Winter Supply Outlook 2016/17
Winter Review 2015/16
SO0015-16
7 October 2016
Rev_3

Winter Supply Outlook 2016/2017
&
Winter Review 2015/2016

Contents

Winter Supply Outlook 2016/17

Executive summary

As part of its obligation under Art. 8(3)(f) of Regulation (EC) 715/2009, ENTSOG has undertaken an assessment of the European gas network for the upcoming winter (October 2016 to March 2017). The analysis focuses on the possible evolution of UGS inventory along the season and the ability of the gas system to face high demand situations. It assesses the potential of gas infrastructures under a given demand and supply situation. Under such assumptions and compared to last Winter Supply Outlook, conclusions are:

- **The European gas infrastructure offers sufficient flexibility across the season in most parts of Europe, provided gas is available**
- **The European gas infrastructure is capable of supplying Ukraine with significant volumes of gas**
- **A disruption of transit through Ukraine under high demand situations still strongly impacts South-East Europe**
- **Higher peak demand in Romania and Serbia, and lower national production in Romania (compared to Winter Outlook 2015/16) explain the extension of the demand curtailment in South-Eastern Europe under Ukrainian disruption**

ENTSOG has used a sensitivity analysis to check if the European gas infrastructure is able to:

- cover the full winter demand under different demand conditions: a Reference Winter and a Cold Winter[1]
- enable shippers to face disruption of Russian gas through Ukraine under high demand situations

The current analysis is developed specifically for this Winter Supply Outlook. It results from TSOs experience and ENTSOG modelling and supply assumptions and should not be considered as a forecast.

[1] The Reference Winter and the Cold Winter are defined on page 5 of the document.

1. Introduction

As part of ENTSOG continuous effort to ensure greater transparency and knowledge regarding the development and operation of the European gas network, ENTSOG presents this Winter Supply Outlook 2016/17. This Outlook aims to provide an overview of the ability of both the European gas network and potential supply to face winter demand. This ability has been tested along both the whole winter and high demand periods.

The winter months require storage withdrawal to cover both short high demand periods and the overall winter demand. The actual level of withdrawal by shippers varies from one country to the other and from time to time due to climatic, price and legal parameters. Compared to last winter the European aggregated inventory level of underground gas storages levels on 1 October is higher. The actual levels for each country show substantial differences from one country to the other. These levels per country have been used as a starting point for the Winter Supply Outlook 2016/17.

ENTSOG has used a sensitivity analysis to check if the European gas infrastructure is able to:

- cover the full winter demand under different demand conditions: a Reference Winter and a Cold Winter
- enable shippers to meet different high demand situations in each country under different supply conditions
- enable shippers to face disruption of Russian gas through Ukraine under high demand situations

When assessing the supply adequacy at European level through TYNDP and Outlooks, ENTSOG aims to enlarge the geographical scope of the study beyond its own perimeter. Winter Supply Outlook 2016/17 covers the EU-28 (less Cyprus and Malta) plus Bosnia, FYROM, Moldova, Serbia and Switzerland as well as exports to Ukraine, Turkey, Kaliningrad and St. Petersburg[2].

[2] There were no significant exports observed to Moldova. For this reason export flows to Moldova are considered equal to 0 in this Winter Supply Outlook.

Two different visions: winter period and high demand situations

As for previous reports the Winter Supply Outlook 2016/17 captures two different but still linked visions of the season.

The first one is an outlook of demand and supply evolution along the winter and the resulting evolution of UGS inventory.

The second one is the analysis of specific and hypothetical events being high demand situations (1-day Design Case and 2-week Cold Spell) and a transit disruption occurring under such high demand situations.

These two visions are assessed separately in the Winter Supply Outlook 2016/17.

2. Assumptions

Modelling approach

The network model for the Winter Supply Outlook is the same as used in the TYNDP 2017 to be published in December 2016. It is handled on country level and takes into account the existing gas infrastructure and the infrastructure planned to be commissioned during the upcoming winter. The technical capacities taken into account were based on the figures from TYNDP 2017[3].

In the model, the send-outs from the terminals are modelled to represent the sum of the off-loaded volumes of arriving cargos and gas from tanks. As for the previous Winter Outlook, the 2-week Cold Spell is split in 2 periods to allow a differentiation of the LNG terminals behaviour between the first and the second week. During the first week, the model will determine the LNG send-outs using the level of LNG supply reaching LNG terminals as calculated in February of the Cold Winter case, plus additional LNG that can be taken from the tanks. The following 7 days allow importers to access a relevant number of cargos, so that the LNG supply reaching the terminals can reach the February maximum supply potential. In addition, the LNG send-outs can use the remaining LNG stored in the tanks. For the additional LNG available from the tanks, the Winter Outlook considers the figures provided by GLE for the TYNDP 2017.

For the underground gas storages (UGS), dynamic modelling is applied, taking into account the influence of UGS inventory on withdrawal deliverability by using withdrawal deliverability curves. These deliverability curves[4] have been revised in cooperation with GSE for the TYNDP 2017. In addition, a 30% UGS inventory level is targeted at the end of the winter, if it does not prevent countries to be balanced.

In all cases, the cooperative modelling is done on the basis of an optimal crisis management. That is, in case a country faces a demand curtailment, all the other countries will cooperate in order to share the same ratio of demand curtailment.

[3] Updated by TSOs on April 2016

[4] See Annex A

2.1. Demand

A Reference Winter has been defined as representing a 1-in-2 year climatic condition. The demand data has been provided by TSOs on a monthly level[5]. A flat daily demand has been considered within each month.

For the purpose of the sensitivity analysis, a Cold Winter has been defined on the basis of the Reference Winter, using a demand deviation. The demand deviation for the Cold Winter is provided by TSOs (see annex B for more detail including per country). This deviation has been applied to the demand of the Reference Winter for each country. The Cold Winter shows an overall increase of 10% of the total demand compared to the Reference Winter.

For comparison purpose, the European aggregated demand for the Reference Winter and Cold Winter are compared to the historical demand as well as average demand (red line) over the last 6 winters below:

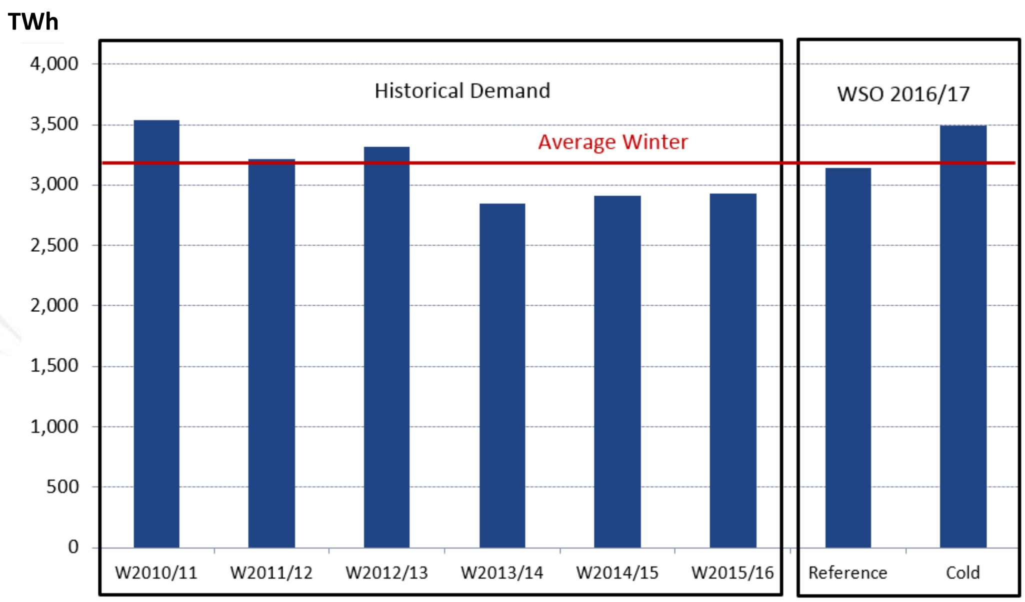


Figure 1: European aggregated demand in the past compared to the visions

These values differ from one country to another.

[5] The number of days within the months are according to the Gregorian calendar.

2.2. Peak demand

Two high demand situations are considered: a 1-day Design Case and a 2-week Cold Spell occurring in February. They are defined in the table below:

Period	Occurrence of the demand provided by each TSO
1-day Design Case	National design standard for gas demand, taking place on 31 January
2-week Cold Spell	High demand during a 14-day period in February (Cold Spell), taking place 15-28 February

2.3. Export from Europe

The analysis considers the following transit from Europe to other regions: Kaliningrad from Lithuania, Saint-Petersburg from Latvia, Ukraine from Slovakia and Turkey from Bulgaria. The levels of the different transits are indicated in the Annex B.

2.4. Supply

For each of the winter demand profiles and high demand situations, specific gas supply maximum availability has been defined as below (also see Annex B):

<table>
<tr><th></th><th>National Production</th><th>UGS[6]</th><th>LNG</th><th>Algeria, Norway, Libya, Russia[7]</th></tr>
<tr><td>Reference Winter</td><td rowspan="2">TSO forecast for winter</td><td rowspan="7">Limited for each country (or zone) by the stored volumes and the deliverability associated with the inventory level</td><td colspan="2" rowspan="2">Limited for the whole winter period to the highest winter average supply observed during the last 5 winters and at monthly level to the maximum monthly average supply observed during the last 5 winters.</td></tr>
<tr><td>Cold Winter</td></tr>
<tr><td rowspan="4">2-week Cold Spell</td><td rowspan="5">TSO forecast for high demand situations</td><td>Week 1</td><td rowspan="4">Limited to the maximum 2-weeks rolling average of the last five winters
Limited to the maximum 2-weeks rolling average of the last five winters</td></tr>
<tr><td>Limited to the observed February flow in the Cold Winter plus additional LNG that can be taken from the tanks to be shared with week 2.</td></tr>
<tr><td>Week 2</td></tr>
<tr><td>Limited to the maximum potential supply in February plus additional LNG that can be taken from the tanks to be shared with week 1.</td></tr>
<tr><td>1-day Design Case</td><td>Limited to the maximum daily supply of the last five winters plus additional LNG that can be taken from the tanks</td><td>Limited to the maximum daily supply of the last five winters</td></tr>
</table>

[6] The influence of UGS inventory on withdrawal deliverability has been considered using deliverability curves provided by GSE (see Annex A). The initial storage level on 1 October 2016 for each country comes from AGSI platform.

[7] All simulations are carried out with partial availability of OPAL taking into account the current exemptions for all simulations cases except for disruptions cases where full availability is considered.

3. Results of Supply vs. Demand balance over the winter

3.1. UGS initial inventory

The Winter Supply Outlook takes into account the actual storage inventory level per country as of October 1st 2016[8] as initial situation. As shown in the map below the storage inventory levels differ from country to country.

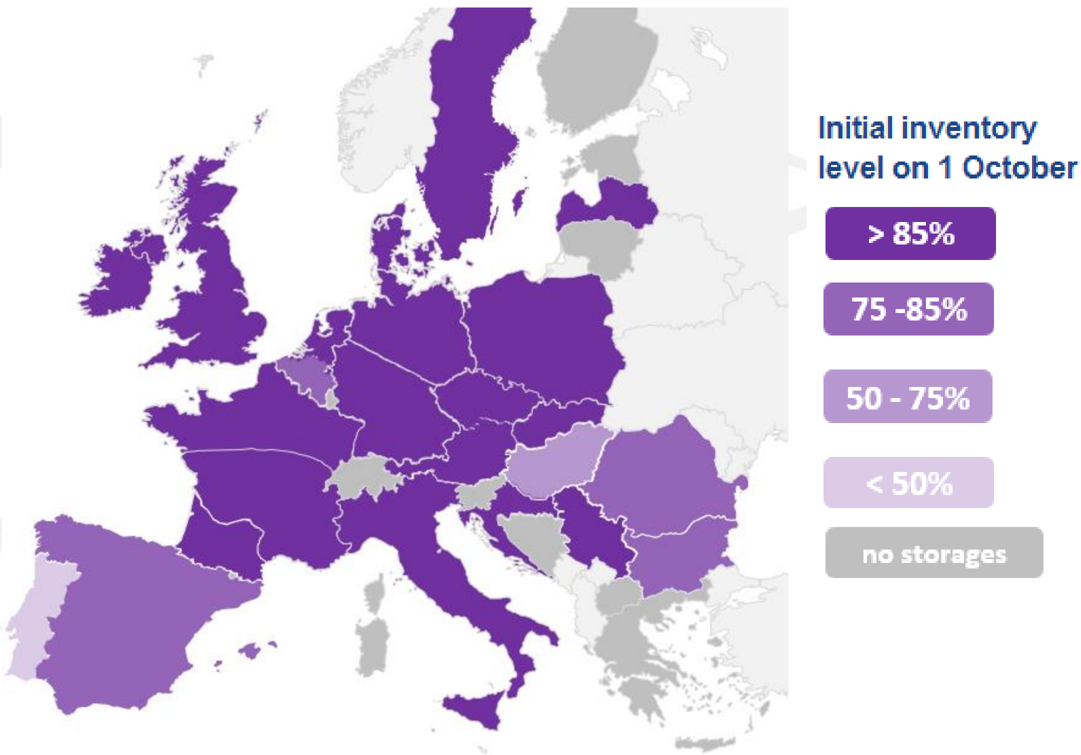


Figure 2: Actual storage inventory levels on 1st of October 2016

In terms of absolute volumes in gas storages, the largest volumes are in Germany, Italy and the Netherlands. On October 1st 2016, the UGS inventory is significantly higher than the previous year (91% Vs 82%).

[8] The initial storage level on 1 October 2016 for each country is based on the information on the AGSI platform captured on 1 October.

