February by 1 TWh to compensate for no import flows from NOS.

Pipeline and LNG supplies: The overall flows of Russian gas stays on a similar level, reaching the maximum supply potential. Nord Stream import flows are re-routed through UA, BY, TR/STR and NOS2.

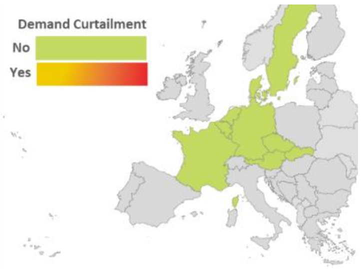
Demand

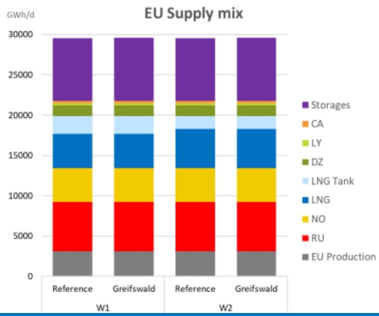
No country is exposed to risk demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #4 - Disruption of the onshore receiving facility of Nord Stream (Greifswald station)

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage slightly increases during February by 0.5 TWh to compensate for no import flows from Nord Stream.

<u>Pipeline and LNG supplies</u>: The overall flows of Russian gas stays on a similar level, reaching the maximum supply potential. Nord Stream import flows are re-routed through UA, BY, TR/STR and NOS2.

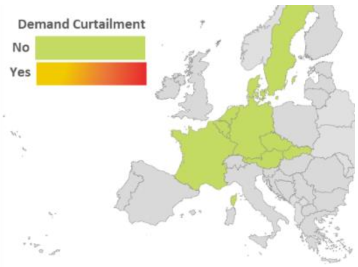
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

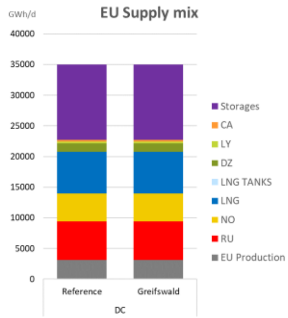
Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages:</u> Storage usage is in line with the reference case.

<u>Pipeline and LNG supplies:</u> All supplies are used at the maximum level defined at the supply potential for whole winter. The Russian flows are redirected via Belarus (capacities planned to be reduced by 2023), Nord Stream 2, Turk Stream and the imports to the Baltic States and Finland.

Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

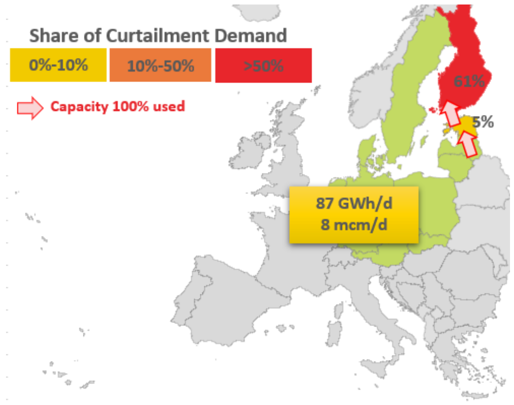
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

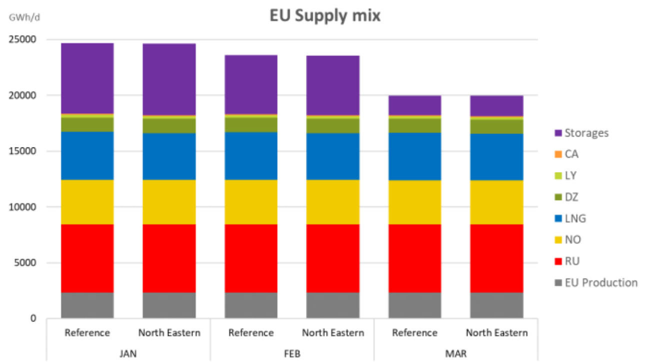
SCENARIO #5 - Disruption of all imports to the Baltic states and Finland

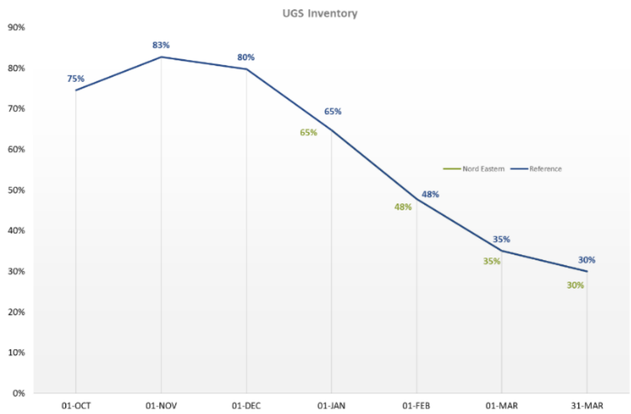
Risk group: Eastern gas supply – North-Eastern	Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Slovakia, Sweden
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage slightly increases during January, February and March by 1.6 TWh

Pipeline and LNG supplies: Commissioning of Balticconnector pipeline allows Finland and the Baltic States to cooperate efficiently up to the maximum technical possibility. Supply usage is in line with the reference case and shows some potential flexibility.

Demand

Results of the simulation show that Finland is exposed up to 61% of demand curtailment in case of disruption of all imports to the Baltic states and to Finland. Risk of demand curtailment in Finland is presented excluding the country-specific possibility of using back-up fuels for gas. The exposure to demand curtailment is observed for the duration of the disruption, in January and February. Estonia cooperates with Finland up to the maximum technical capacity of Balticconnector, being exposed to 3% demand curtailment in February. The commissioning of Balticconnector allows gas to flow from the Baltic States to support Finland, which was not effective in 2017. Additionally, the commissioning of the GIPL project (PL-LT interconnection) integrates the gas systems of the Eastern Baltic Sea region and Continental Europe. GIPL is used up to the maximum capacity between Lithuania and Latvia.

SCENARIO #5 - Disruption of all imports to the Baltic states and Finland

Country	Demand curtailment JAN	Demand curtailment FEB
Finland	97 GWh/d ≈ 9 mcm/d	85 GWh/d ≈ 8 mcm/d
Estonia	8 GWh/d ≈ 0.5 mcm/d	1.6 GWh/d ≈ 0.15 mcm/d
Latvia	-	-
Lithuania	-	-

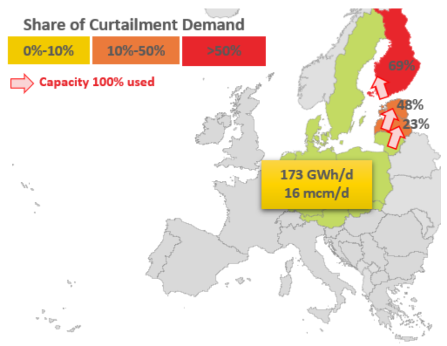
Within the risk group:

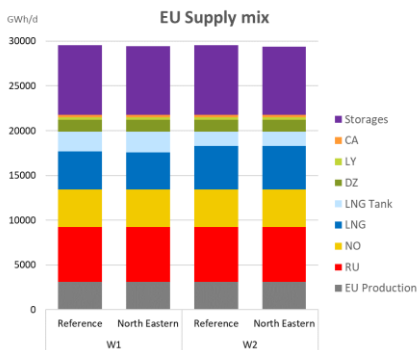
	Risk group demand	Demand curtailment
JAN	6,589 GWh/d	105 GWh/d ≈ 10 mcm/d
FEB	6,082 GWh/d	87 GWh/d ≈ 8 mcm/d
MAR	5,121 GWh/d	-

Exports to Ukraine (UA) can be maintained while transit to Kaliningrad is interrupted in line with the considered assumptions.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage slightly increases during both weeks by 1.7 TWh.

Pipeline and LNG supplies: Commissioning of Balticconnector pipeline allows Finland and the Baltic States to cooperate efficiently up to maximum technical possibility. Supply usage is in line with the reference case. LNG flows to Lithuania up to the maximum technical send-out capacity.

LNG tanks: Necessary to provide extra LNG capacity during both weeks.

Demand

Results of the simulation show a risk of demand curtailment in Finland up to 69% in case of disruption of all imports to the Baltic states and Finland. Risk of demand curtailment in Finland is presented excluding the country-specific possibility of using back-up fuels for gas. Risk of demand curtailment is observed in both weeks. Latvia and Estonia cooperate with Finland up to the maximum technical capacity available of Balticonnector, sharing the risk of demand curtailment within the range of 23-48%. The commissioning of the Balticconnector allows gas to flow from the Baltic States to support Finland which was not possible in 2017. The capacity from Lithuania to Latvia is fully used. Additionally, the commissioning of the GIPL project in 2021 (PL-LT interconnection) integrates the gas systems of the Eastern Baltic Sea region and Continental Europe. The GIPL project is used up to the capacity limitation between Lithuania and Latvia.

SCENARIO #5 - Disruption of all imports to the Baltic states and Finland

Country	Demand curtailment W1	Demand curtailment W2
Finland	125 GWh/d ≈ 11 mcm/d	125 GWh/d ≈ 11 mcm/d
Estonia	27 GWh/d ≈ 3 mcm/d	27 GWh/d ≈ 3 mcm/d
Latvia	7 GWh/d ≈ 0.7 mcm/d	21 GWh/d ≈ 2 mcm/d
Lithuania	-	-

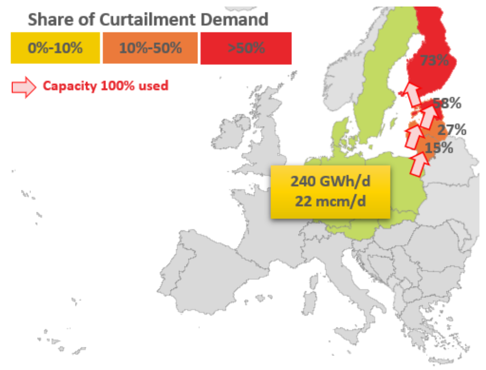
<u>Within the risk group:</u>

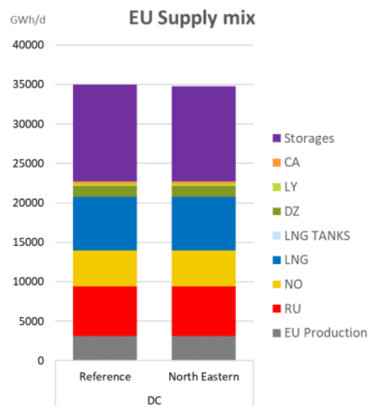
	Risk group demand	Demand curtailment
W1	7,927 GWh/d	159 GWh/d ≈ 14 mcm/d
W2	7,927 GWh/d	173 GWh/d ≈ 16 mcm/d

Exports to Ukraine (UA) can be maintained while transit to Kaliningrad is interrupted in line with the considered assumptions.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage slightly increases during peak day by 0.2 TWh

<u>Pipeline and LNG supplies</u>: the commissioning of the Balticconnector pipeline allows Finland and the Baltic States to cooperate efficiently up to its maximum technical possibility. Supply usage is in line with the reference case. LNG flows to Lithuania up to the maximum technical send-out capacity.

Demand

Finland is exposed up to 73% of demand curtailment in case of disruption of all imports to the Baltic states and Finland. the exposure to demand curtailment in Finland is presented excluding the country-specific possibility of using back-up fuels for gas. Latvia, Estonia and Lithuania cooperate with Finland up to the maximum technical capacity of Balticconnector, sharing the exposure to demand curtailment within the range of 15-58%. The implementation of Balticconnector allows gas to flow from the Baltic States to support Finland which was not possible in 2017. Additionally, the commissioning of the GIPL project in 2021 (PL-LT interconnection) integrates the gas systems of the Eastern Baltic Sea region and Continental Europe. The GIPL project is used up to its maximum capacity to cooperate with Lithuania.