3.2. Demand balance along the winter

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

The graph below shows the supply and demand balance at European level for the Reference Winter.

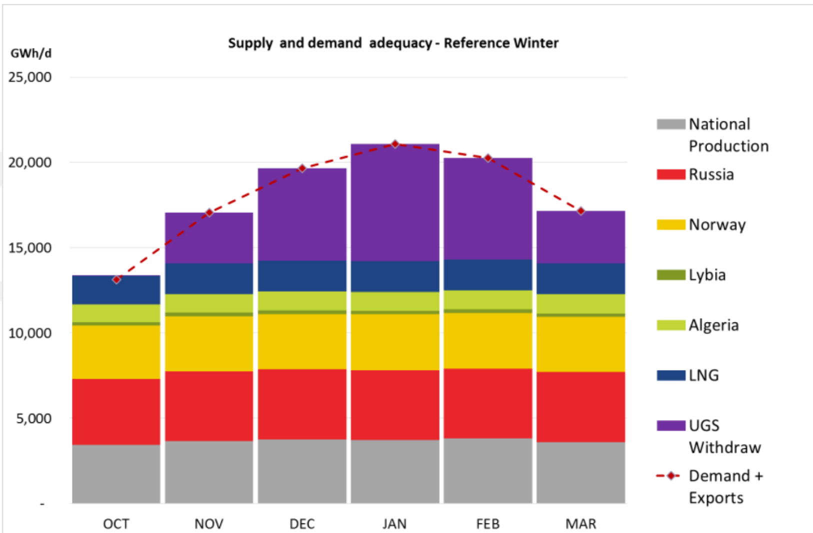


Figure 3: Supply and demand adequacy - Reference Winter

The graph below shows the changes in supply and demand at European level for the Cold Winter compared to the Reference Winter. For the Cold Winter simulation, all supplies are used at their maximum. Hence, the extra supply of Norwegian gas is higher than the extra supply of Russian gas because supply from Russia was already used at a high level in the normal winter, and Norway had a little bit more flexibility.

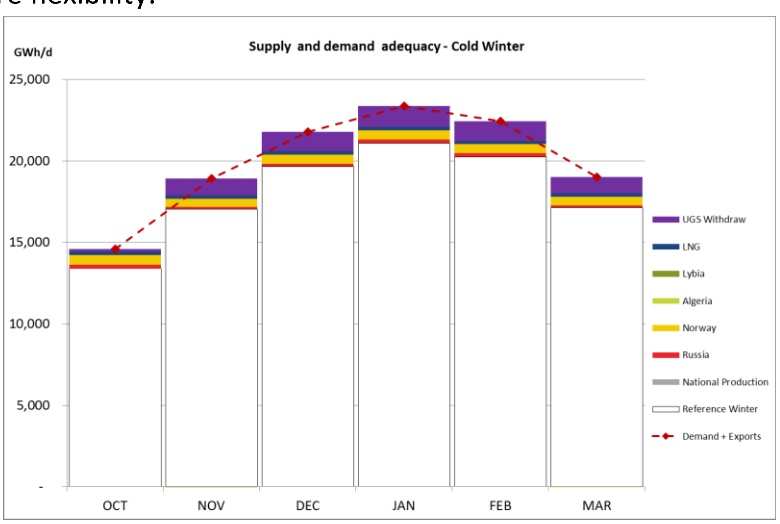


Figure 4: Supply and demand adequacy - Cold Winter

3.3. Evolution of UGS inventory level

The graph below shows the evolution of the European aggregated UGS inventory level resulting from the modelling defined in the previous chapter for the Reference Winter and the Cold Winter:

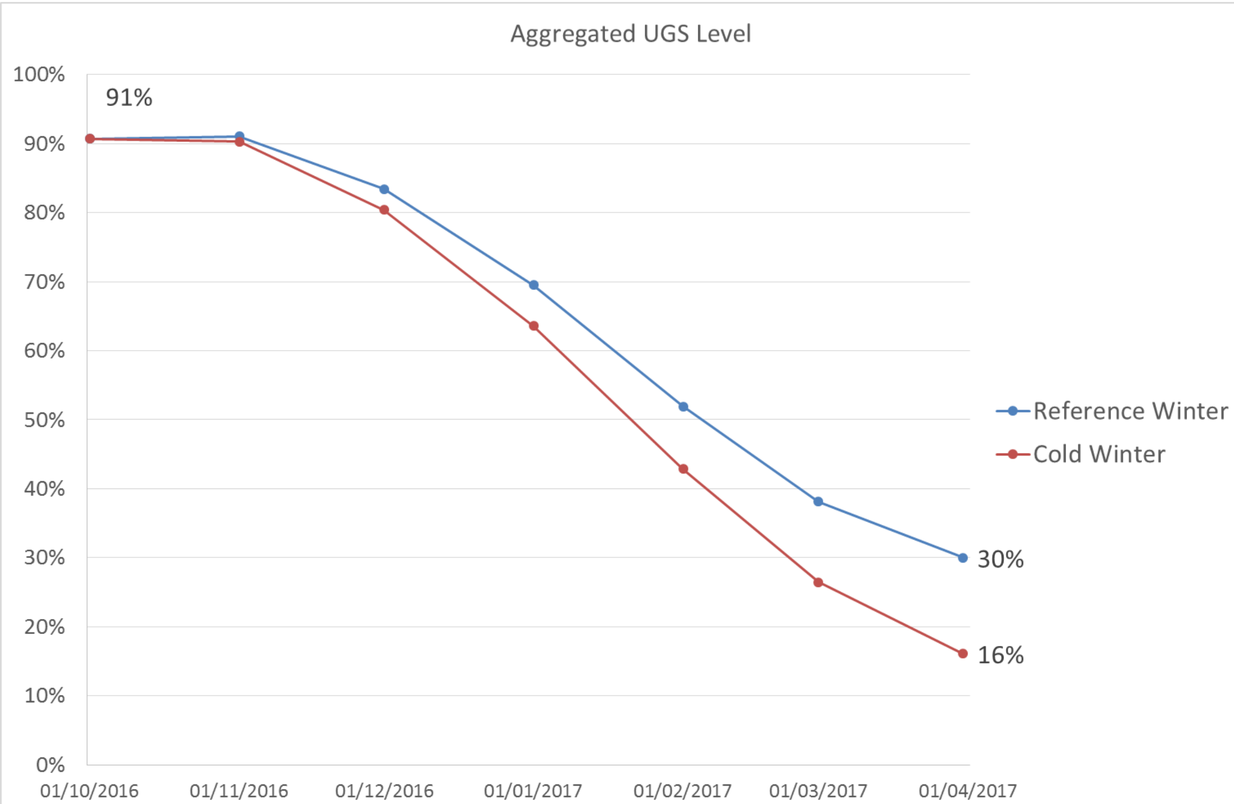


Figure 5 - Winter evolution of the aggregated UGS stock level

As mentioned as part of the modelling assumptions, a target level of 30% inventory level is set for storages in every country.

During the Reference Winter this target inventory level of 30% at the end of the winter can be reached. The associated withdrawal of gas from storages combined with the assumed supply flexibility is sufficient for the supply and demand adequacy.

During the Cold Winter, based on the assumed supply flexibility, additional volumes are needed from the storages, leading to an EU aggregated inventory level at the end of the winter below the 30% target, at 16% (see Annex A).

4. Results of Supply vs. Demand balance during the high demand situations

The high demand situations are considered as taking place following a beginning of the winter season corresponding to the Cold Winter situation. The initial storage inventory levels on 30 January (End of Day) for the Design Case and on 14 February (End of Day) for the 2-week Cold spell are therefore derived from the Cold Winter modelling. The corresponding storage withdrawal deliverability is considered (see Annex A).

Hereafter is the chart comparing the supply mix for a cold winter in February and during a 2-week Cold Spell:

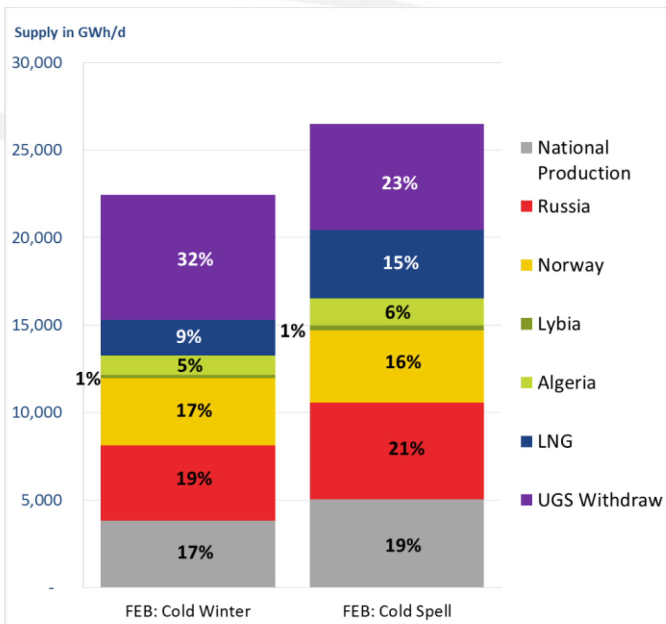


Figure 6: Comparison of supply mixes in February during Cold Winter and during 2-week Cold Spell[9]

The supply mix is the same during week-1 and week-2. There is no change in the LNG supply share between week-1 and week-2 as the extra LNG required can be taken from the tanks.

[9] FEB: February, Week 1: first week (15-21 February), Week 2: second week (22-28 February)

The main results are the following ones:

> 1-Day Design Case: No country faces demand curtailment, but some show low Remaining Flexibility (France North, Finland and Sweden);
> During the 2-week Cold Spell: No country faces demand curtailment, but some show low Remaining Flexibility (Finland and Sweden);

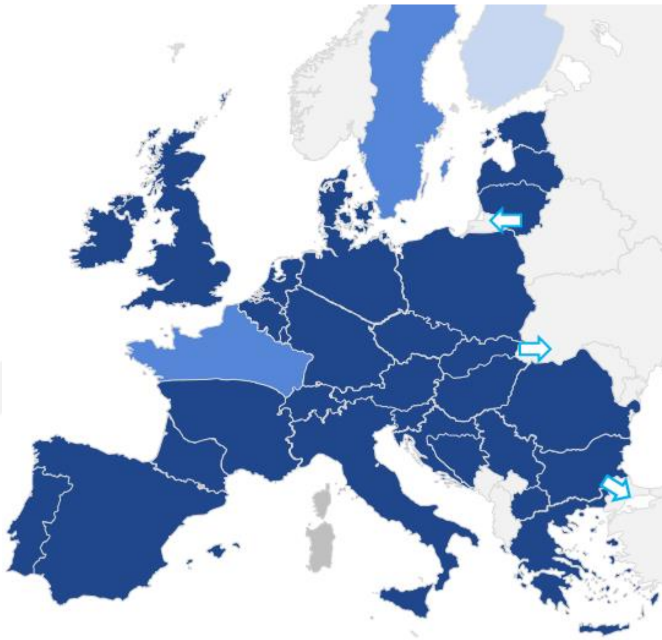
For the high demand cases during a Cold Winter the results of the evolution of the pan-EU storage inventory level are shown in the table below. The low and high supply assumptions for the pipeline and LNG supply allow flexibilities during the 2-week Cold Spell, which are reflected in the results for the final inventory level.

		Level before event	**Level after event**
1-day Design Case	31 January	44%	43%
2-week Cold Spell	15-28 February	35%	28%

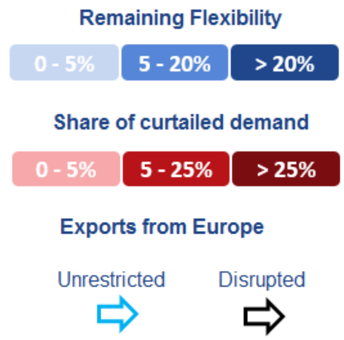
For each high demand situation and each zone, modelling results consist in the calculation of:

> The Remaining Flexibility representing the maximum demand increase of a country before facing curtailment (see Annex C for detailed calculation process)
> The potential level of demand curtailment

4.1. Results for 1-day Design Case during a Cold winter



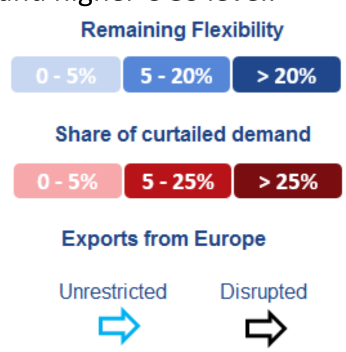
No country faces demand curtailment. The lower level of Remaining Flexibility for Finland, and Sweden is consistent with the Winter Supply Outlook 2015/16.
Compared to the previous Winter Supply Outlook changes for France North result from an update of UGS withdrawing capacities figures.



Exports to Ukraine: 309 GWh/d

4.2. Results for 2-week Cold spell during a Cold Winter

No country faces demand curtailment.
Compared to the Winter Supply Outlook 2015/16, Sweden no longer faces a demand curtailment on the 2-week cold spell, related to lower demand projection and higher UGS level.



5. Results of disruption case event

Transit disruption of Ukraine

This vision is included in ENTSOG's Winter Supply Outlooks since Winter Supply Outlook 2013/14. The disruptions of the Ukrainian transit are assessed during the 1-day Design Case and the 2-week Cold Spell.

Imaginable scenarios for such a vision might be:

> A technical disruption event caused by:
  - the age and state of the upstream transit system or
  - an unpredictable incident

> A political disruption resulting from
  - an escalation of the Ukrainian-Russian conflict

> A disruption resulting from economic reasons
  - offtakes for domestic demand above the contracted volumes in the upstream transit system

The below graph shows, for information, the UGS level of Ukraine through last year.