SCENARIO #5 - Disruption of all imports to the Baltic states and Finland

Country	Demand curtailment
Finland	145 GWh/d ≈13 mcm/d
Estonia	41 GWh/d ≈ 4 mcm/d
Latvia	32 GWh/d ≈ 3 mcm/d
Lithuania	22 GWh/d ≈ 2 mcm/d

Within the risk group:

	Risk group demand	Demand curtailment
peak day	9,186 GWh/d	240 GWh/d ≈ 22 mcm/d

Exports to Ukraine (UA) can be maintained while transit to Kaliningrad is interrupted in line with the considered assumptions.

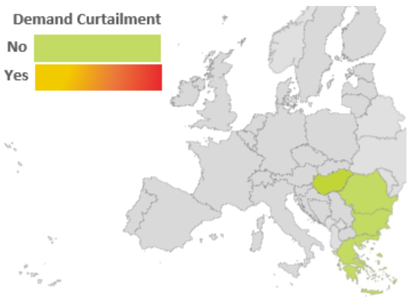
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

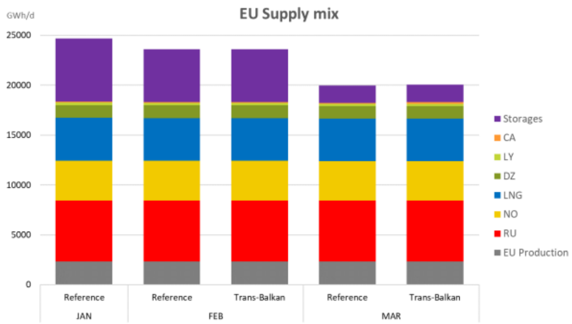
SCENARIO #6 - Disruption of the largest infrastructure to the Balkan region

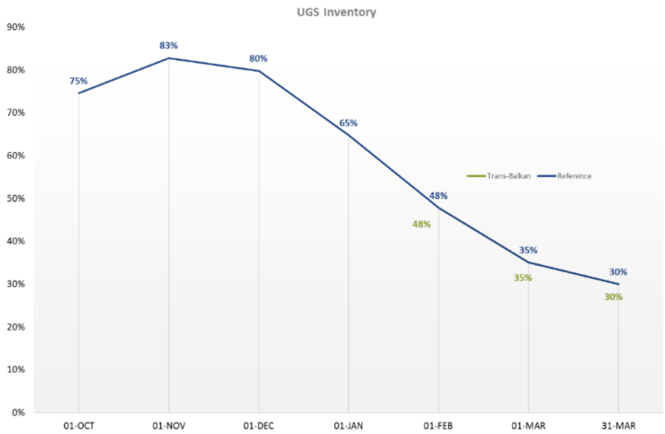
Risk group: Eastern gas supply – Trans-Balkan	Bulgaria, Greece, Hungary, Romania
Disruption duration:	2 weeks (15 February – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: The overall supply stays at similar levels as in the reference case. Gas originally flowing through Trans Balkan Pipeline can be delivered to Bulgaria via Turk Stream and the Interconnector Greece-Bulgaria.

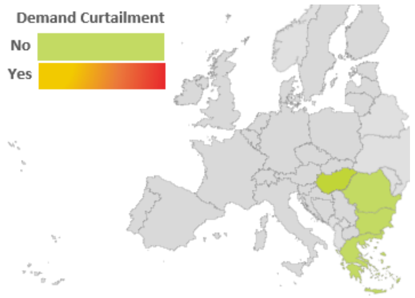
Demand

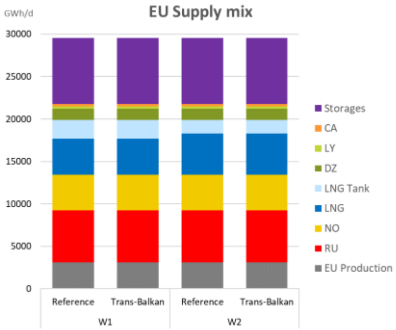
No country is exposed to demand curtailment. Following the commissioning of Turk Stream in 2020 and IGB in 2022 (gas Interconnector Greece-Bulgaria), Bulgaria is no longer exposed to risk of demand curtailment compared with previous edition.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #6 - Disruption of the largest infrastructure to the Balkan region

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage is the same as in the reference situation.
Pipeline and LNG supplies: Same supply structure as in case of reference situation – gas originally flowing through Trans Balkan Pipeline can be delivered to Bulgaria via Turk Stream and Gas Interconnector Greece-Bulgaria.

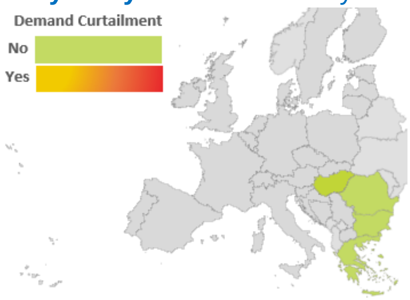
LNG tanks: Necessary to provide extra LNG capacity during both weeks.

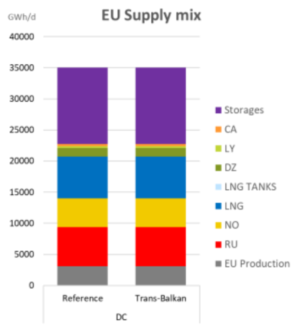
Demand

No country is exposed to risk of demand curtailment. Thanks to the commissioning of IGB in 2022 (Gas Interconnector Greece-Bulgaria) and Turk Stream in 2020, Bulgaria is no longer exposed to demand curtailment compared to the previous edition.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day / 20 years: 15 February





Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: Same supply behaviour as in the reference situation – gas originally flowing through Trans Balkan Pipeline can be delivered to Bulgaria via Turk Stream and the Interconnector Greece-Bulgaria.

Demand

No country is exposed to demand curtailment. Thanks to the commissioning of Turk Stream in 2020 and IGB in 2022 (Gas Interconnector Greece-Bulgaria), Bulgaria is no longer exposed to demand curtailment compared to the previous edition.

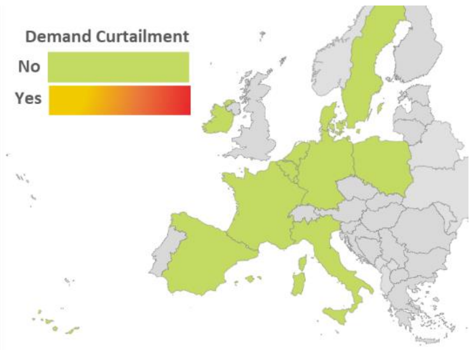
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

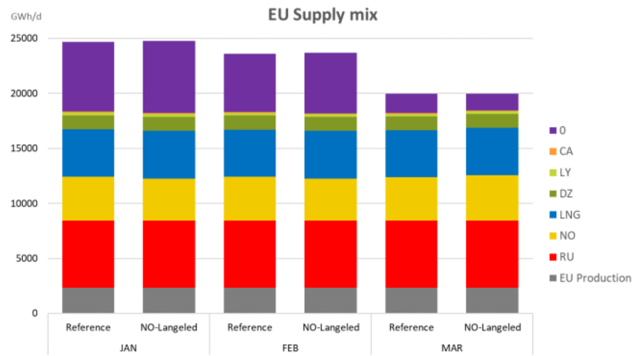
SCENARIO #7 - Disruption of the largest offshore infrastructure to the UK
(Technical disruption of Langeled pipeline)

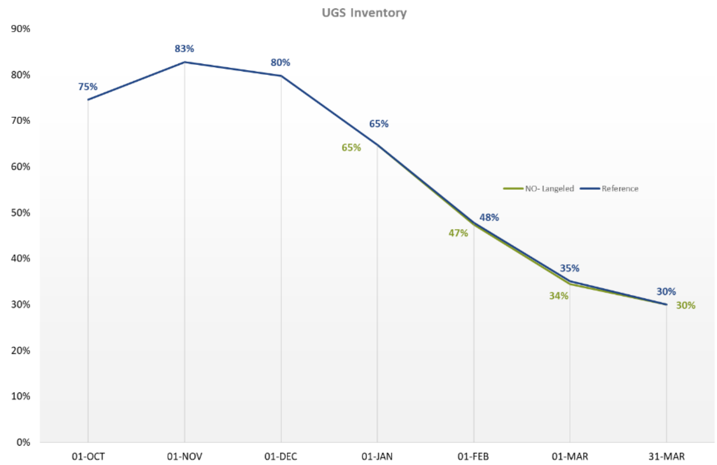
Risk group: North Sea gas supply – Norway	Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Poland, Portugal, Sweden	
Disruption duration:	2 months (1 January – 28 February)	

Simulation results

January-March







Supply

Storages: Storage usage increases during January and February by 12 TWh.

Pipeline and LNG supplies: Supplies and are not used at their maximum supply potential. There are less imports from NO to UK. The overall flows of Norwegian gas decrease and it is replaced mainly by LNG supply and storage usage.

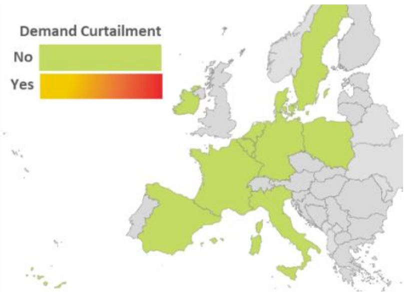
Demand

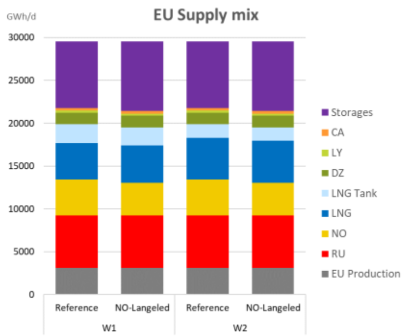
No country is exposed to demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #7 - Disruption of the largest offshore infrastructure to the UK
(Technical disruption of Langeled pipeline)

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage slightly increases during both weeks by 4.7 TWh

Pipeline and LNG supplies: Less imports from NO to UK. The overall flows of Norwegian gas decrease and are replaced mainly by LNG and storage usage. The LNG supply in the UK is used up to the maximum send-out capacity.

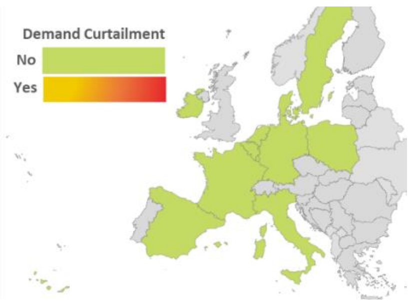
LNG tanks: Necessary to provide extra LNG capacity during both weeks.

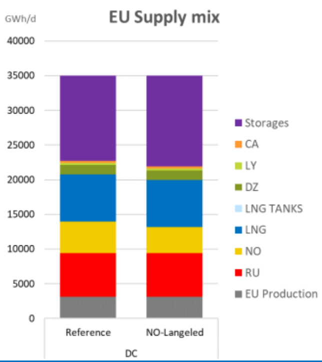
Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

Storages: Storage usage slightly increases by 0.8 TWh.

Pipeline and LNG supplies: Less imports from NO to UK. The overall flows of Norwegian gas decrease and are replaced mainly by LNG supply and storage usage. The LNG supply in the UK is used up to the maximum send-out capacity.

Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to risk of demand curtailment as explained in the reference case.