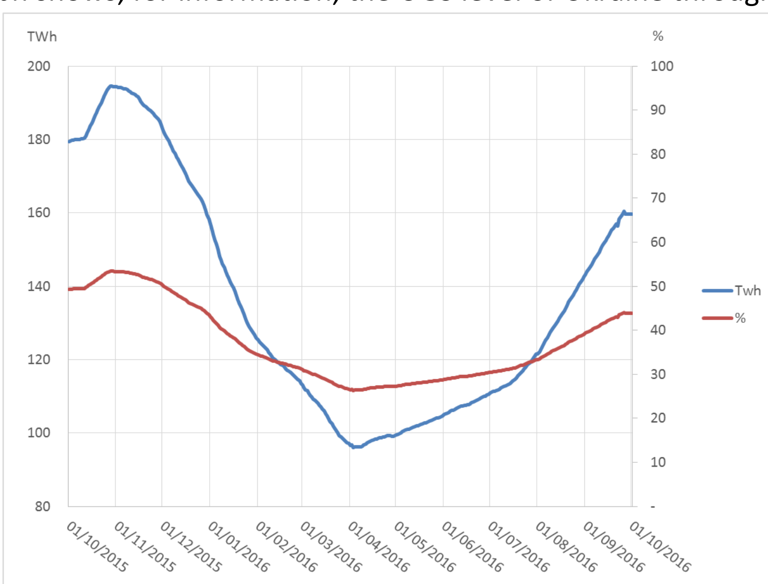


Figure 7: Gas storages in Ukraine (source GIE's AGSI platform)[10]

Please note that the vision on transit disruption of Ukraine in this report is a hypothetical case just for the purposes of this Winter Supply Outlook.

[10] Excluding the gas storages on Crimea, for which updates are temporarily unavailable according to GSE.

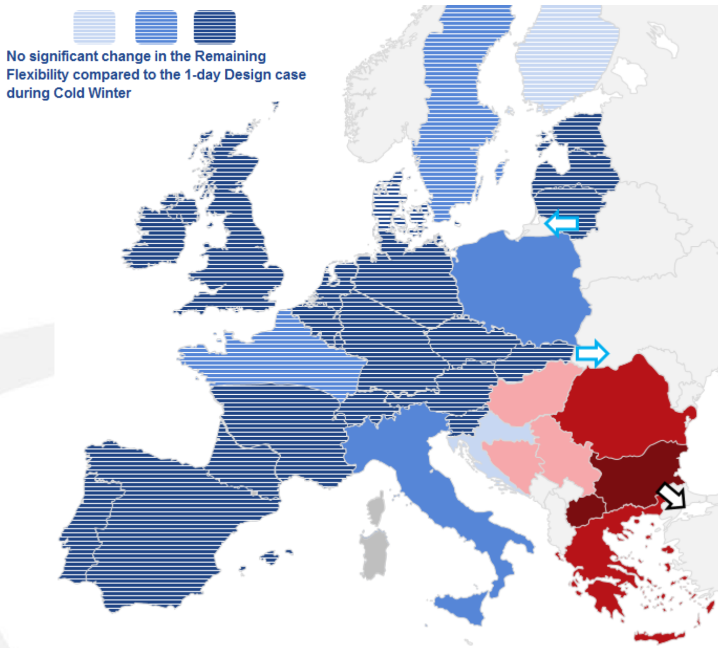
Modelling results

For the transit disruption through Ukraine during each high demand situation and each zone, modelling results consist in the calculation of:

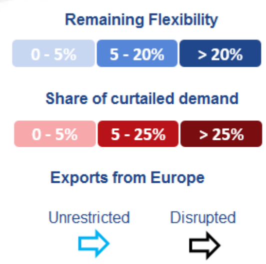
- The Remaining Flexibility as the maximum demand increase of a country before facing curtailment (see Annex C for detailed calculation process)
- The potential level of demand curtailment

The results show that in case of a high demand situation combined with a disruption of Ukrainian transit, in addition to the countries affected in the Design Case and 2W-Cold Spell situation, some countries in the South-East Europe are facing demand curtailment.

5.1. Results for 1-day Design Case during a Cold Winter with transit disruptions through Ukraine

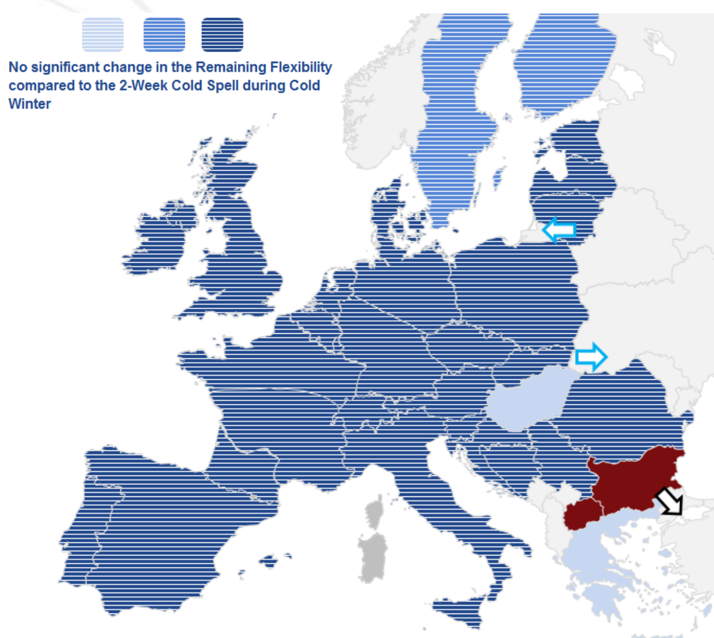


The disruption will induce curtailment in South-Eastern Europe. The curtailments in Bulgaria, FYROM and Greece are consistent with former results. The extension of the demand curtailment to Bosnia, Hungary, Romania and Serbia are a consequence of a higher local peak demand and a lower national production of Romania. It is to notice that the use of a cooperative model still shows a low flexibility in south-eastern Europe mostly due to bottle-necks between the different countries.

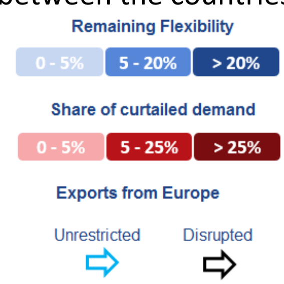


Exports to Ukraine: 309 GWh/d

5.2. Results for a 2-week Cold spell during a Cold Winter with transit disruptions through Ukraine



A demand curtailment is observed in Bulgaria and FYROM, even if Romania Serbia still have a high remaining flexibility. It is to notice that the use of a cooperative model still shows a low flexibility in south-eastern Europe mostly due to bottle-necks between the countries.



Exports to Ukraine: 309 GWh/d

6. Conclusion

According to the ENTSOG modelling and supply assumptions, this Winter Supply Outlook confirms the ability of the European gas infrastructures to face a Cold Winter 2016/17 with sufficient flexibility in most parts of Europe. This assessment is valid throughout the season and under high demand situations.

As for previous Winter Supply Outlooks, the assessment of high demand situation confirms:

- the ability of the gas infrastructure to supply Ukraine with significant volumes of gas
- the ability of the gas infrastructure to face high demand situations and provide flexibility to the gas market
- the lack of infrastructure resilience of South-East Europe in case of an interruption of Russian gas transit through Ukraine

The level of storages across Europe significantly contributes to the balance of demand across the season. It also contributes to the ability to physically send gas to Ukraine especially in case of disruption of transit through Ukraine.

Please note that the supply assumptions and the integrated flow patterns used in this report are a hypothetical case just for the purposes of this Winter Supply Outlook.

Legal Notice

ENTSOG has prepared this Winter Outlook in good faith and has endeavoured to prepare this document in a manner which is, as far as reasonably possible, objective, using information collected and compiled by ENTSOG from its members and from stakeholders together with its own assumptions on the usage of the gas transmission system. While ENTSOG has not sought to mislead any person as to the contents of this document, readers should rely on their own information (and not on the information contained in this document) when determining their respective commercial positions. ENTSOG accepts no liability for any loss or damage incurred as a result of relying upon or using the information contained in this document.

Annex A - Underground Storages assumptions and outputs

UGS deliverability curve

In order to capture the influence of UGS inventory level on the withdrawal capacity, ENTSOG has used the deliverability curves made available by GSE. These curves represent a weighted average of the facilities (salt caverns, aquifers or depleted fields) of each area.

	UGS inventory											
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%	
AT	100%	99%	98%	96%	96%	92%	87%	78%	69%	60%	25%	Withdraw deliverability
BE	100%	100%	100%	100%	100%	100%	100%	100%	35%	35%	24%	
BG	74%	74%	100%	100%	100%	100%	89%	79%	79%	60%	25%	
HR	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
CZ	100%	100%	100%	100%	100%	97%	75%	70%	45%	40%	25%	
CZd*	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
DK	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
FRn	100%	99%	97%	94%	91%	88%	82%	72%	63%	51%	43%	
FRs	100%	99%	99%	98%	98%	97%	91%	74%	62%	48%	25%	
FRt	100%	98%	96%	93%	91%	89%	83%	73%	64%	55%	45%	
DE	100%	99%	98%	97%	97%	95%	85%	73%	60%	48%	26%	
HU	100%	100%	100%	100%	99%	96%	93%	83%	72%	59%	48%	
IE	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
IT	100%	100%	96%	94%	93%	91%	89%	77%	69%	62%	25%	
LV	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
NL	100%	97%	94%	92%	89%	86%	80%	72%	63%	54%	34%	
PL	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
PT	100%	100%	100%	100%	80%	80%	80%	80%	80%	40%	25%	
RO	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
RS	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
SK	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
ES	100%	80%	72%	67%	63%	60%	55%	50%	45%	40%	25%	
SE	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	
UK	100%	98%	96%	95%	94%	92%	85%	74%	63%	53%	25%	

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

Figure 8 - UGS deliverability curves

Winter 2016/17 inventory level evolution

Below table provides the picture of UGS inventory level evolution as resulting from modelling:

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	final level
Reference Winter	91%	91%	83%	69%	52%	38%	30%
Cold Winter	91%	90%	80%	64%	43%	26%	16%

Figure 9 – Evolution of UGS inventory level

Annex B - Data for Winter Supply Outlook 2016/17

	Demand GWh/day							
	October	November	December	January	February	March	1-Day DC	2-Week
AT	243	281	339	385	343	308	385	343
BA	4	7	9	9	7	6	12	10
BE	475	605	661	675	684	584	1,232	1,072
BG	72	92	104	127	129	92	165	110
CH	110	115	130	155	175	135	210	205
CZ	250	324	409	419	452	323	722	592
DEg*	1,159	1,432	1,635	1,687	1,671	1,433	2,485	1,976
DEn*	1,235	1,640	1,935	1,933	1,969	1,577	3,590	2,576
DK	71	99	122	132	129	113	231	189
EE	14	18	21	30	23	20	53	40
ES	846	986	1,119	1,104	1,115	940	1,520	1,216
FI	102	159	175	185	185	171	240	220
FRn*	739	1,170	1,406	1,532	1,548	1,173	2,913	1,677
FRs*	287	455	547	596	602	456	1,133	652
FRt*	106	156	186	191	176	143	330	214
GR	96	117	157	153	122	96	186	133
HR	98	111	131	133	108	103	140	108
HU	275	392	454	547	426	367	810	740
IE	132	134	172	166	178	146	276	215
IT	1,661	2,340	2,812	3,265	2,974	2,512	4,765	4,089
LT	57	70	79	87	72	75	151	125
LU	23	28	30	36	36	32	49	39
LV	41	51	58	72	77	60	78	78
MK	3	5	9	11	4	4	14	6
NL	1,109	1,364	1,509	1,626	1,586	1,341	3,516	2,897
PL	445	523	578	628	612	546	898	784
PT	161	166	164	176	145	175	176	175
RO	279	372	453	556	393	353	667	429
RS	62	62	62	62	62	62	104	95
SE	25	33	43	47	46	36	86	76
SI	25	31	35	39	34	31	45	39
SK	129	186	226	245	220	181	302	260
UK	2,123	2,781	3,030	3,201	3,131	2,804	5,329	4,126
UA**	129	186	226	245	220	181	302	416
TR**	285	314	427	447	389	321	478	478
RU**	97	118	119	123	118	113	161	157

(*): Germany and France demand provided by balancing zone (DEg: market area GASPOOL, DEn: market area NCG, FRn: GRTgaz Nord, FRs: GRTgaz Sud and FRt: TIGF)

(**): Net exports to Turkey and Russia (Kaliningrad and Saint-Petersburg region)

Figure 10 – Demand and exports forecasts

Cold Winter demand deviation

	Cold winter Demand deviation from the reference case		Cold winter Demand deviation from the reference case		Cold winter Demand deviation from the reference case
AT	13%	*FI*	26%	*MK*	4%
BA	6%	*FR*	7%	*NL*	22%
BE	6%	*GR*	8%	*PL*	7%
BG	5%	*HR*	20%	*PT*	8%
CH	10%	*HU*	16%	*RO*	8%
CZ	10%	*IE*	4%	*RS*	6%
DE	11%	*IT*	7%	*SE*	12%
DK	42%	*LT*	5%	*SI*	9%
EE	6%	*LU*	6%	*SK*	14%
ES	21%	*LV*	17%	*UK*	10%

Figure 11 – Weather sensitivity of winter demand

Supply assumption (maximum per period)

GWh/d			DZ	LY	NO	RU	LNG
Winter period		MAX on whole Winter	1,094	208	3,773	4,246	1,995
		MAX per month	1,389	247	3,913	4,822	2,120
High demand	2-week Cold Spell	Week1	1,530	278	4,208	5,496	Same flow as for the cold winter
		Week2	1,530	278	4,208	5,496	2,120
	1-Day Design Case MAX		1,601	329	4,259	5,610	4,141

Figure 12 – Supply assumptions imports

GWh/d	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	1-day DC	2-week
NP	3,444	3,653	3,766	3,730	3,812	3,615	4,938	4,938

Figure 13 – Supply assumptions indigenous production

LNG Tank flexibility

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

LNG Tank Flexibility		*LNG Tank Flexibility*	
BE	35%	*LT*	3%
ES	41%	*NL*	35%
FRn	73%	*PL*	35%
FRs	63%	*PT*	35%
GR	35%	*SE*	35%
IT	15%	*SI*	35%
		UK	35%

Figure 14: LNG tank flexibility

Annex C – Definition of the Remaining Flexibility indicator

This indicator measures the resilience of a balancing zone (Zone) as the room before being no longer able to fulfil its demand without creating new demand curtailment in other countries. The value of the indicator is set as the possible increase in demand of the Zone before an infrastructure or supply limitation is reached somewhere in the European gas system.