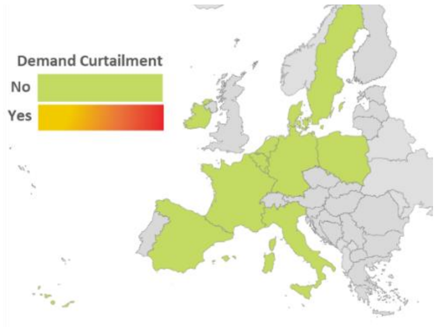
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

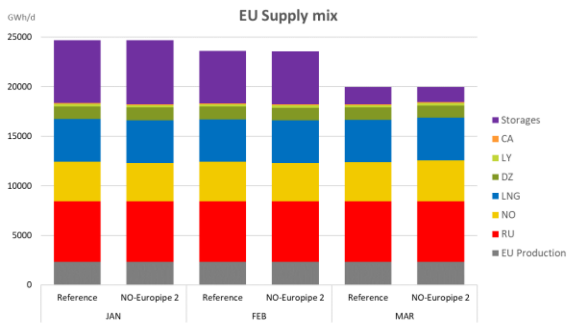
SCENARIO #8 - Disruption of the largest offshore infrastructure to continental EU (EUROPIPE II)

Risk group: North Sea gas supply – Norway	Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Poland, Portugal, Sweden	
Disruption duration:	2 months (1 January – 28 February)	

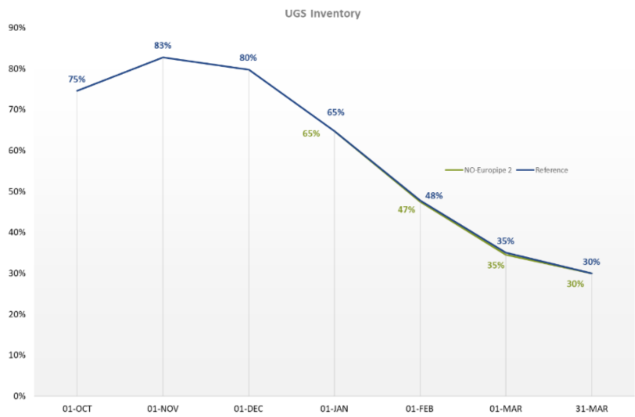
Simulation results

January-March





Technical disruption of Europipe II pipeline (72.1 MSCM/d), Europipe I with 45.7 MSCM/d remains operational.



Supply

Storages: Storage usage increases during January and February by 5 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. The overall flows of Norwegian gas to the EU decrease and are replaced mainly by LNG supply and storage usage.

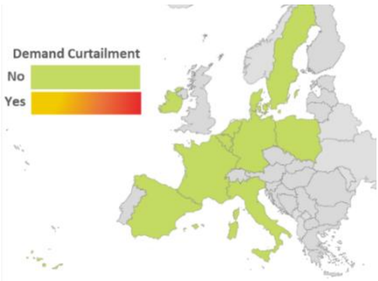
Demand

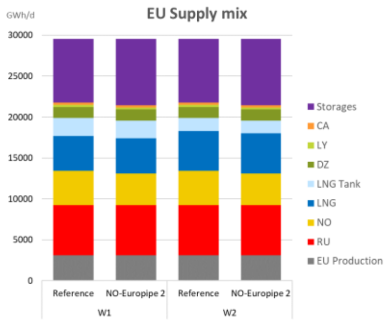
No country is exposed to demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #8 - Disruption of the largest offshore infrastructure to continental EU (EUROPIPE II)

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage increases during both weeks by 4 TWh.

<u>Pipeline and LNG supplies</u>: The overall flows of Norwegian gas decrease and are replaced mainly by storage usage. Norwegian gas supply is used up to the reduced import capacity. The LNG supply in BE, NL, FR, UK, SE and PL is used up to the maximum send-out capacity.

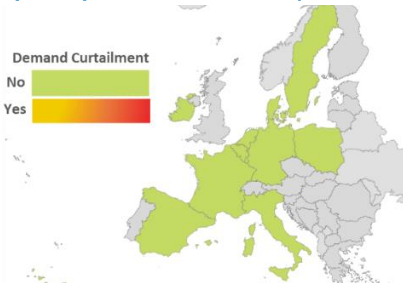
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

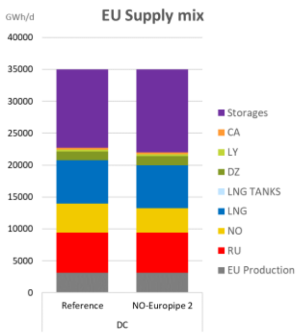
Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage slightly increases by 0.7 TWh.

<u>Pipeline and LNG supplies</u>: The overall flows of Norwegian gas decrease and are replaced mainly by storage usage. Norwegian gas supply is used up to the reduced import capacity. The LNG supply in BE, NL, FR, UK, SE and PL is used up to the maximum send-out capacity.

Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

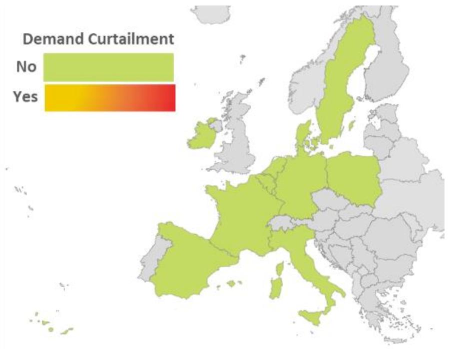
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

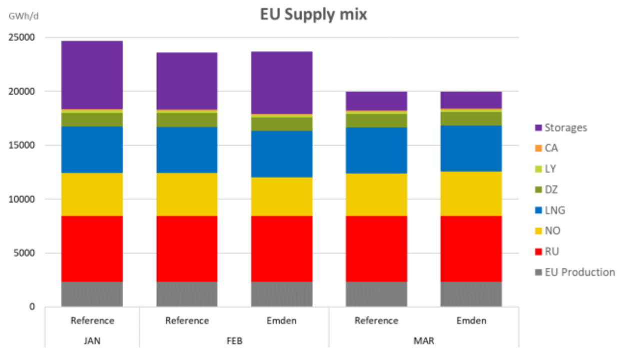
SCENARIO #9 - Disruption of the largest onshore infrastructure from Norway (Technical disruption of Emden station)

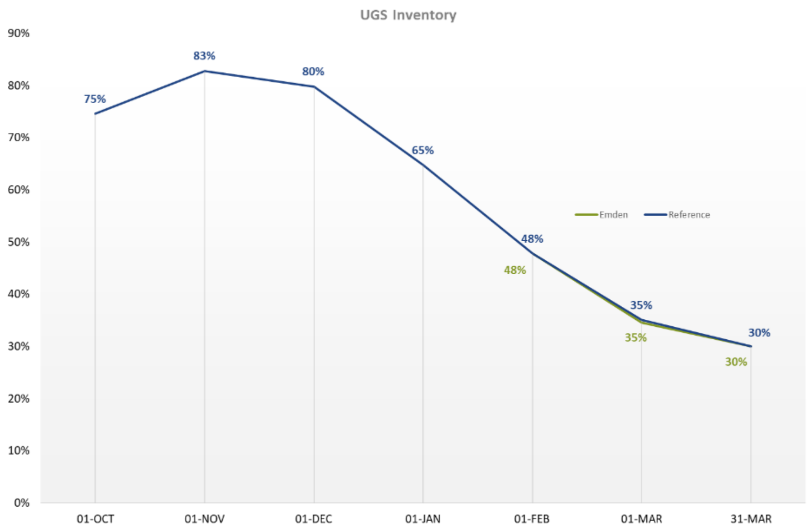
Risk group: North Sea gas supply – Norway	Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Poland, Portugal, Sweden
Disruption duration:	2 weeks (15 February – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage increases during February by 13 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. The overall flows of Norwegian gas to the EU decrease and are replaced mainly by storage usage.

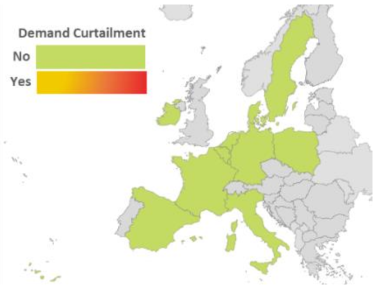
Demand

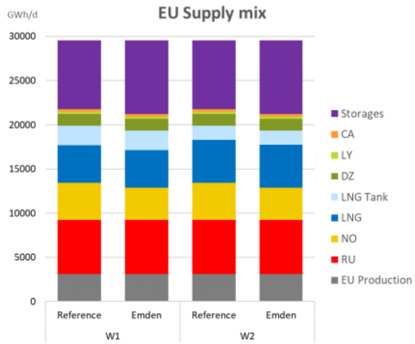
No country is exposed to demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #9 - Disruption of the largest onshore infrastructure from Norway (Technical disruption of Emden station)

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage increases during both weeks by 8 TWh.

Pipeline and LNG supplies: The overall flows of Norwegian gas decrease and are replaced mainly by storages usage. Norwegian gas supply is used up to the reduced import capacity. The LNG supply in BE, NL, FR, UK, SE and PL is used up to the maximum send-out capacity.

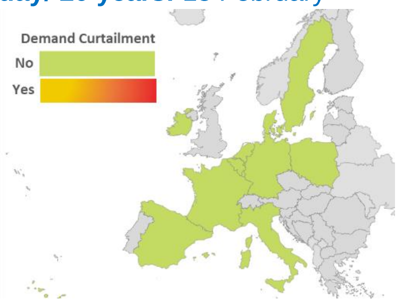
LNG tanks: Necessary to provide extra LNG capacity during both weeks.

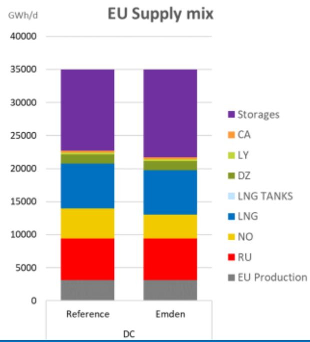
Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

Storages: Storage usage slightly increases by 1 TWh.

Pipeline and LNG supplies: The overall flows of Norwegian gas decrease and are replaced mainly by storage usage. Norwegian gas supply is used up to the reduced import capacity. The LNG supply in BE, NL, FR, UK, SE and PL is used up to the maximum send-out capacity.

Demand

No country is exposed to demand curtailment. DK and SE are no longer expose to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

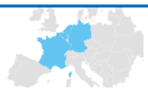
SCENARIO #10 &1 1 - Disruption of the largest L-gas storage and L-gas supply

As for Union-wide SoS simulation 2017, it was also decided to delegate the treatment of the scenarios concerning L-gas to the Gas Platform[8]. The involved TSOs of the Gas Platform have prepared the L-gas scenarios. The coordinators of the involved members states (Belgium, France, Germany and the Netherlands) of the Gas Platform have agreed upon the L-gas scenarios.

SCENARIO #10 - Disruption of the largest L-gas storage (UGS Norg – NL) *Gas Platform*

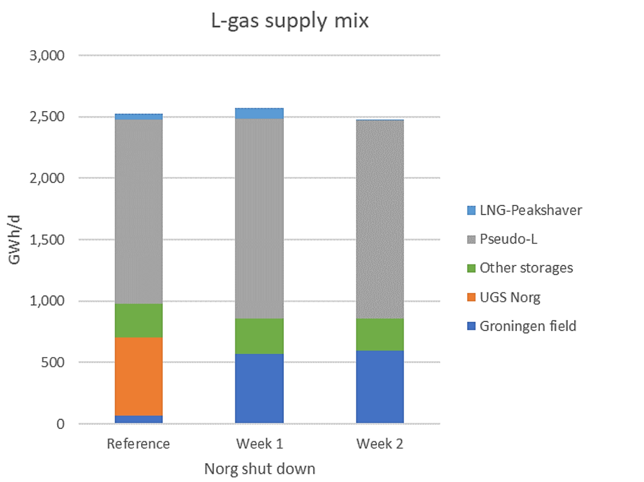
Risk group: Low Calorific Gas

Germany, Belgium, France, The Netherlands



Simulation results

2-week: Cold spell period for 2 weeks (coldest period of two weeks of the last 30 years, reference period used in simulations: December 27, 1996 – January 9, 1997).



Supply

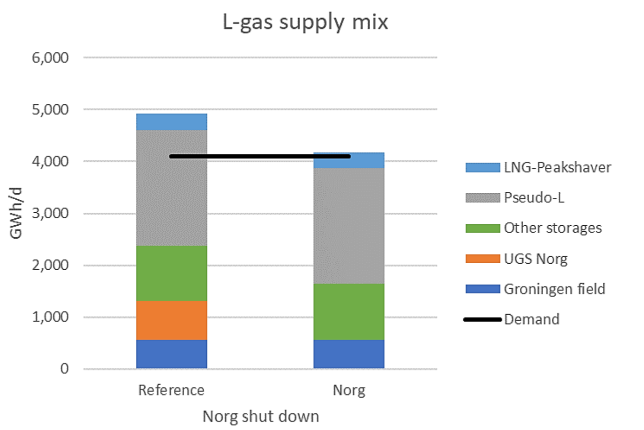
Increased production of (mainly) the Groningen field within the boundaries set by the Dutch government and pseudo L-gas production (quality conversion from H-gas to L-gas).

Demand

No demand curtailment.

Dutch domestic demand can be supplied and exports to Germany, Belgium and France can be maintained.

Peak day: The peak is considered at minus 17°C (effective temperature at weather station De Bilt, The Netherlands), because this temperature is used as the design temperature of the transmission system in The Netherlands (reference day used in simulation: January 14, 1987).



Supply

The amount of supply in the L-gas system is sufficient to meet demand in case of Norg disruption.

Demand

No demand curtailment.

Dutch domestic demand can be supplied and exports to Germany, Belgium and France can be maintained.

Results analysis

Sufficient compensation available within The Netherlands.

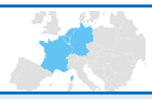
[8] The Gas Platform is the regional cooperation for gas for Belgium, France, Germany, Luxembourg and the Netherlands. It is an intergovernmental initiative where ministries responsible for energy policy discuss issues related to security of supply and market integration, in close cooperation with the National Regulatory Authorities and Transmission System Operators. Ad hoc, the European Commission or other European authorities participate as observer. The Benelux Secretariat provides support.

SCENARIO #11 - Disruption of the L-gas supply (pseudo L-gas facility Wieringermeer – NL)

Gas Platform

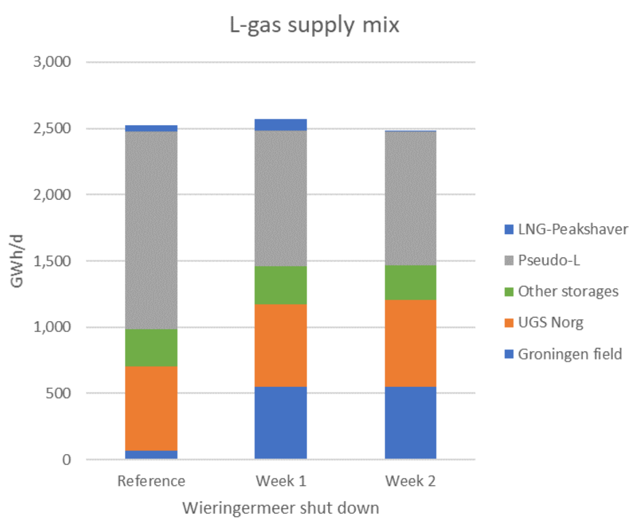
Risk group: Low Calorific Gas

Germany, Belgium, France, The Netherlands



Simulation results

2-week: Cold spell period during 2 weeks (coldest period of two weeks of the last 30 years, reference period used in simulations: December 27, 1996 – January 9, 1997).



Supply

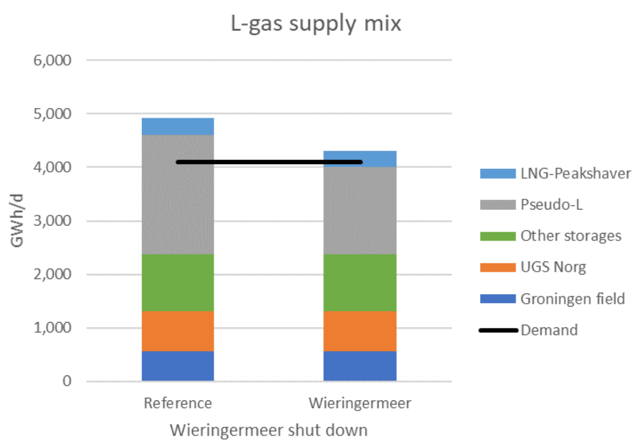
Increased production of (mainly) the Groningen field within the boundaries set by the Dutch government and pseudo L-gas production (enrichment and quality conversion from H-gas to L-gas).

Demand

No demand curtailment.

Dutch domestic demand can be supplied and exports to Germany, Belgium and France can be maintained.

Peak day: The peak is considered at minus 17°C (effective temperature at weather station De Bilt, The Netherlands), because this temperature is used as the design temperature of the transmission system in The Netherlands (reference day used in simulation: January 14, 1987).



Supply

The amount of supply in the L-gas system is sufficient to meet demand in case of Wieringermeer disruption.

Demand

No demand curtailment.

Dutch domestic demand can be supplied and exports to Germany, Belgium and France can be maintained.

Results analysis

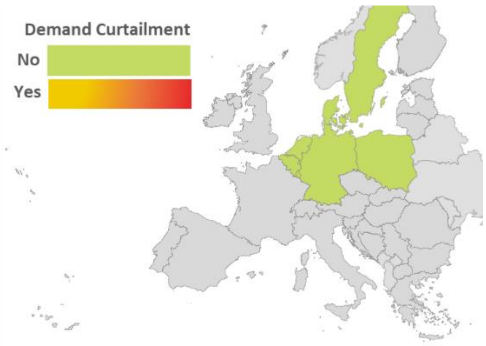
Sufficient compensation available within The Netherlands.

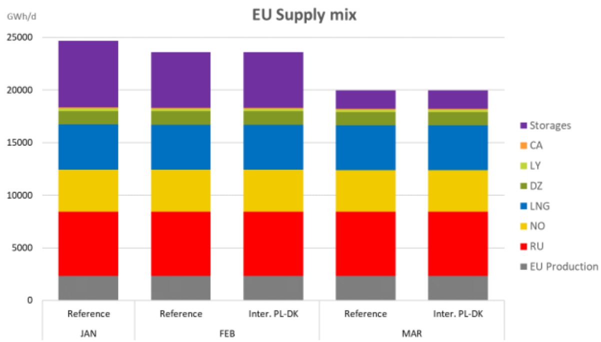
SCENARIO #12 - Disruption of the largest infrastructure to Denmark (Baltic Pipe)

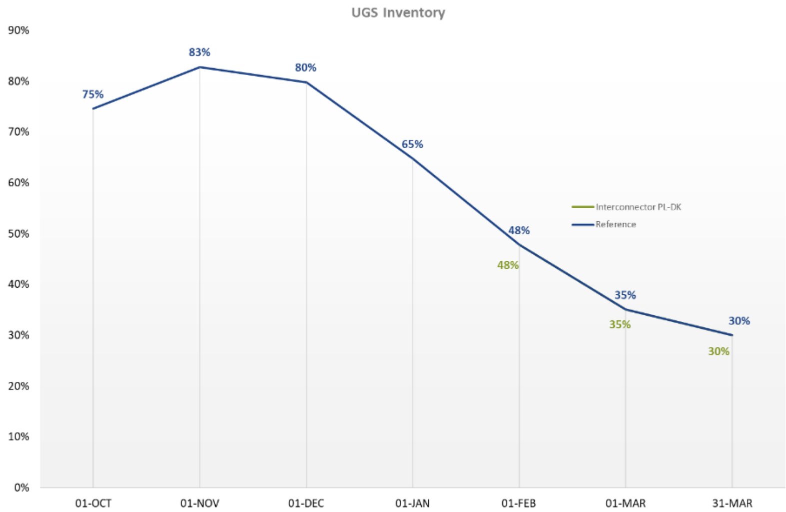
Risk group: North Sea gas supply – Denmark	Denmark, Germany, Luxembourg, Netherlands, Poland, Sweden
Disruption duration:	2 weeks (15 February – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: The overall import flows to the EU stay on a similar level as in the reference case.

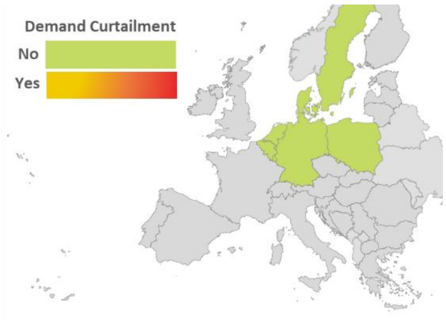
Demand

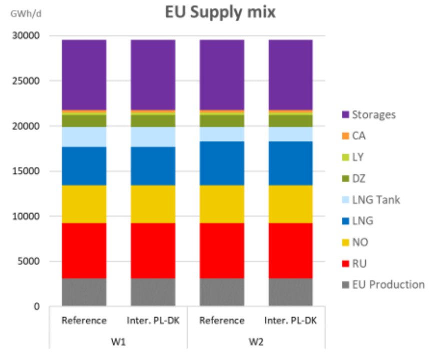
No country is exposed to demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #12 - Disruption of the largest infrastructure to Denmark (Baltic Pipe)

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: The overall import flows to the EU stay on a similar level as in the reference case, reaching the maximum supply potential.

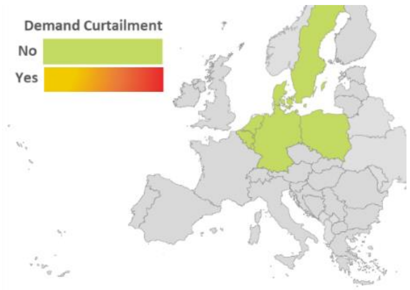
LNG tanks: Necessary to provide extra LNG capacity during both weeks.

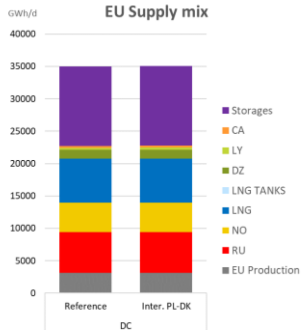
Demand

No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: The overall import flows to the EU stay on a similar level as in the reference case, reaching the maximum supply potential.

Demand

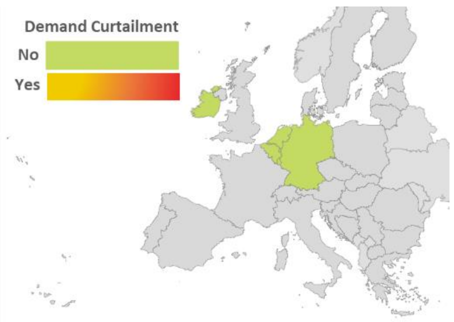
No country is exposed to demand curtailment. DK and SE are no longer exposed to demand curtailment as explained in the reference case.