The Remaining Flexibility of the Zone Z is calculated as follows (steps 2 and 3 are repeated independently for each Zone):

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

The Remaining Flexibility of the considered Zone is defined as 100% minus the percentage of disruption of the additional demand.

The higher the value, the better the resilience is. A zero value would indicate that the Zone is not able to fulfil an additional demand and a 100% value will indicate it is possible to supply a demand multiplied by a factor two.
The approach enables the consideration of possible infrastructure or supply constraints beyond the entry into the Zone.

Winter Review 2015/2016

Executive Summary

ENTSOG has completed the review of the European gas supply and demand picture for Winter 2015/16 (October to March). The Seasonal Reviews aim at a deeper comprehension of the development of the demand and supply in the previous seasons and the identification of trends that cannot be captured at national or regional level. They also help to build experience and a solid background for the assumptions considered in the Winter Outlook. Such knowledge is also factored in the recurrent TYNDP process in order to ensure consistence and continuous improvement of ENTSOG reports, and will be factored in the ongoing R&D plan.

- **Seasonal gas demand in Europe was 0.4% higher (+12 TWh) than the previous winter. Peak day consumption increased by 7% (+1,611 GWh/d)**
- **UGS working gas volume utilisation was lowest after 2013/2014 of the last six winters**
- **The share of National production in the European supply decreased from 31% to 26% (-70 TWh)**
- **The share of Russian gas in the European supply increased from 26% to 32% (+191 TWh)**

Detailed data for the cross-border flows are available on the Transparency Platform[11].

Stakeholders' comments on this seasonal analysis are welcome and would enable ENTSOG to improve its knowledge of seasonal and market dynamics influencing the use of infrastructures. Comments would serve as a basis for the R&D plan and are beneficial for the quality of further reports.

[11] Transparency Platform: https://transparency.entsog.eu/

1. Introduction

This review, as part of the ENTSOG Annual Work Program 2015, is published on a voluntary basis and aims at providing an overview of the demand and supply balance during Winter 2015/16. The report brings transparency on the internal analysis carried out by ENTSOG for the purpose of developing the seasonal Supply Outlooks and the Union-wide TYNDP, as well as for the ongoing R&D plan.

The report aims to provide an overview of European trends that could not be captured at national level and to build experience for future reports. This report should not be seen as a direct review of previous Seasonal Outlooks.

Regarding European dynamics, the report highlights the wide heterogeneity of national demand profiles and supply sources. These differences are linked among others to physical rationales such as climate, demand breakdown or producing field flexibility for example.

Overview

The following section highlights specific disruption and market events which occurred during the period between October 2015 and March 2016.

Disruption events

Some occurrences on the European gas market caused fluctuations in the supply and demand balance, the major ones were:

October

- NO: small outages due to planned Norwegian field maintenance.

November/December

- NO/UK: unplanned outages on both the Norwegian and UK Continental Shelves.

January/February

- NL: partial withdrawal outages at Bergermeer.

March

- DZ: flows of Algerian gas through MEG/GME pipeline to Tarifa dropped almost 80% for maintenance.
- UK: cuts in Britain's Rough gas storage site under essential maintenance.
- NO: unplanned outage hits Norway’s Sleipner area.

Market events

Some general gas related topics and information came up or were noticeable, major ones were:

NOVEMBER

- The Netherlands limited the production of the Groningen gas field for the 2015/16 gas year to 27 Bcm (from previous 33 Bcm/y cap), but could be raised again on cold weather situations.

DECEMBER

- Spot prices close 2015 with an overall decreasing trend on weak demand, mild temperatures and oil bearish sentiment.

JANUARY

- European gas demand boosted on one week cold snap in mid-January.

FEBRUARY

- Record gas deliveries to Europe from Russia (9.2 Bcm) and Norway (9.7 Bcm).
- Russian flows are much higher year on year, first two months, as low oil prices keep Russian gas competitive through the long-term oil-indexed gas contracts.

MARCH

- The JKM LNG spot price followed a decreasing trend dropping down to $7/MMbtu for March delivery, the lowest price on record since June 2009, deepest level seen during the prior years to the Fukushima disaster on March 11, 2011.

2. Gas Prices and quantities at European hubs

The following graphs show the evolution of gas prices in Europe during the winter 2015/16:

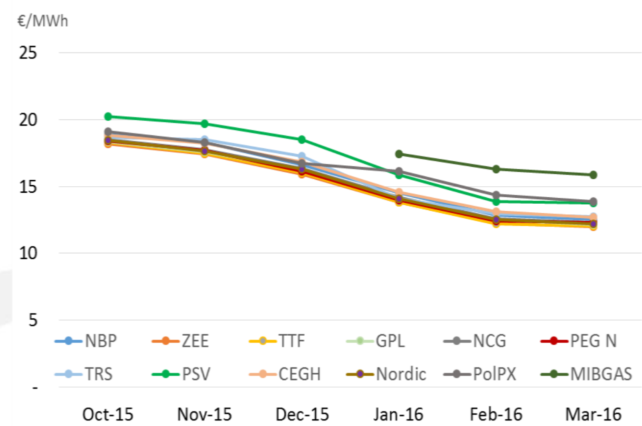


Figure 1 – Month-ahead average prices at European hubs in €/MWh.

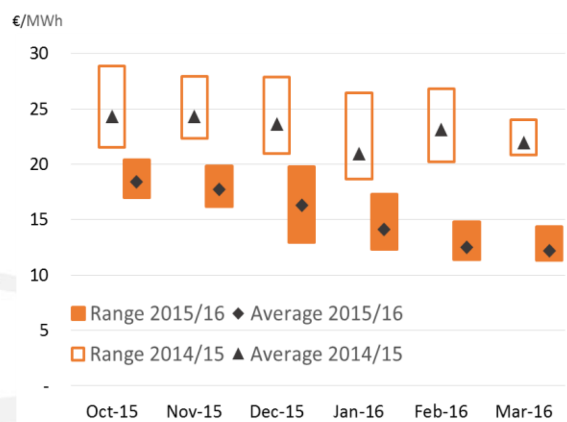


Figure 2 – Ranges and averages of the month-ahead hub prices at European hubs in €/MWh

Figure 1 shows the evolution of the month-ahead winter average prices at different European gas hubs and figure 2 shows the maximum range and average of the month-ahead winter price for the last two winters over all the European hubs (source Bloomberg).
The MIBGAS spot market trading sessions started on December 16th 2015 (data source: MIBGAS website).

The average price over all hubs was lower and continuously decreasing than seen in the previous winter when it was more stable between 20 and 25 €/MWh. The maximum price range was lower than in winter 2014/2015. As the previous winter review already covered, price convergence between the different European hubs continued with the exception of the Italian PSV and the Polish PolPX prices, which were a bit above the other hubs. Nevertheless, all European hubs showed generally a similar downward trend, meaning that the hubs basically reacted in the same direction when facing gas-related events.

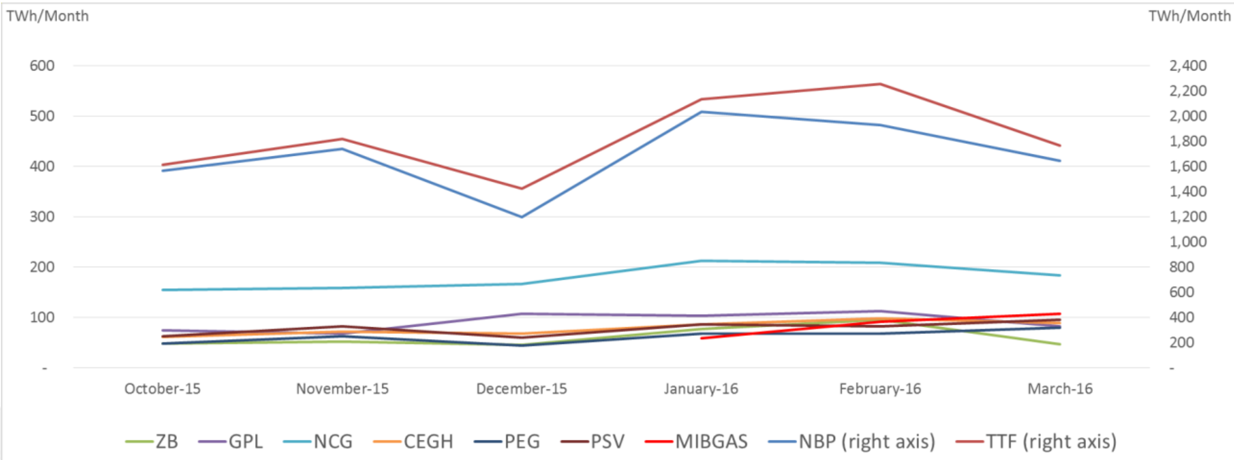


Figure 3 – Total traded quantities at European gas hubs in TWh/month[12].

Figure 3 shows the evolution of the total traded quantities at the different European gas hubs seen in winter 2015/16 (source Platts and MIBGAS). In terms of trading quantities, the highest level has been reached at the TTF at around 2,300 TWh on February 2016, and NBP has reached 2,200 TWh in January 2016. Except for those two hubs, maximum traded quantities were still far behind and ranged between 75 TWh for the PEGs and 213 TWh for the NCG hub. Only NBP and TTF hubs showed a quite big fluctuation in trading quantities throughout all the winter period.

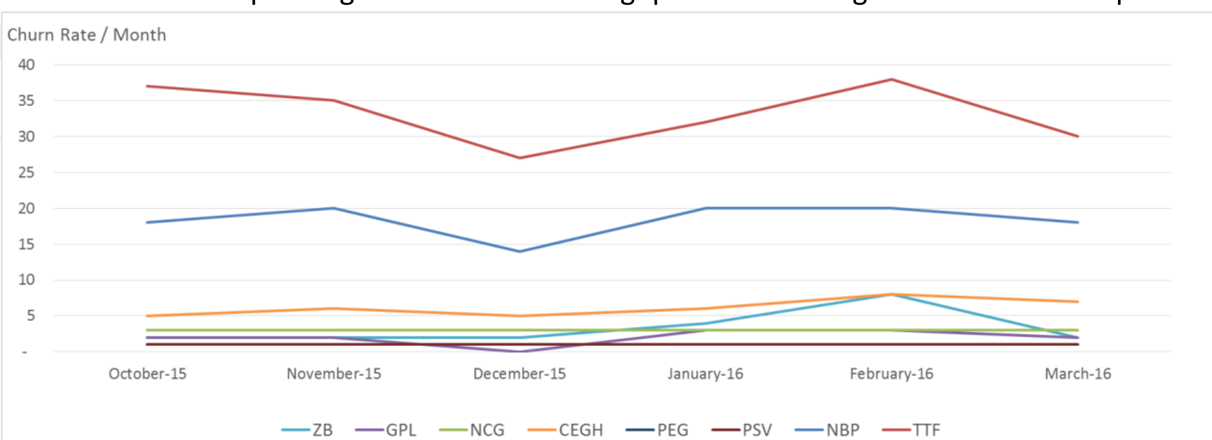


Figure 4 – Evolution of the churn rate per month for the different European gas hubs in the previous winter.

Figure 4 shows the evolution of the churn rate between the different European gas hubs for the previous winter[13]. As seen for the total traded volumes at the hubs, the spread between the NBP and TTF and the rest of the European gas hubs was relatively important implying more trading action at these two hubs.

[12] Total traded quantities means the sum of all energy units (here in the unit of TWh) which have been traded at a hub in the specific month regardless the underlying product.

[13] The churn rate is the ratio between traded volume and physical gas throughput at a gas hub.

3. Demand

3.1. European seasonal gas demand

The overall gas demand was very similar for winter 2015/16 (2,927 TWh) compared to winter 2014/15 (2,915 TWh). Temperatures for both winters 2014/15 and 2015/16 were mild.

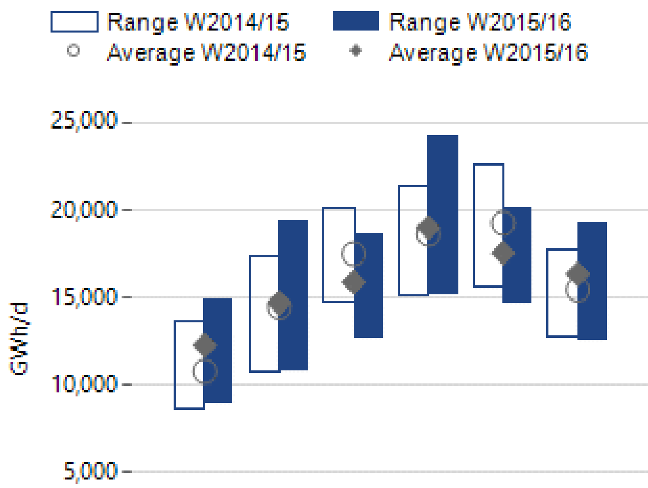


Figure 5 - Residential, Commercial and Industrial

Figures 6 and 7 show the demand range and average on a monthly basis when split into Residential, Commercial and Industrial or Power Generation sectors, for the countries where the demand breakdown is available. Residential, Commercial and Industrial sector represented 81% out of 2,008 TWh.