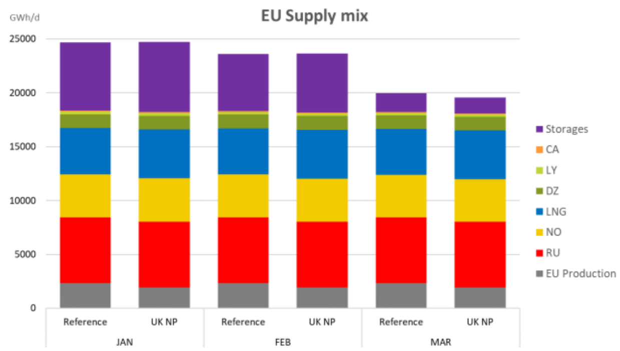
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

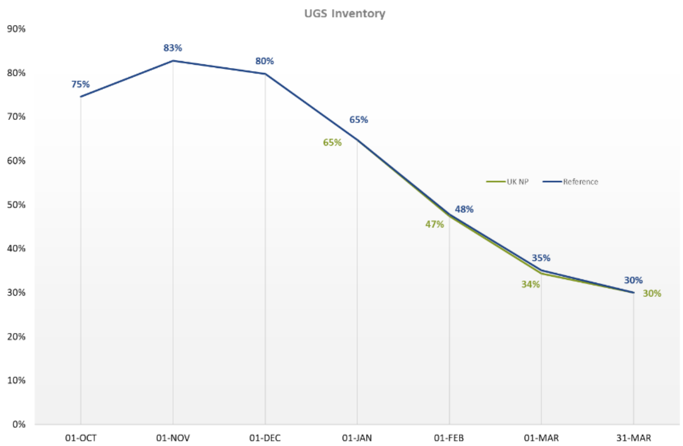
SCENARIO #13 - Disruption of the largest offshore production infrastructure from the UK (Technical disruption of Forties Pipeline system)	
Risk group: North Sea gas supply – United Kingdom	Belgium, Germany, Ireland, Luxembourg, Netherlands
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage increases during January and February by 9 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. The overall flows of national production decrease by the corresponding capacity of the Forties Pipeline system and are replaced mainly by Norwegian supply, LNG supply and storage usage. National production is used up to the reduced capacity.

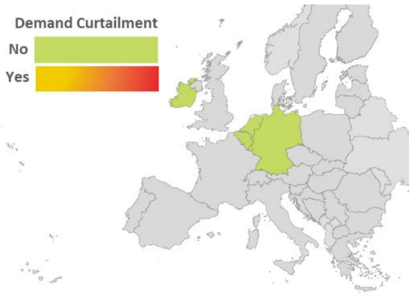
Demand

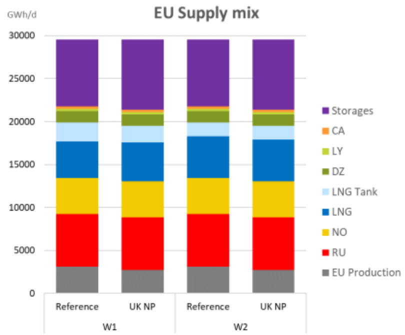
No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #13 - Disruption of the largest offshore production infrastructure from the UK (Technical disruption of Forties Pipeline system)

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage increases during both weeks by 5 TWh.

Pipeline and LNG supplies: The overall flows of national production decrease and are replaced mainly by storage usage. National production is used up to the reduced capacity. The overall import flows reach the maximum supply potential. The LNG supply in BE, NL, FR, and UK is used up to the maximum send-out capacity. Storages can provide the flexibility of the reduced NP.

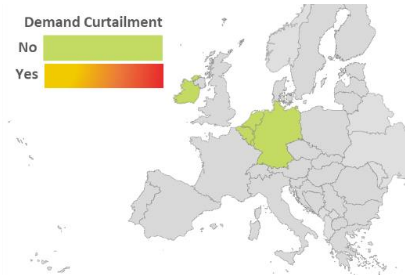
LNG tanks: Necessary to provide extra LNG capacity during both weeks.

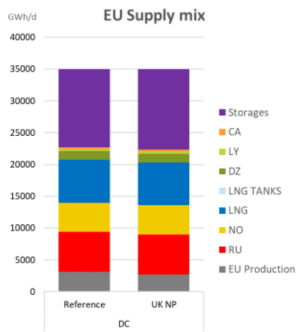
Demand

No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

Storages: Storage usage slightly increases by 1 TWh.

Pipeline and LNG supplies: The overall flows of national production decrease and are replaced mainly by storage usage. National production is used up to the reduced capacity. The overall import flows reach the maximum supply potential. The LNG supply in BE, NL, FR, and UK is used up to the maximum send-out capacity. Storages can provide the flexibility of the reduced NP.

Demand

No country is exposed to risk of demand curtailment.

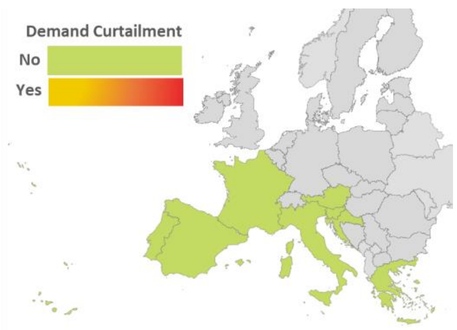
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

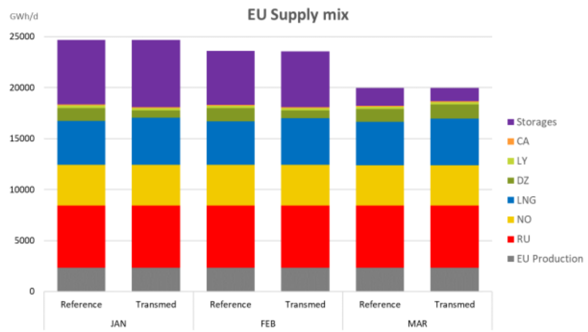
SCENARIO #14 - Disruption of the largest offshore infrastructure to Italy
(Technical disruption of the Transmed system)

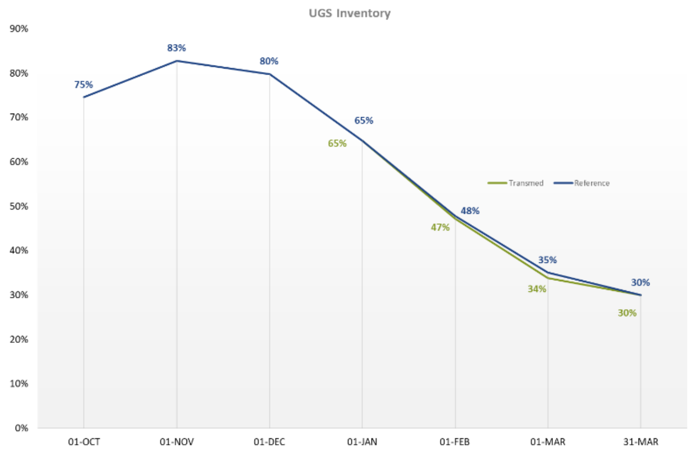
Risk group: North-African gas supply – Algeria	Greece, Spain, France, Croatia, Italy, Malta, Austria, Portugal, Slovenia
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage increases during January and February by 13 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. The overall flow of Algerian gas into EU is reduced by the imports from North Africa to Italy and it is replaced mainly by LNG supply, storage usage and Caspian gas.

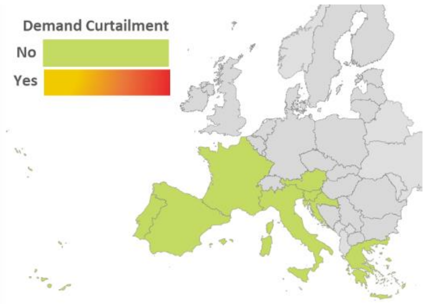
Demand

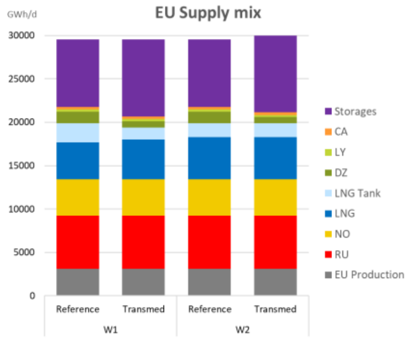
No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #14 - Disruption of the largest offshore infrastructure to Italy
(Technical disruption of the Transmed system)

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage increases during both weeks by 15 TWh.

<u>Pipeline and LNG supplies</u>: The overall flow of Algerian gas into EU is reduced by the imports from North Africa to Italy and it is replaced mainly by LNG supply and storage usage. The overall Algerian import flows reach the maximum supply potential. LNG imports to Italy are up to the maximum send-out capacity while Algerian imports to Spain increase up to the maximum technical capacity.

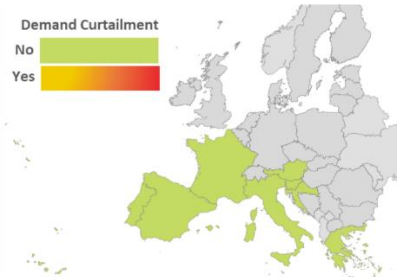
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

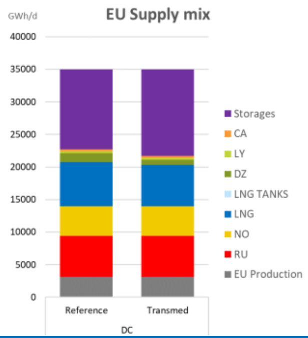
Demand

No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage increases by 1 TWh.

<u>Pipeline and LNG supplies</u>: The overall flow of Algerian gas into EU is reduced by the imports from North Africa to Italy and it is replaced mainly by storage usage. The overall Algerian import flows reach the maximum supply potential, apart for LNG that will be used up to the maximum needed to satisfy demand. LNG imports to Italy are up to the maximum send-out capacity while Algerian imports to Spain increase up to the maximum technical capacity.

Demand

No country is exposed to risk of demand curtailment.

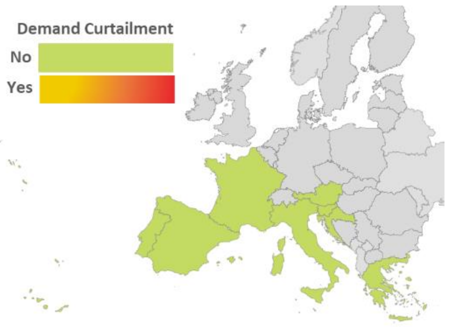
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

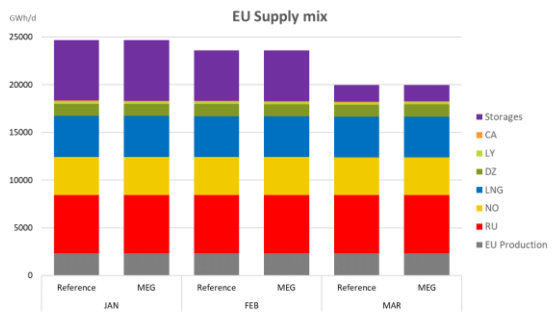
SCENARIO #15 - Disruption of the largest offshore infrastructure to Spain (Technical disruption of the MEG system)

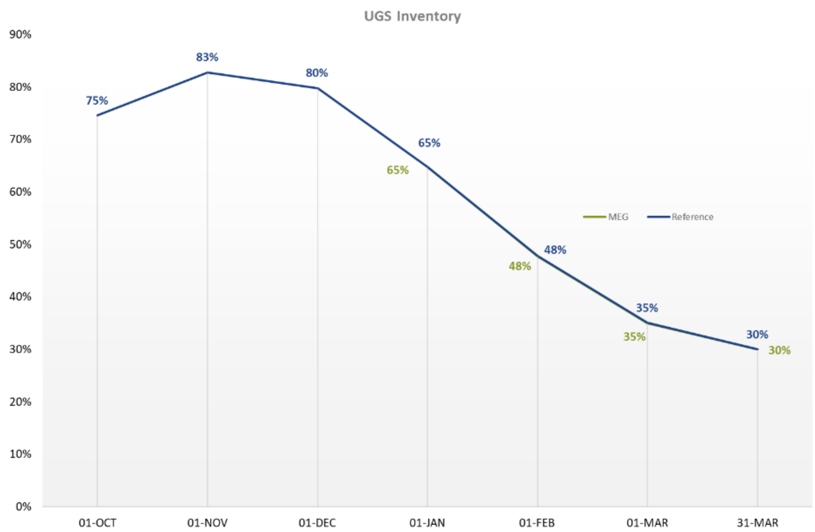
Risk group: North-African gas supply – Algeria	Greece, Spain, France, Croatia, Italy, Malta, Austria, Portugal, Slovenia
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage is the same as in the reference situation.

Pipeline and LNG supplies: Supplies shows some potential flexibility. The Algerian gas flowing through MEG is re-directed to MEDGAZ and Transmed not reaching neither of them the full technical capacity.

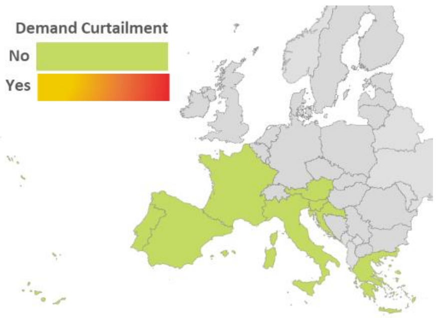
Demand

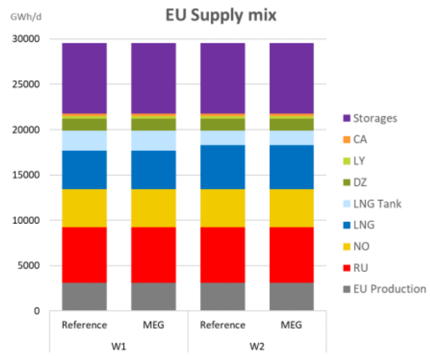
No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #15 - Disruption of the largest offshore infrastructure to Spain (Technical disruption of the MEG system)

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage is the same as in the reference situation.

<u>Pipeline and LNG supplies</u>: The overall import flows to the EU stay on a similar level as in the reference case. Algerian supply is used up to the maximum supply potential. The Algerian gas flowing through MEG is re-directed to MEDGAZ and Transmed not reaching neither of them the full technical capacity.

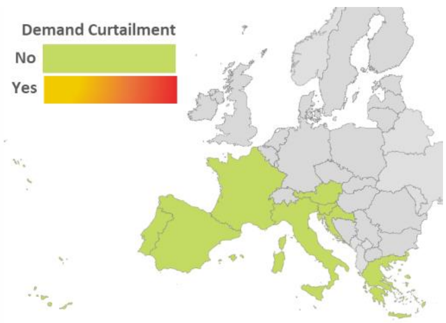
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

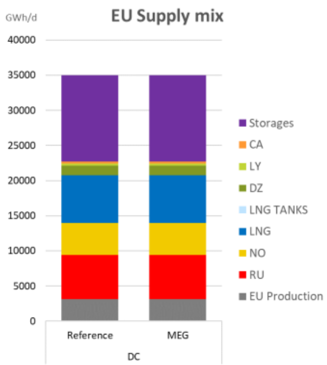
Demand

No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage is the same as in the reference situation.

<u>Pipeline and LNG supplies</u>: The overall flow of Algerian gas imports is reduced, and it is mainly replaced by LNG supply.

Demand

No country is exposed to risk of demand curtailment.

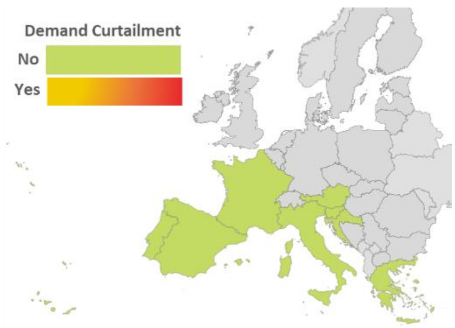
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

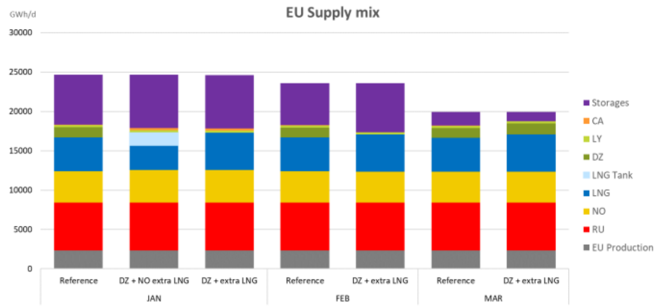
SCENARIO #16 - Disruption of all imports from Algeria including LNG

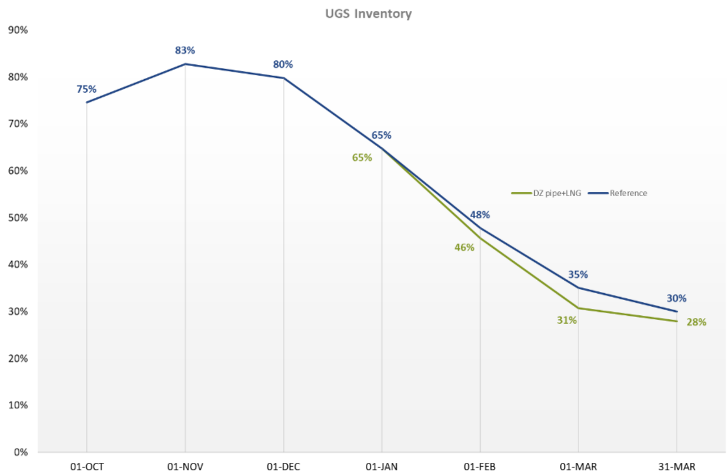
Risk group: North-African gas supply – Algeria	Greece, Spain, France, Croatia, Italy, Malta, Austria, Portugal, Slovenia	
Disruption duration:	2 months (1 January – 28 February)	

Simulation results

January-March







Specificity of scenario #16 - Algerian disruption:

Disruption scenario #16 considers the disruptions of the imports from Algeria via both pipelines and LNG cargos. It is assumed that DZ LNG cannot be substituted for additional cargos coming from different suppliers for a period of 3 weeks. A period of 3 weeks is assumed necessary to attract more LNG cargos to substitute the Algerian LNG (see Table 4 for more details).

Supply

Storages: Storage usage increases during January and February by 39 TWh.

Pipeline and LNG supplies: Norwegian and Caspian gas supply are used up to their maximum supply potential in January to compensate the decrease of LNG cargos during the first 3 weeks and the disruption of Algerian supply. Storage gas is also used to compensate the lack of Algerian supply.

LNG tanks: Gas from LNG tanks is used to compensate the missing LNG cargos during the first 3 weeks (total 35 TWh).

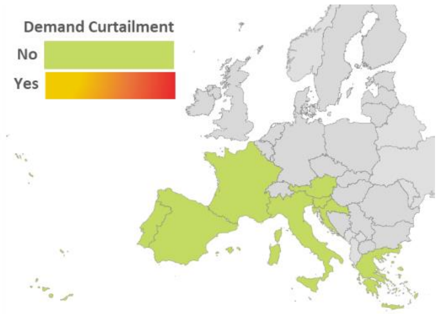
SCENARIO #16 - Disruption of all imports from Algeria including LNG

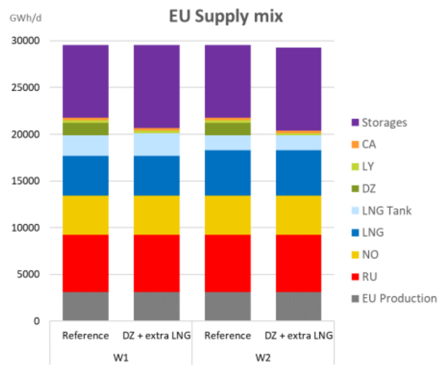
Demand

No country is exposed to risk of demand curtailment. Compared to the previous edition, Greece no longer faces risk of demand curtailment during the 2-month disruption. following the commissioning of TANAP, Greece can additionally access the Caspian gas supply.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage increases s during both weeks by 15 TWh.

<u>Pipeline and LNG supplies</u>: Russian, Norwegian, Libyan and Caspian gas supplies are used up to their maximum supply potential. Gas from the storages is used to compensate no Algerian supply.

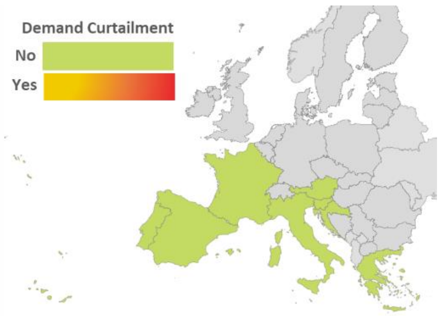
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

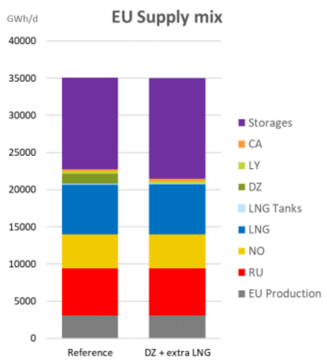
Demand

No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage increases by 13 TWh.

<u>Pipeline and LNG supplies</u>: All supplies are used up to their maximum supply potential (apart from NO that is used up to its maximum import capacity). Gas from the storages is used to compensate the absence of Algerian supply.

Demand

No country is exposed to demand curtailment. Compared to the previous edition, Italy, Croatia and Slovenia no longer face demand curtailment during peak day.

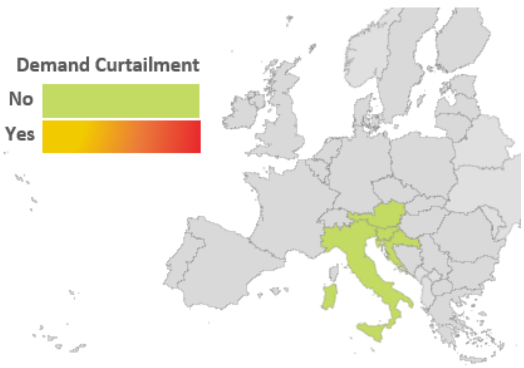
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

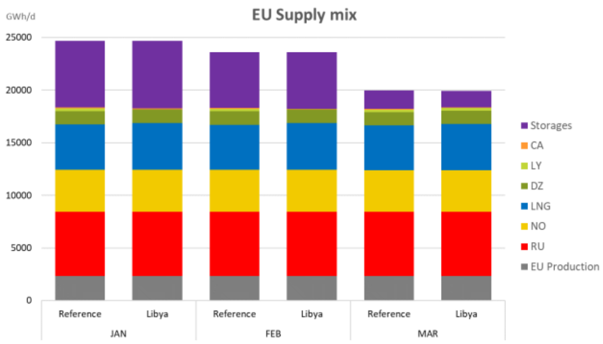
SCENARIO #17 - Disruption of all imports from Libya

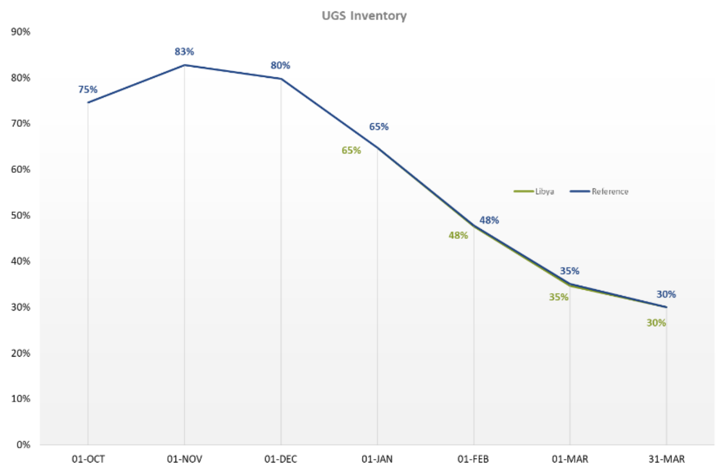
Risk group: North-African gas supply – Libya	Croatia, Italy, Malta, Austria, Slovenia
Disruption duration:	2 months (1 January – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage increases during January and February by 4 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. The overall flow of Libyan gas to Italy is replaced mainly by LNG supply, Caspian gas and gas from the storages.