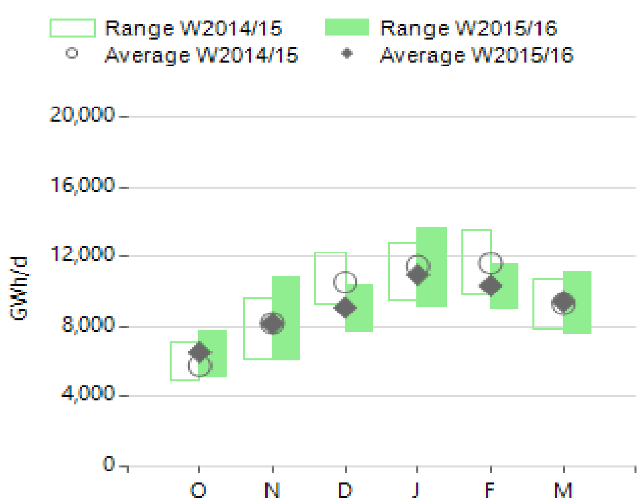


Figure 6 - Residential, Commercial and Industrial (*)

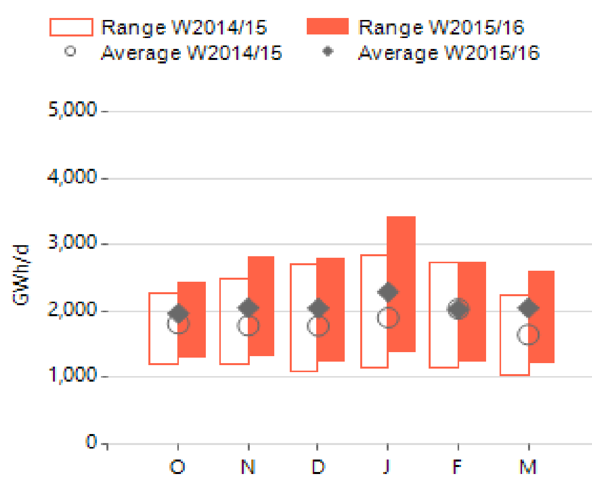


Figure 7 - Power Generation gas demand (*)

(*) These graphs refer to the countries for which demand breakdown is available (Belgium, Croatia, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom).

3.2. Electricity power generation from gas

No data are available for the whole winter 2015/2016 yet for the share of natural gas and coal in the electricity mix.

In Winter 2014/2015 and for the first time in the 5 previous winters, generation of electricity from Gas increased marginally, whereas Coal and Other sources reduced.
This is despite the reduction in Gas prices as Coal overall remained a more economical option.

Source: own elaboration based on data provided by ENTSO-E in 2015

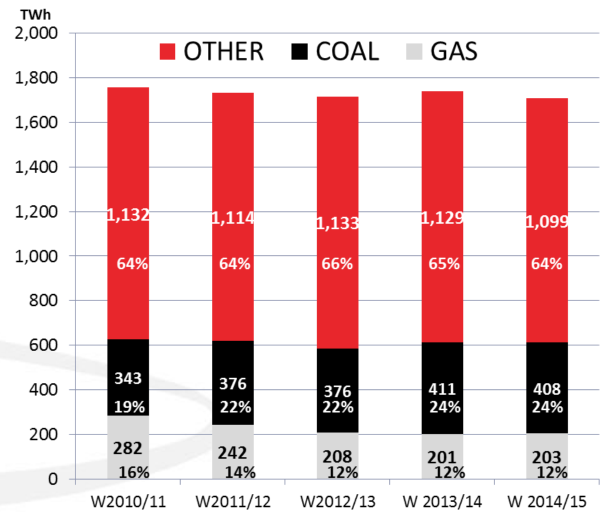


Figure 8 - Gas and coal in the electricity mix Winters 2010-15

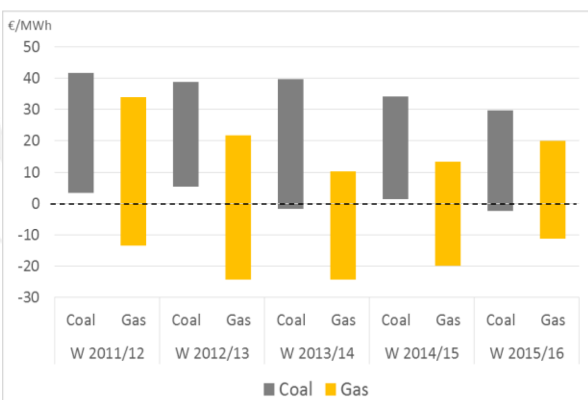


Figure 9 – Range of clean dark vs. clean spark spread over the season in €/MWh

Source: based on data provided by Bloomberg

Figure 9 shows the evolution of the minimum and maximum month ahead clean spark spread[14] (gas) and clean dark spread[15] (coal) of the previous winters[16]. Until 2014, market conditions for power generation from coal and gas were quite divergent, showing stable high maximums and minimum spreads at around zero for coal. In contrast, since 2014, both maximum and minimum spreads for gas showed an upward trend converging to the spread range of coal. Generally these spreads are driven by the respective input prices for gas and coal, the price of CO2 allowances and the power prices in the different countries.

[14] The clean spark spread is the difference between the price received by a generator for electricity produced and the cost of the natural gas needed to produce that electricity, including any carbon costs
*Clean Spark Spread = Price of Electricity - [(Price of Gas) * (Heat Rate)] – Carbon Price*

[15] The clean dark spread follows the same methodology as the clean spark spread but applies to coal rather than gas

[16] This graph represents data for the countries Germany, United Kingdom, the Netherlands, Italy, Spain, France and Czech Republic. Even though there are European countries missing, it could generally give information on the European market conditions for power generation from coal and gas seen in the previous winters. Data retrieved from Bloomberg.

No data are available for the whole winter 2015/2016 yet for the the electricity generation mix. In absolute terms, the electricity produced from gas was 203 TWh in Winter 2014/15, representing 12% of the generation mix. As shown in the graphs below, the share of fossil fuels in the power generation dropped to 39%, a reduction of 1% compared to the previous winter. The composition of the fossil fuel generation remained largely similar in percentage terms. Non fossil fuels also saw variations from the previous year, with reductions from Hydro (-2%), Nuclear (-1%) and increases from Wind (+1%) and Other (+1%).

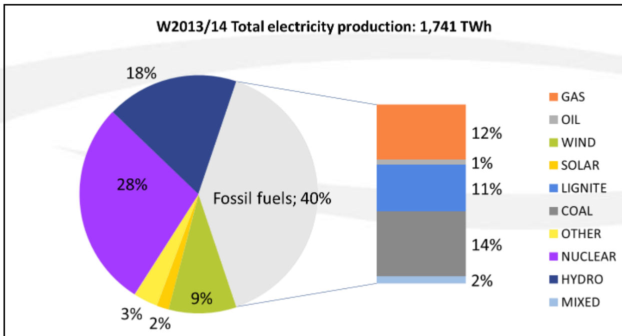


Figure 10 - Winter 2014/15 Electricity generation mix

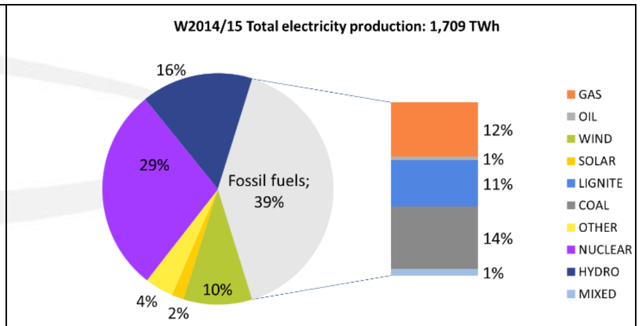


Figure 11 - Winter 2011/15 Electricity generation mix

Source: own elaboration based on data provided by ENTSO-E in 2015.

3.3. Winter demand evolution 2009-2015

The demand for the winter 2015-2016 was very similar than for the winter 2015-15. As for 2014-2015, it was statistically a warm winter.

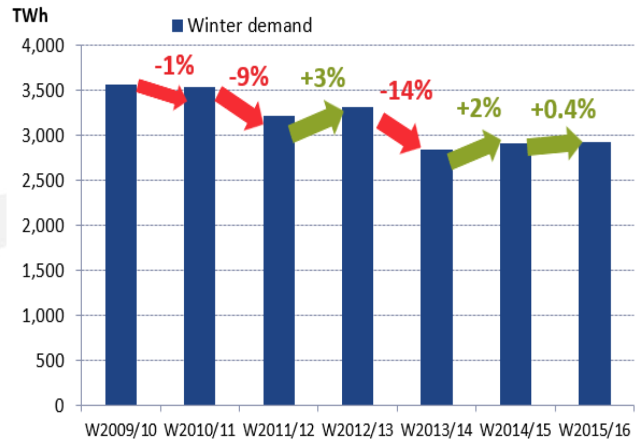


Figure 12 - Total consumption Winter 2009-16

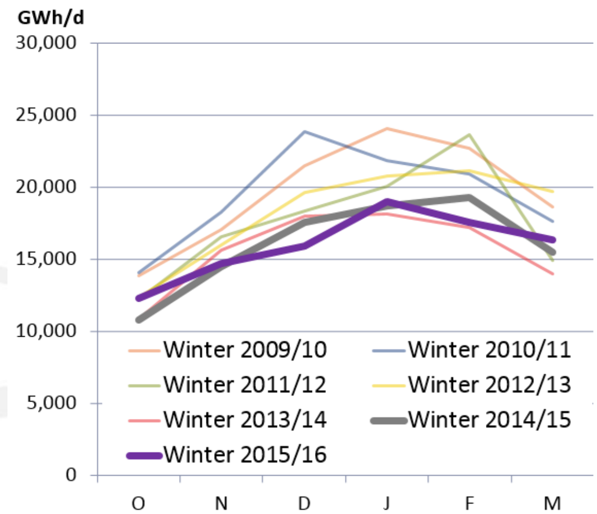


Figure 13 - Demand. Monthly average. Winter 2009-16

As shown below, by sector - for the countries where the demand breakdown is available - demand for power generation increased for the second time in a row in the last 5 winters.

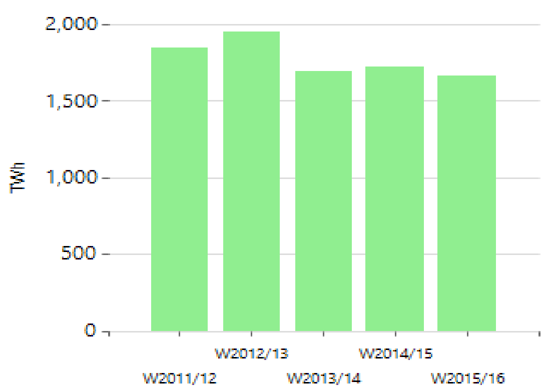


Figure 16c - Final Demand (BE, CH, DK, EE, ES, FI, FR, GR, HR, HU, IE, IT, LT, LU, NL, PT, SE, SI, SK, UK

Figure 14 - Residential, commercial and industrial consumption. Winter 2011-2016 (*)

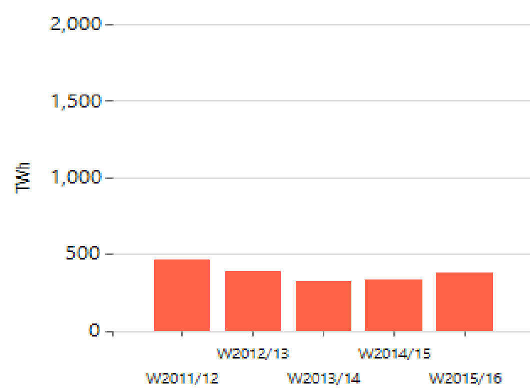


Figure 16d - Power Generation (BE, DK, EE, ES, FI, FR, GR, HR, HU, IE, IT, LT, LU, NL, PT, SE, SI, SK, UK

Figure 15 - Gas consumption for power generation. Winter 2011-2016 (*)

** These graphs use data from the countries for which demand breakdown is available (Belgium, Croatia, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom). In years and countries where the data breakdown has not been provided, then demand forms part of Residential, Commercial and Industrial.*

> **Country detail**

As for the winter 2014/15 there is a significant mix between countries with positive and negative variances. Winters 2015/16 and 2014/15 were similar, with mild temperatures.