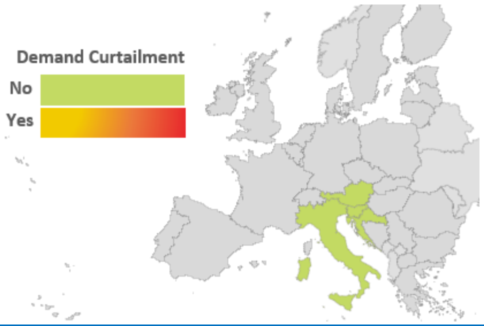
Demand

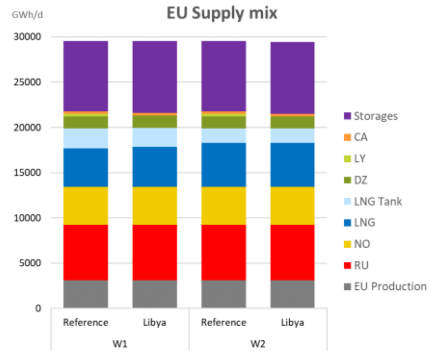
No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #17 - Disruption of all imports from Libya

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage increases during both weeks by 4 TWh.

<u>Pipeline and LNG supplies</u>: The overall flow of Libyan gas to Italy is replaced mainly by gas from the storages.

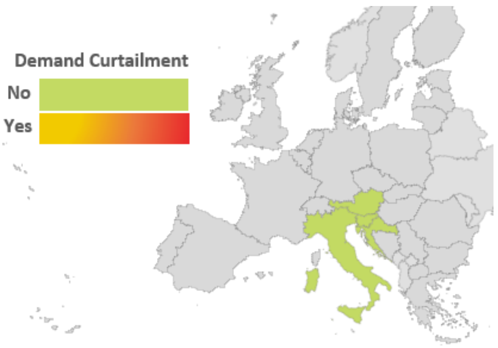
<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

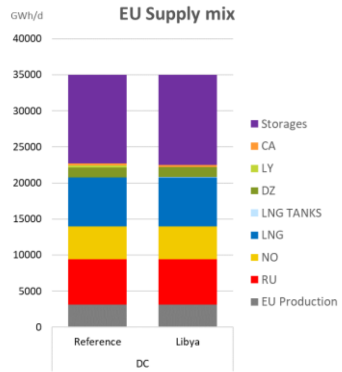
Demand

No country is exposed to risk of demand curtailment.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage increases by 0.3 TWh.

<u>Pipeline and LNG supplies</u>: The overall flow of Libyan gas to Italy is replaced mainly by gas from the storages.

<u>LNG tanks</u>: Necessary to provide extra LNG capacity.

Demand

No country is exposed to risk of demand curtailment.

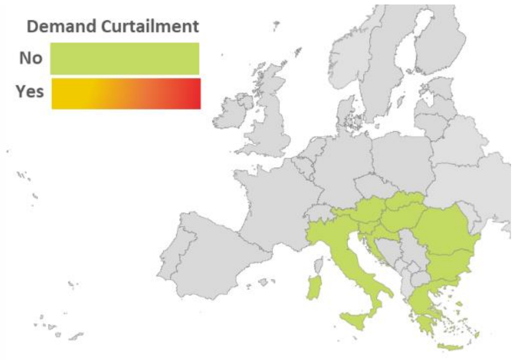
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

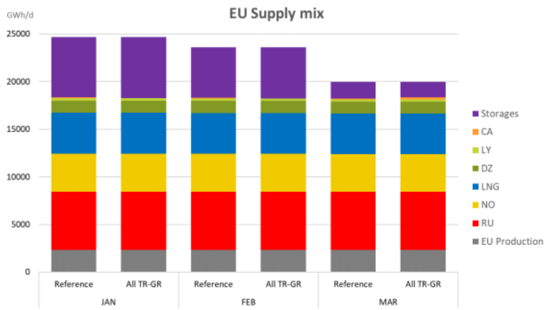
SCENARIO #18 - Disruption of all imports from Turkey to Greece

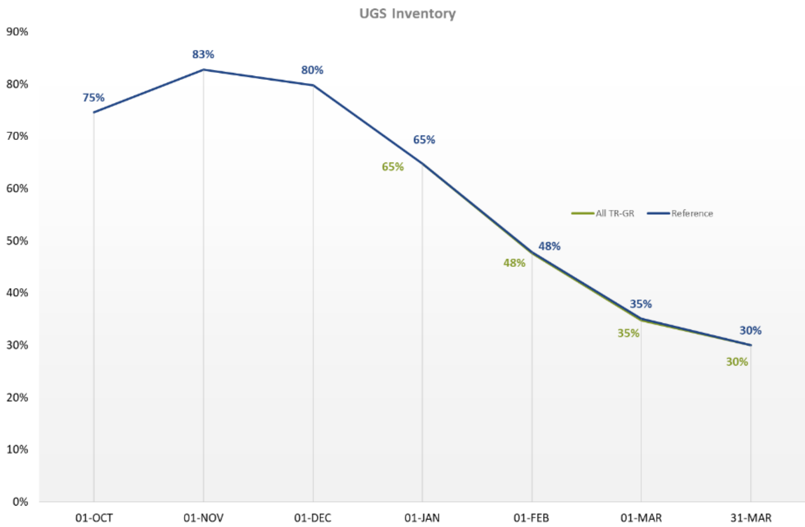
Risk group: Southern Gas Corridor — Caspian	Bulgaria, Greece, Croatia, Italy, Hungary, Malta, Austria, Romania, Slovenia, Slovakia	
Disruption duration:	2 months (1 January – 28 February)	

Simulation results

January-March







Supply

Storages: Storage usage increases during the months of January and February increase by 4 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. No Caspian gas reaches the EU due to the disruption of the TANAP pipeline and the entry point at Kipi. The overall flow of Caspian gas to Europe is replaced mainly by LNG supply, Algerian pipe gas and gas from the storages.

Demand

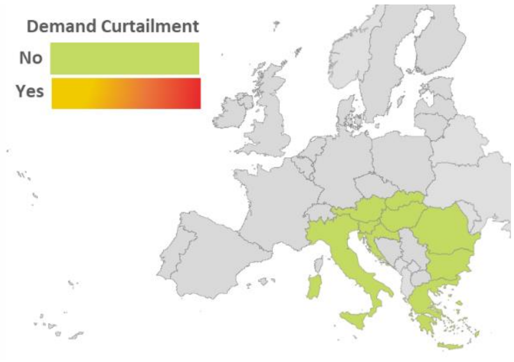
No country is exposed to risk of demand curtailment.

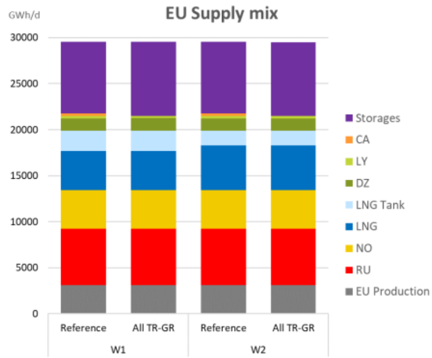
Exports to Ukraine (UA) are maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #18 - Disruption of all imports from Turkey to Greece

2-week / 20 years: Simulated from 15 to 28 February





Supply

<u>Storages</u>: Storage usage increases during both weeks by 3 TWh.

<u>Pipeline and LNG supplies</u>: The overall flow of Caspian gas to Europe is replaced mainly by LNG and gas from the storages. All supplies are used up to their maximum supply potential.

<u>LNG tanks</u>: Necessary to provide extra LNG capacity during both weeks.

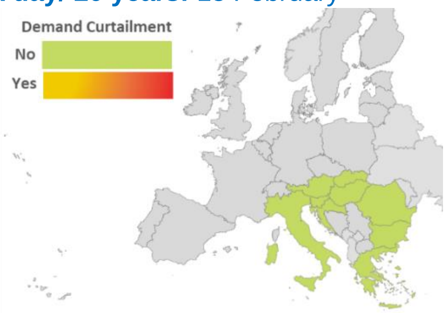
Demand

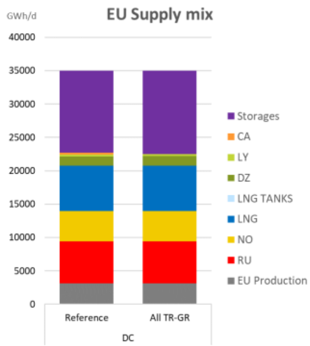
No country is exposed to risk of demand curtailment.

Exports to Ukraine (UA) are maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

<u>Storages</u>: Storage usage increases by 0.1 TWh.

<u>Pipeline and LNG supplies</u>: The overall flow of Caspian gas to Europe is replaced mainly by LNG supply and gas from the storages. All supplies are used up to their maximum supply potential.

Demand

No country is exposed to risk of demand curtailment.

Exports to Ukraine (UA) are maintained.