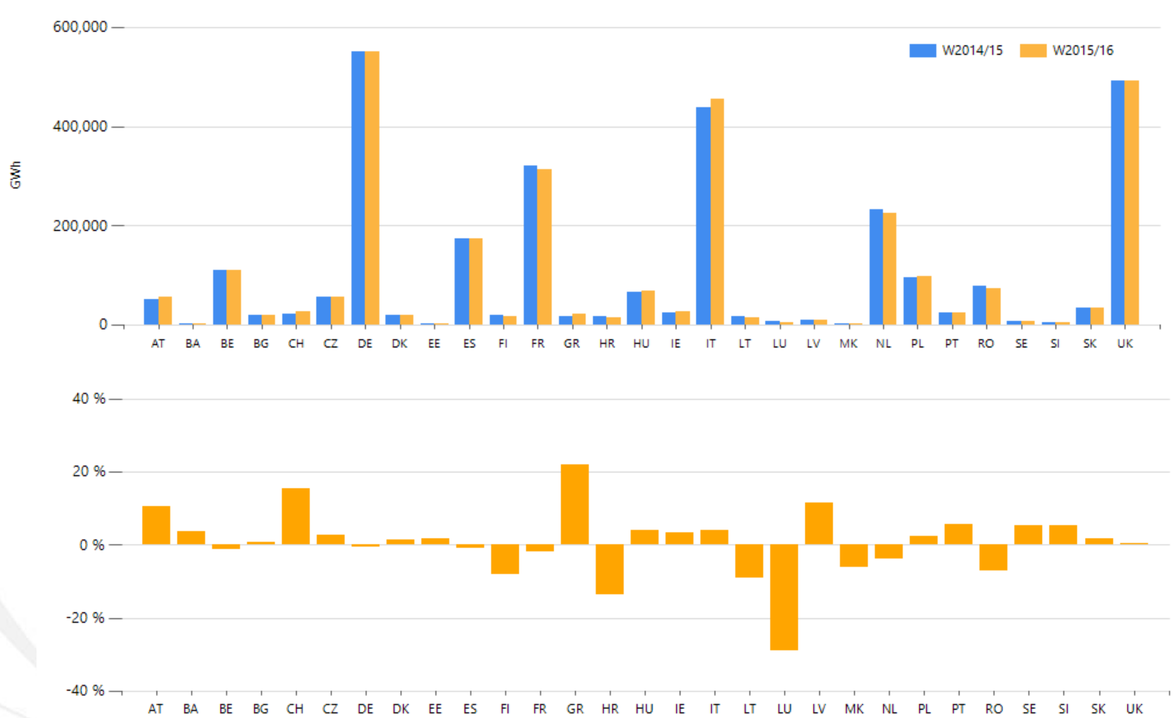


Figure 16 - Winter demand and variation winter 2015/16 Vs. winter 2014/2015, Country detail

3.4. Peak demand 2015/2016

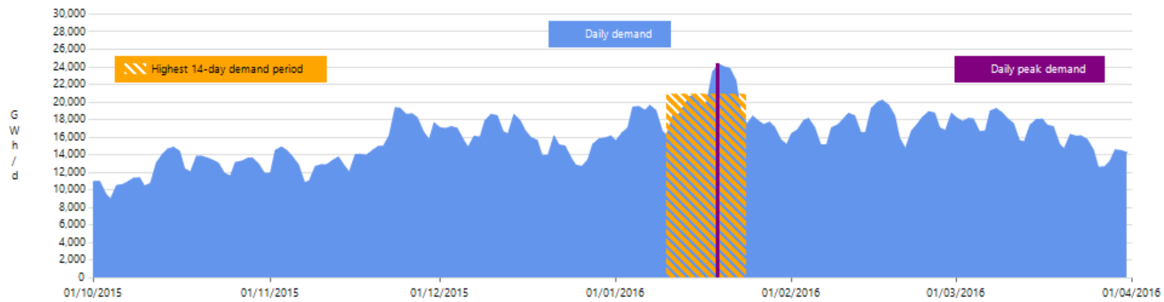


Figure 17 - Winter 2015/16 demand profile

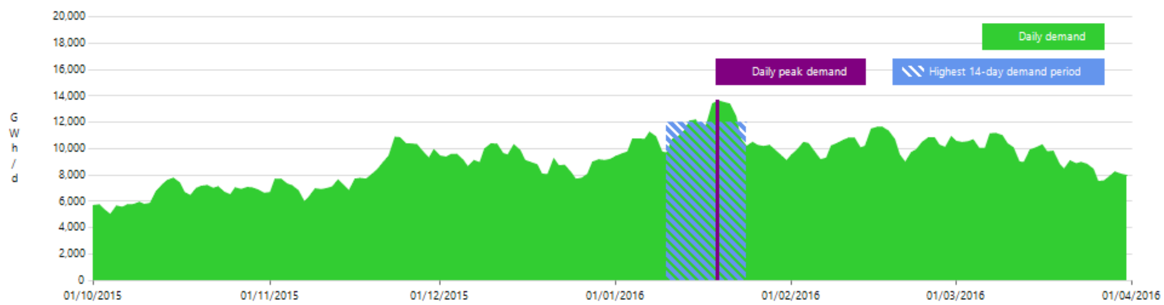


Figure 18 - Winter 2015/16 demand profile (Residential, commercial and Industrial) (*)

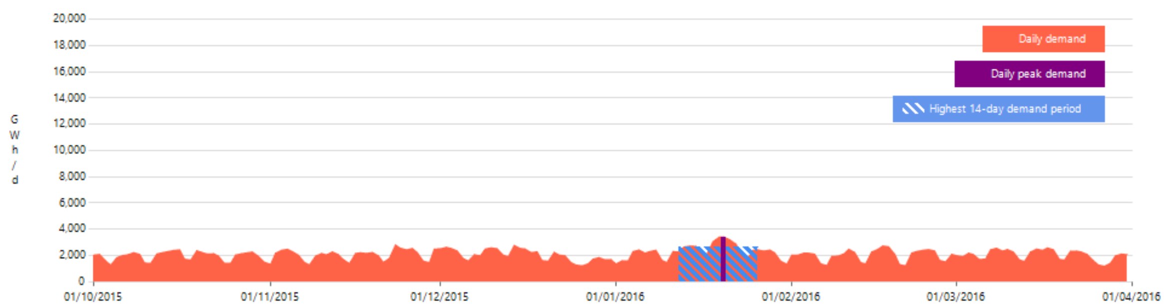


Figure 19 - Winter 2015/16 demand profile (Power generation) (*)

14-day Peak period	Jan. 11th to Jan. 24th 2015	**Peak day**	19/01/2016
Average 14-day consumption	20,837 GWh/d	**Peak consumption**	24,326 GWh/d

Peak demand was reached mid of January, in the heart of the 14-day peak period. The peak day as well as the 14-day for the residential, commercial & industrial and power generation consumption are coincident.

(*) These graphs refer to the countries for which demand breakdown is available (Belgium, Croatia, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom).

3.5. Peak demand evolution 2011-2016

Although the 14-days demand remained stable, the peak day demand increased by 7% compared to last year, but below the value of 2012/2013 (Peak 14-Day: 23.5 TWh/d, Peak: 25.8 TWh/d).

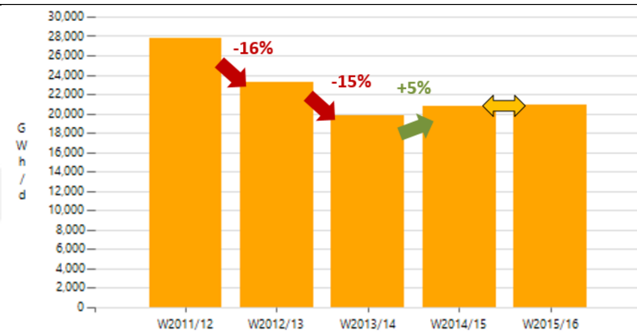


Figure 20 - Average daily demand for highest 14-day demand period. Winters 2011-2016

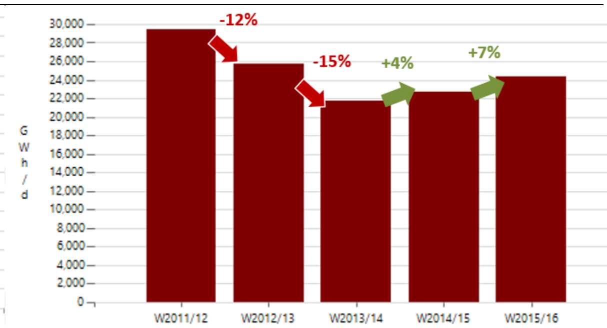


Figure 21 - Daily peak demand. Winters 2011-2016

The charts below show a comparison between the peak demand periods, the 14 day average and peak day, for the last two winters where a greater level of detail is available on the split between gas demand for Power Generation and for Residential, Commercial and Industrial.

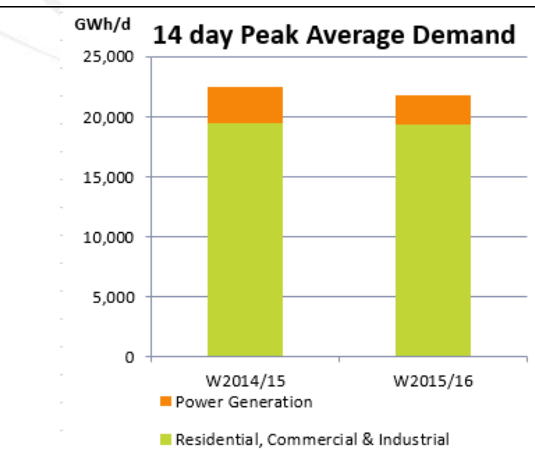


Figure 22 - Average daily demand for highest 14-day demand period split by type

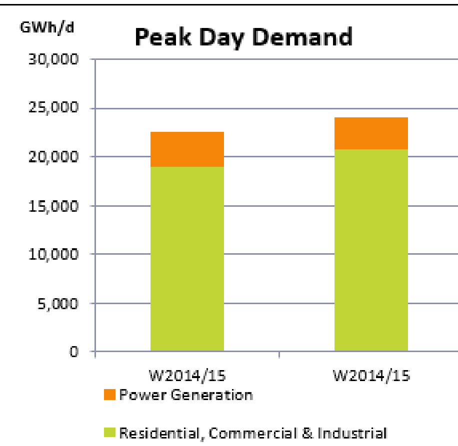


Figure 23 - Daily peak demand split by type

(*) These graphs refer to the countries for which demand breakdown is available (Belgium, Croatia, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom).

Seasonal modulation

The pattern followed by winter demand is strongly linked to the climatic conditions, like the presence of cold snaps or particularly mild conditions in one or several months along the winter. The graph below shows the deviation of the monthly average demand from the winter average for each of the last five winters.

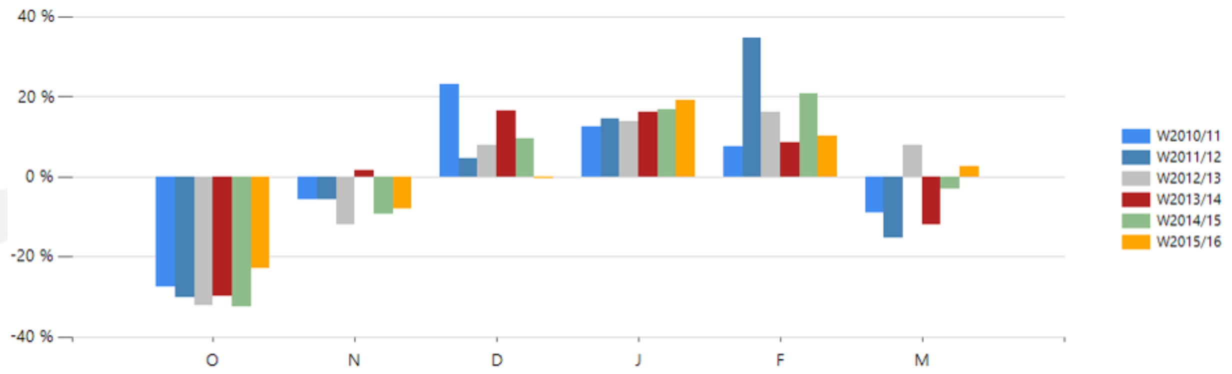


Figure 24 - Winter modulation 2011-2016

Figure 25 shows the monthly variation between the maximum and minimum daily demand. When comparing Winter 2015/16 with previous winters, the ranges seen are very narrow.

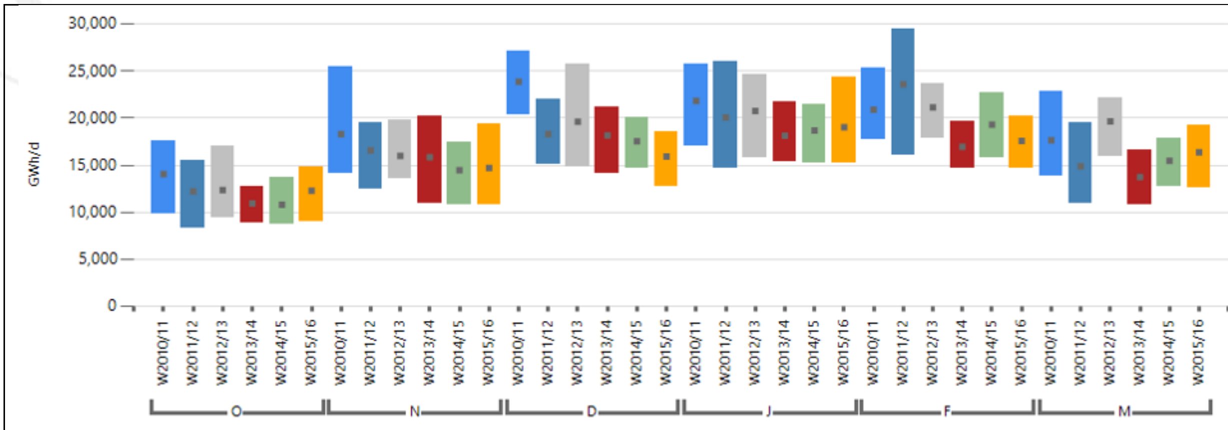


Figure 25 - Monthly demand ranges

> Country detail

While the seasonal demand was stable across Europe in Winter 2015/16, several countries experienced a variation over 15% in the peak consumption: Estonia +58%, Finland +29%, Luxemburg -21% and Poland +16%.

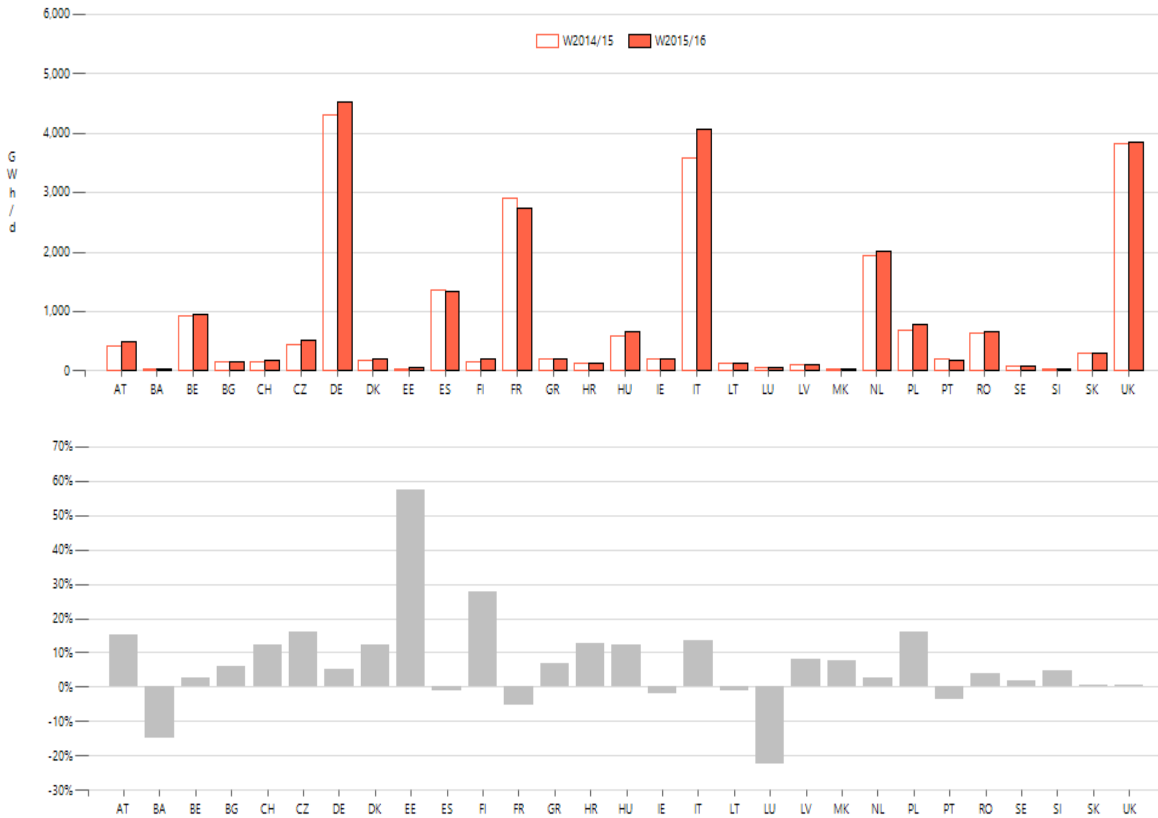


Figure 26 - Daily peak demand and variation 2015/16 Vs. 2014/15

As shown in Figure 27, several countries saw an increase of the 14-day peak demand compared to last winter, however decreases were seen in France, Germany, and Spain which comprise a large share of the total European demand.

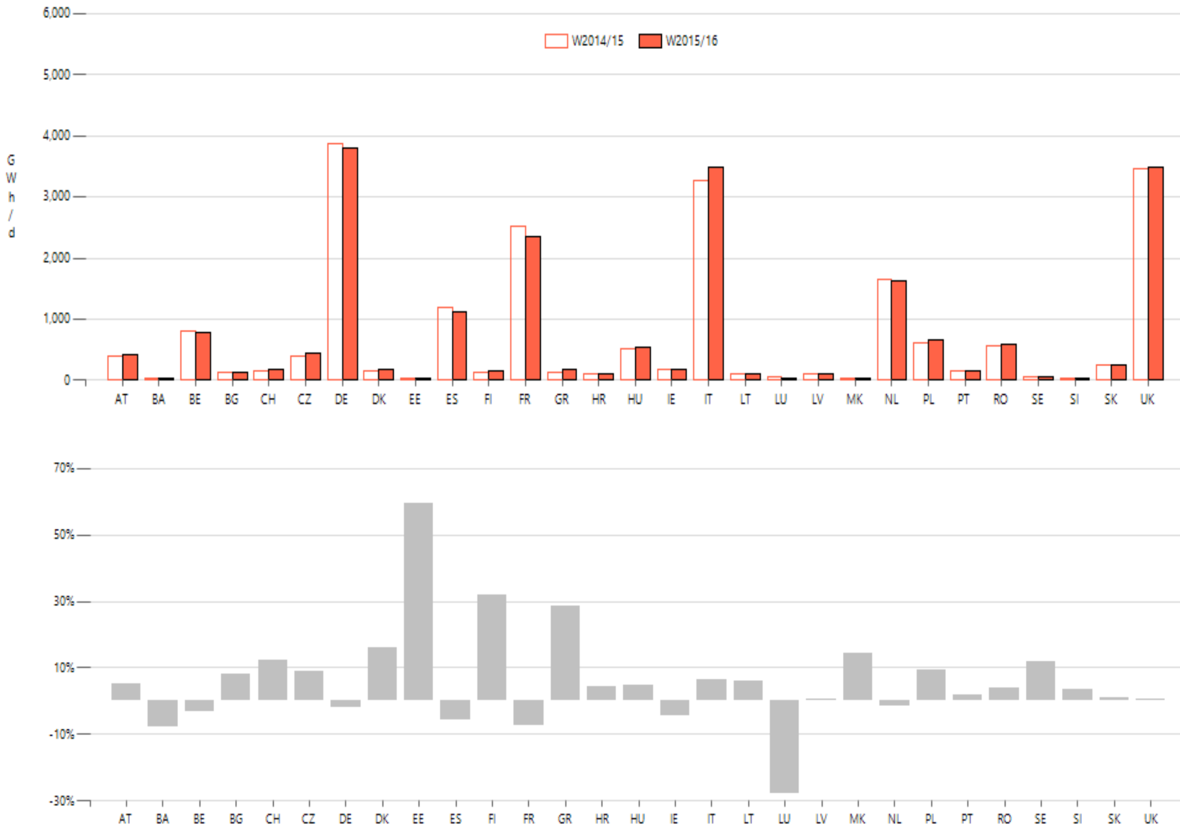


Figure 27 - Highest 14-day demand and variation 2015/16 Vs. 2014/15

The following graph shows the minimum, maximum and average daily demand during Winter 2015/16, as well as the daily maximum and minimum of the last 6 winters per countries:

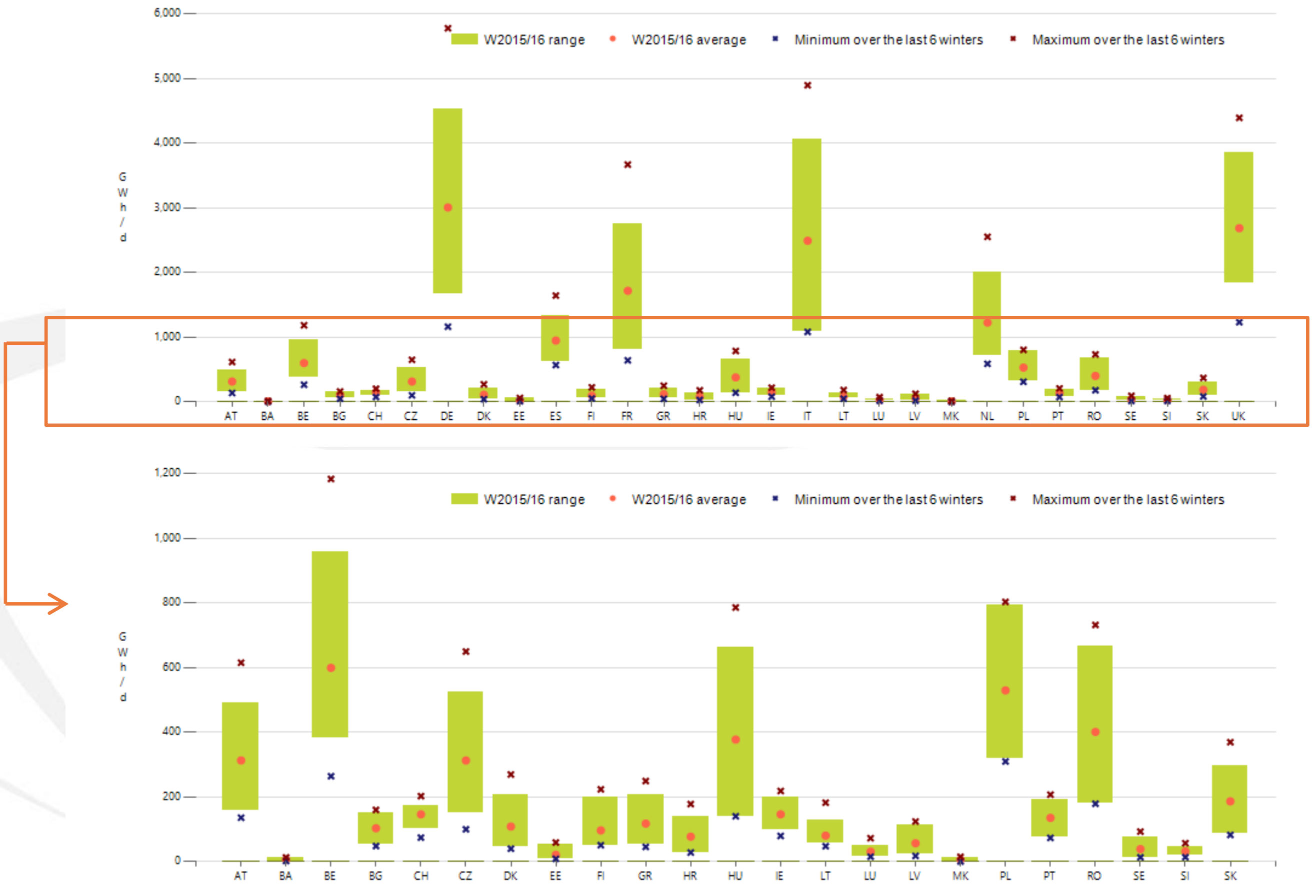


Figure 28 - Winter maximum and minimum

> Simultaneity

In order to measure the simultaneity between the peak days in different countries, the "Unsimultaneous Peak" is described as the sum of the peak day demands of the individual countries having occurred un-simultaneously, defining:

- The European peak simultaneity (EPS)
  - EPS = European Peak Demand / Un-simultaneous Peak (%)
- The simultaneity of an individual country in the European peak day (CPS)
  - CPS = Country demand on the European peak day/Country peak demand (%)

So defined, the European peak simultaneity during the peak day on 19 January 2016, was 98%, a value slightly above the average of 95% seen over the previous 5 winters.

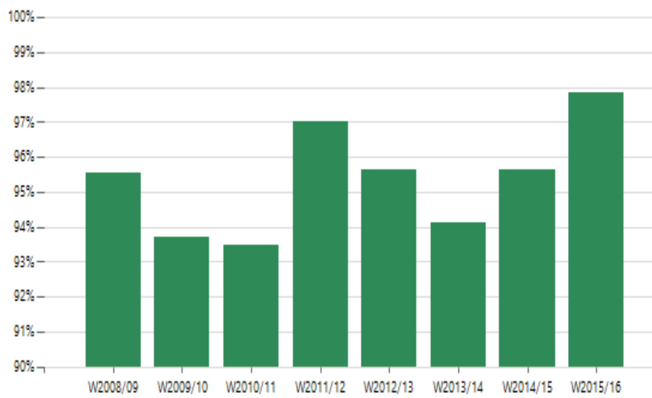


Figure 29 - European peak simultaneity

Winter	Day	Peak Demand (GWh/d)	EU Peak Simultaneity (%)
W2008/09	09/01/2009	25,863	96%
W2009/10	26/01/2010	27,431	94%
W2010/11	17/12/2010	27,091	93%
W2011/12	07/02/2012	29,452	97%
W2012/13	12/12/2012	25,772	96%
W2013/14	30/01/2014	21,769	94%
W2014/15	05/02/2015	22,715	96%
W2015/16	19/01/2016	24,326	98%

Table 1 - 2009-2016: Peak demands and their simultaneity

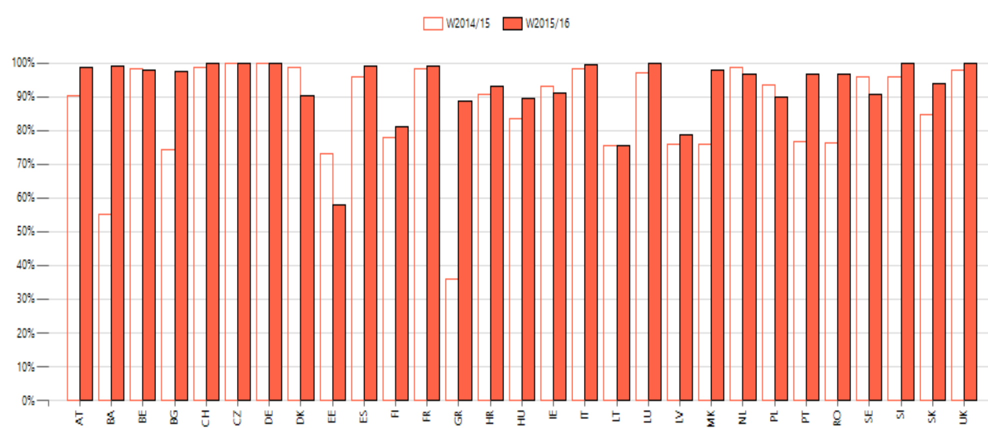


Figure 30 - Simultaneity of the highest single day between last 2 winters

Figure 30 - Simultaneity of the highest single day between last 2 winters

4. Supply

4.1. European seasonal gas supply

The graph below shows the evolution of the aggregated gas supply in Europe during winter 2015/16.