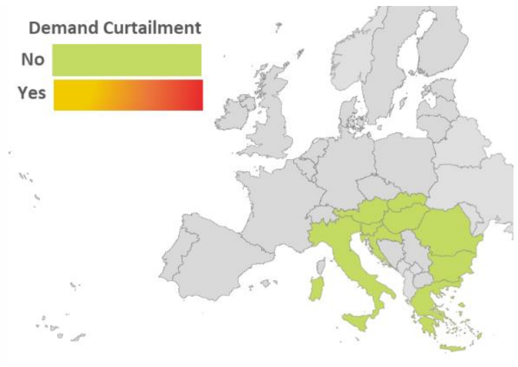
Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

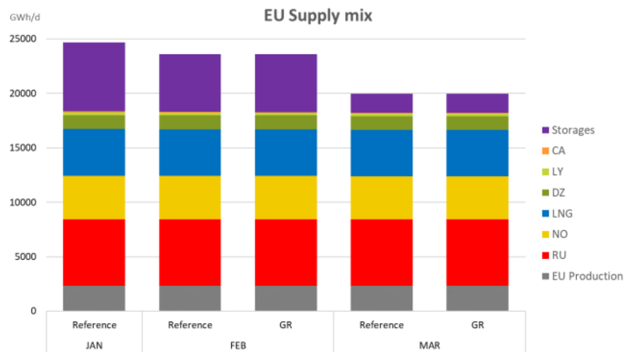
SCENARIO #19 - the largest onshore infrastructure to Greece (TANAP)

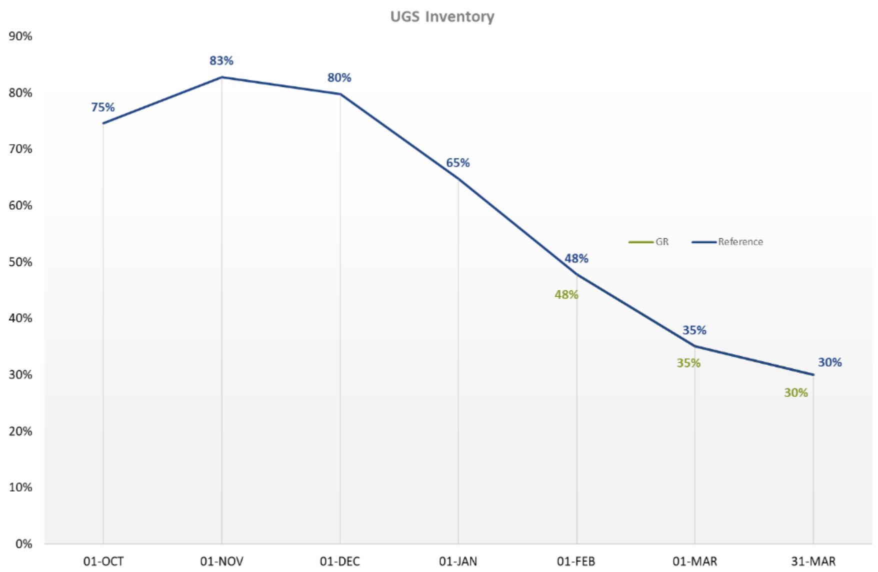
Risk group: Southern Gas Corridor — Caspian	Bulgaria, Greece, Croatia, Italy, Hungary, Malta, Austria, Romania, Slovenia, Slovakia
Disruption duration:	2 weeks (15 February – 28 February)

Simulation results

January-March







Supply

Storages: Storage usage increases during February by 0.6 TWh.

Pipeline and LNG supplies: Supplies shows some potential flexibility. Caspian gas supply is used up to the reduced import capacity. Caspian gas is flowing into the EU only through Kipi. Caspian gas is mainly replaced by Algerian supply and storage use during February.

Demand

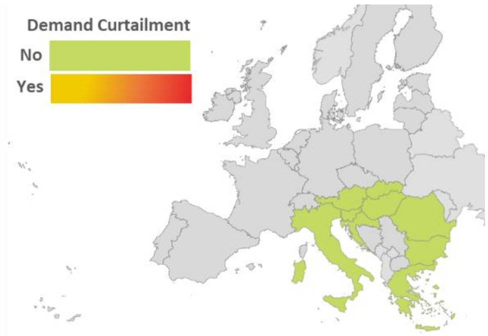
No country is exposed to risk of demand curtailment.

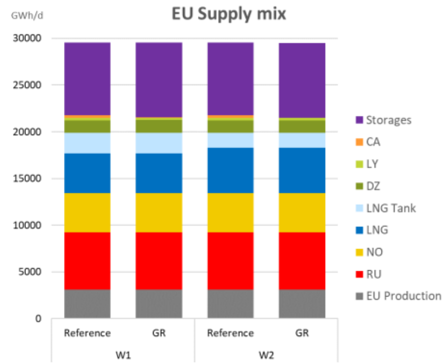
Exports to Ukraine (UA) are maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

SCENARIO #19 - the largest onshore infrastructure to Greece (TANAP)

2-week / 20 years: Simulated from 15 to 28 February





Supply

Storages: Storage usage increases during both weeks by 3 TWh.

Pipeline and LNG supplies: Caspian gas supply is used up to the reduced import capacity. Caspian gas is replaced mainly by gas from the storages. Supply sources are used up to their maximum supply potential.

LNG tanks: Necessary to provide extra LNG capacity during both weeks.

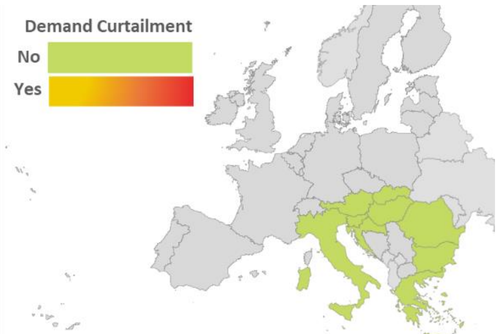
Demand

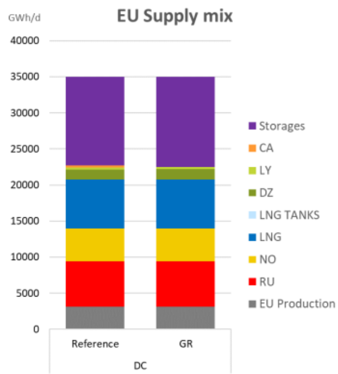
No country is exposed to risk of demand curtailment.

Exports to Ukraine (UA) are maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

Peak day/ 20 years: 15 February





Supply

Storages: Storage usage increases by 0.2 TWh.

Pipeline and LNG supplies: Caspian gas supply is used up to the reduced import capacity. Caspian gas is replaced by gas from the storages.

Demand

No country is exposed to risk of demand curtailment.

Exports to Ukraine (UA) are maintained.

Nord Stream 2 sensitivity (without Nord Stream 2): no changes.

5. Annexes: data tables

5.1. Annex I: Demand

Table 5.Average daily demand [GWh/d].

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

5.2. Annex II: National production

Table 6. Average daily production [GWh/d].

Country	OCT	NOV	DEC	JAN	FEB	MAR	2-week	Peak day
AT	27	27	27	27	27	27	27	27
BGn	2	2	2	2	2	2	2	2
CZ	4	4	4	4	4	4	4	4
DE	38	38	38	38	38	38	38	38
DEI	128	128	128	128	128	128	128	128
ES	5	5	5	5	5	5	5	5
DK	103	103	103	103	103	103	103	103
FI	0	0	0	0	0	0	0	0
HR	15	15	15	15	15	15	16	16
HU	45	45	45	45	45	45	50	50
IE	45	45	45	45	45	45	46	46
IT	110	110	110	110	110	110	122	122
NL	452	452	452	452	452	452	994	994
PL	61	61	61	61	61	61	71	71
RO	251	251	251	251	251	251	255	255
SE	0	0	0	0	0	0	0.15	0.15
SK	1	1	1	1	1	1	2	2
UK	1,044	1,044	1,044	1,044	1,044	1,044	1,248	1,248

5.3. Annex III: Storages

Table 7. Storage working gas volumes and initial levels (WGV: source AGSI+).

Name	Working Gas Volume [GWh]	Initial filling level [% of WGV]
AT	45,325	75%
ATm	17,510	75%
ATn	32,353	75%
BEh	9,001	75%
BGn	6,270	75%
CZ	29,000	75%
CZd	6,944	75%
DE	4,862	75%
DEd	1,832	75%
DEdL	4,374	75%
DEg	101,085	75%
DEgL	16,346	75%
DEm	34,178	75%
DEmL	3,012	75%
DEn	71,674	75%
DEnL	6,076	75%
DK	10,460	75%
ES	34,248	75%
FRa	47,000	75%
FRn	28,500	75%
FRnL	13,400	75%
FRs	10,300	75%
FRt	33,100	75%
HR	5,216	75%
HU	69,643	75%
IT	206,204	75%
LV	24,200	50%
NL	143,707	75%
PL	37,460	75%
PT	3,570	75%
RO	32,991	75%
RS	4,532	75%
SE	86	75%
SKm	43,448	75%
UK	20,890	75%

Table 8. Injection curves.

	UGS inventory											
Name	**100%**	**99%**	**90%**	**80%**	**70%**	**60%**	**50%**	**40%**	**30%**	**20%**	**10%**	**0%**
AT	0%	65%	78%	85%	90%	93%	96%	97%	99%	99%	100%	100%
ATm	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
ATn	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
BEh	0%	18%	18%	35%	35%	100%	100%	100%	100%	100%	100%	100%
BGn	0%	56%	63%	63%	100%	100%	100%	100%	100%	100%	100%	100%
CZ	0%	30%	40%	60%	75%	85%	100%	100%	100%	100%	100%	100%
CZd	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DE	0%	50%	62%	73%	81%	89%	96%	98%	99%	99%	100%	100%
DEd	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEdL	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEg	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEgL	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEm	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEmL	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEn	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DEnL	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
DK	0%	75%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
ES	0%	85%	85%	90%	90%	90%	95%	100%	100%	100%	100%	100%
FRa	0%	76%	76%	80%	84%	88%	92%	96%	100%	100%	100%	100%
FRn	0%	62%	68%	77%	85%	93%	95%	98%	100%	100%	100%	100%
FRnL	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
FRs	0%	42%	57%	60%	65%	70%	76%	82%	88%	92%	96%	100%
FRt	0%	98%	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%
HR	0%	33%	83%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HU	0%	88%	89%	91%	92%	94%	95%	100%	100%	100%	100%	100%
IT	0%	15%	31%	62%	62%	62%	79%	79%	100%	100%	100%	100%
LV	0%	50%	60%	100%	100%	100%	100%	100%	100%	100%	100%	100%
NL	0%	58%	68%	78%	82%	86%	91%	93%	97%	98%	99%	100%
PL	0%	54%	70%	83%	83%	89%	87%	88%	89%	90%	97%	100%
PT	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
RO	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
RS	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
SE	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
SKm	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%
UK	0%	48%	62%	75%	80%	85%	92%	94%	98%	99%	99%	100%

Injection availability

Table 9. Withdraw curves.

	UGS inventory											
Name	**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%
ATm	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
ATn	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	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%
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%
DE	100%	100%	100%	99%	99%	99%	86%	74%	60%	46%	31%	0%
DEd	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEdL	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEg	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEgL	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEm	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEmL	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEn	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
DEnL	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%
ES	100%	80%	72%	67%	63%	60%	55%	50%	45%	40%	40%	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%
HR	100%	100%	100%	100%	100%	96%	80%	65%	48%	32%	14%	0%
HU	100%	100%	100%	100%	100%	97%	95%	84%	72%	52%	40%	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%
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%
SE	100%	100%	99%	98%	98%	98%	84%	70%	56%	41%	27%	0%
SKm	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%

Withdraw deliverability

5.4. Annex IV: LNG

Table 10. LNG tank capacity and flexibility

Name	LNG Tank Capacity [GWh]	LNG Tank Flexibility [% of LNG Tank Capacity]
BEh	2,644	35%
ES	13,337	68%
ESa	9,381	68%
FI	538	54%
FRn	6,371	76%
FRs	2,809	60%
GR	1,541	57%
HR	959	54%
IT	1,627	63%
ITa	1,713	33%
LT	1,165	3%
NL	3,699	35%
PL	2,192	74%
PT	2,672	43%
SE	343	54%
UK	14,385	64%

5.5. Annex V: Capacities

Separate file

Abbreviations:

Country codes are defined according to the ISO standard 3166-1

DC: Design Case, identical with Peak Day

EC: European Commission

ENTSOG: European Network of Transmission System Operators for Gas

EU: European Union

GCG: Gas Coordination Group

GIE: Gas Infrastructure Europe

GLE: Gas LNG terminals operators Europe

GSE: Gas Storages operators Europe

H-gas: High calorific gas

L-gas: Low calorific gas

LNG: Liquified Natural Gas

SoS: Security of Supply

TSO: Transmission System Operators

UGS: Underground Gas Storage

WGV: Working Gas Volumes

WSO: Winter Supply Outlook

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