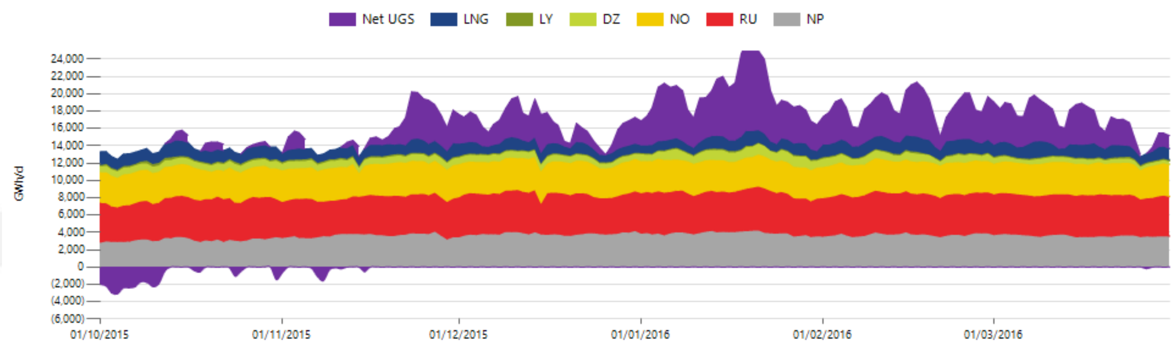


Figure 31 - Winter 2015/16 supply profile

The next graphs give an overview of Imports and National production supply shares during Winters 2014/15 and 2015/16 in both absolute and relative terms. **Total winter supply: 2,594 TWh**

Figure 32 shows the seasonal supplies by source for the last two winters in absolute figures.

The average increase of total gas supply was 7%, but it was not homogeneous between the different supply sources.

There were significant reductions from National production (-10%).

This was countered by the increase in Algerian (30%), Norwegian (4%), and Russian (32%) imports.

However, the most significant decrease in the use of supply sources was UGS (-28%), to compare with the 29% increase of winter 2014/2015.

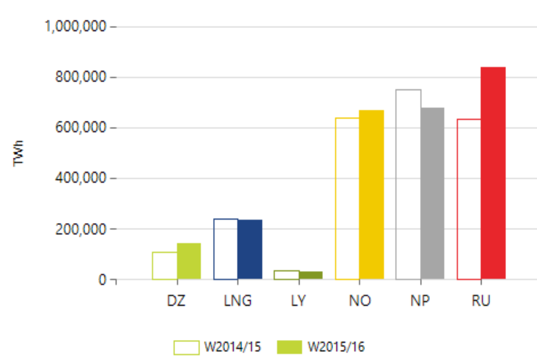


Figure 32 - Seasonal supply

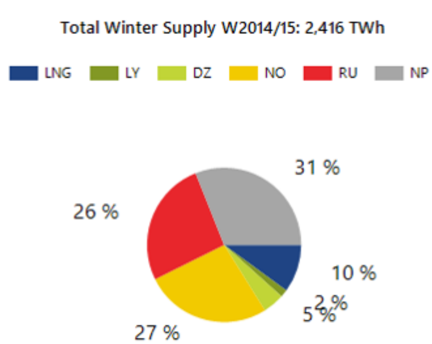


Figure 33 - Supply shares. Winter 2014/15

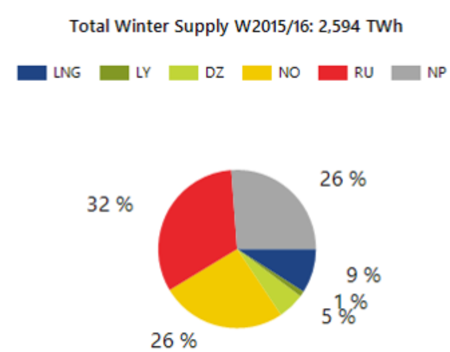


Figure 34 - Supply shares. Winter 2015/16

4.2. Supply Modulation

The following graphs illustrate for national production and each import supply source per month, the average flow and the monthly and seasonal range (between the lowest and highest daily flow of each month and for the whole winter).

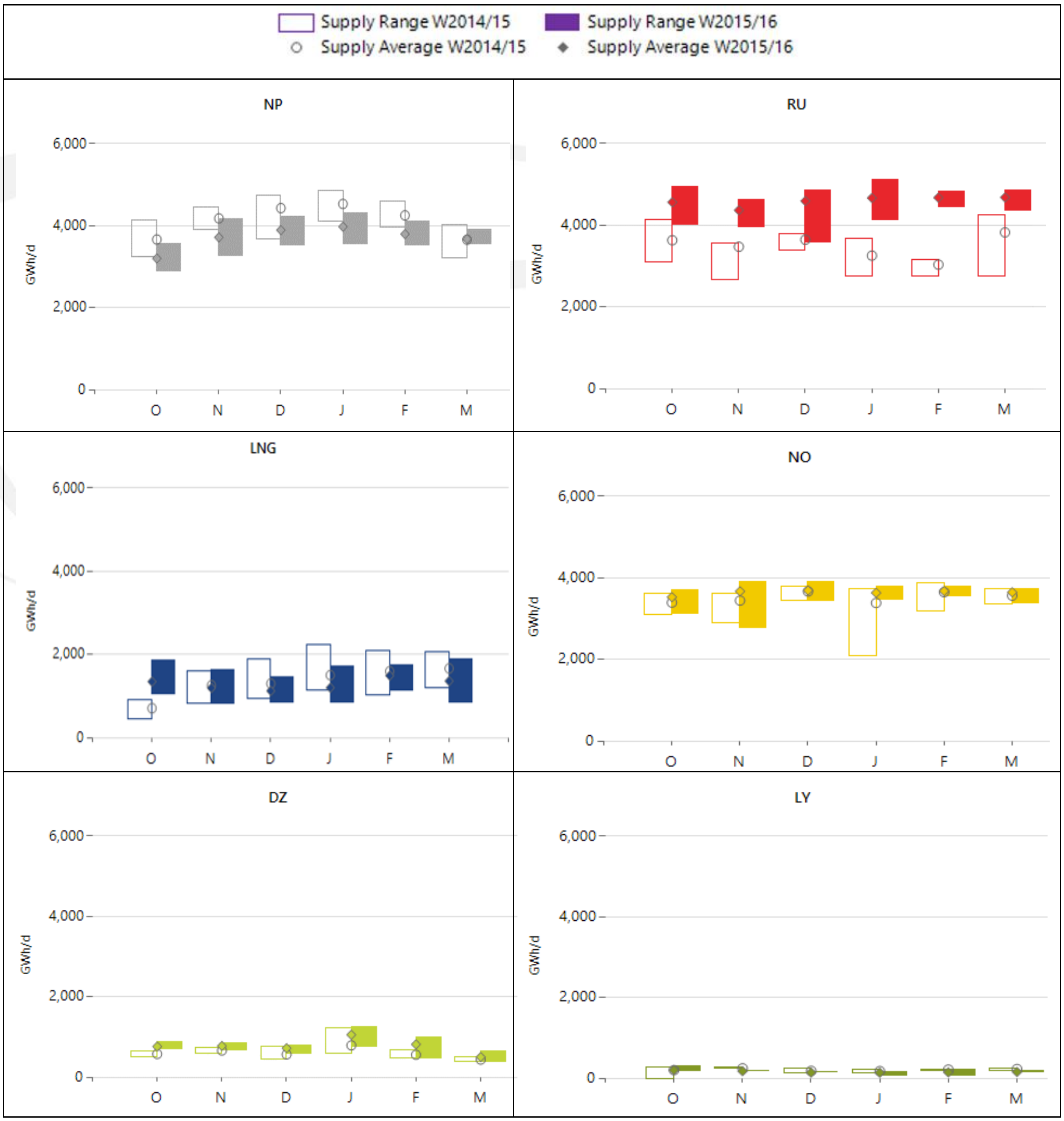


Figure 35- Supply modulation

4.3. Underground Storages

The utilisation of the Underground storages depends on many factors, linked to price signals such as summer-winter spread or climatic and economic considerations having impact on gas demand. As previously mentioned in this report, the high use of UGS this winter despite low overall demand has been driven by its use as an alternative to other supply sources that saw reductions from the previous winter. This was facilitated by the high stock level, although it is comparable to previous winters.

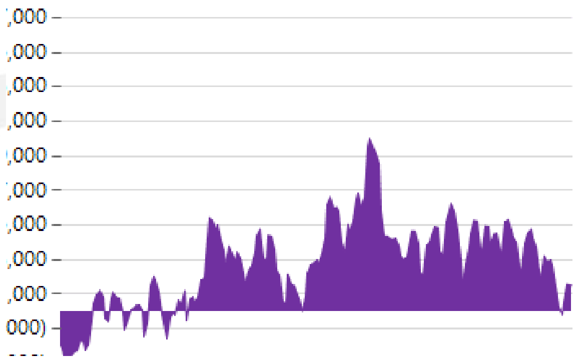


Figure 36 - UGS injection/withdraw profile.

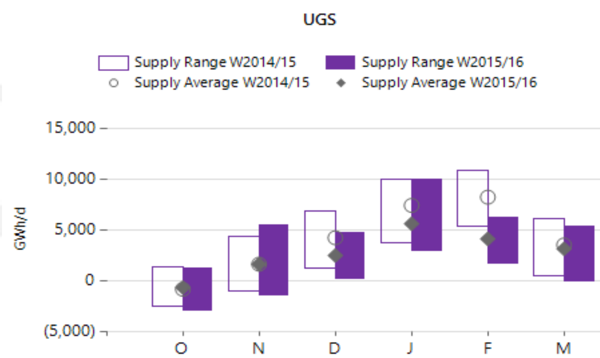


Figure 37 – UGS Withdrawal and Injection during Winter 2014-15 and 2015-2016

The peak deliverability of UGS was 10,426 GWh/d, a 15% decrease from the previous year, with a similarly mild winter.

Figure 38 compares the stock level evolution curve of the last 5 winters.

The stock level for the winter 15/16 started from a low level (82%). Despite this, the injection period was short and the maximum stock level (84%) was reached on October 12th, and by the end of the winter, the stock level was 36%, as a consequence of a warm winter.

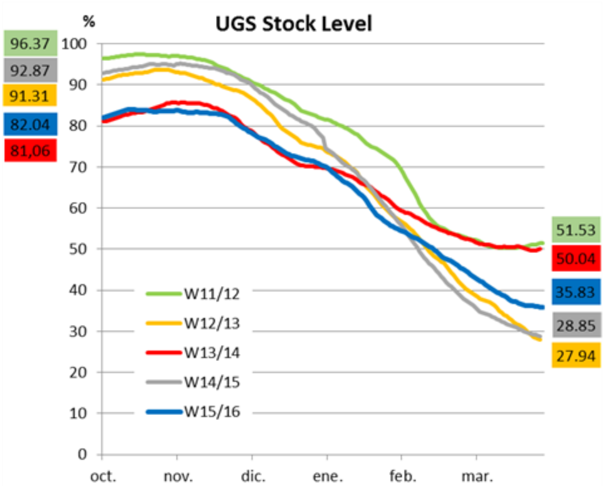


Figure 38 - Evolution of stock level. Winters 2010-2015 (Source AGSI)

Winter	UGS Utilization (% WGV)
W11/12	47
W12/13	66
W13/14	36
W14/15	66
W15/16	48

Table 2 - UGS winter use (Source AGSI)

The UGS utilisation was lower than for the previous winter (48% Vs 66%), but higher than 2013/14.

4.4. Supply coverage of high daily demands

Due to the different ability of the different supply sources to increase or decrease the supply levels in response to demand, the supply mix varies significantly depending on the demand level. The following graphs compare the supply level of the different sources under different demand conditions. It shows that underground storages are the main source of flexibility in high demand situations.

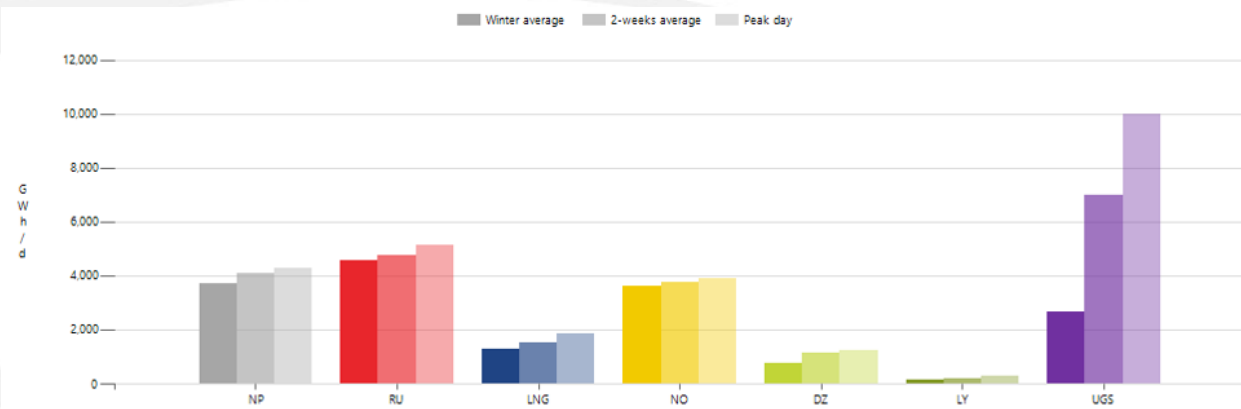


Figure 39 – Winter 2015/16 daily average supply / Average daily supply for highest 14-day demand period / Daily supply for the daily peak demand

4.5. Winter supply evolution 2011-2016

The following graphs show the evolution of the different supply sources both in absolute and relative terms during the last 5 winters.

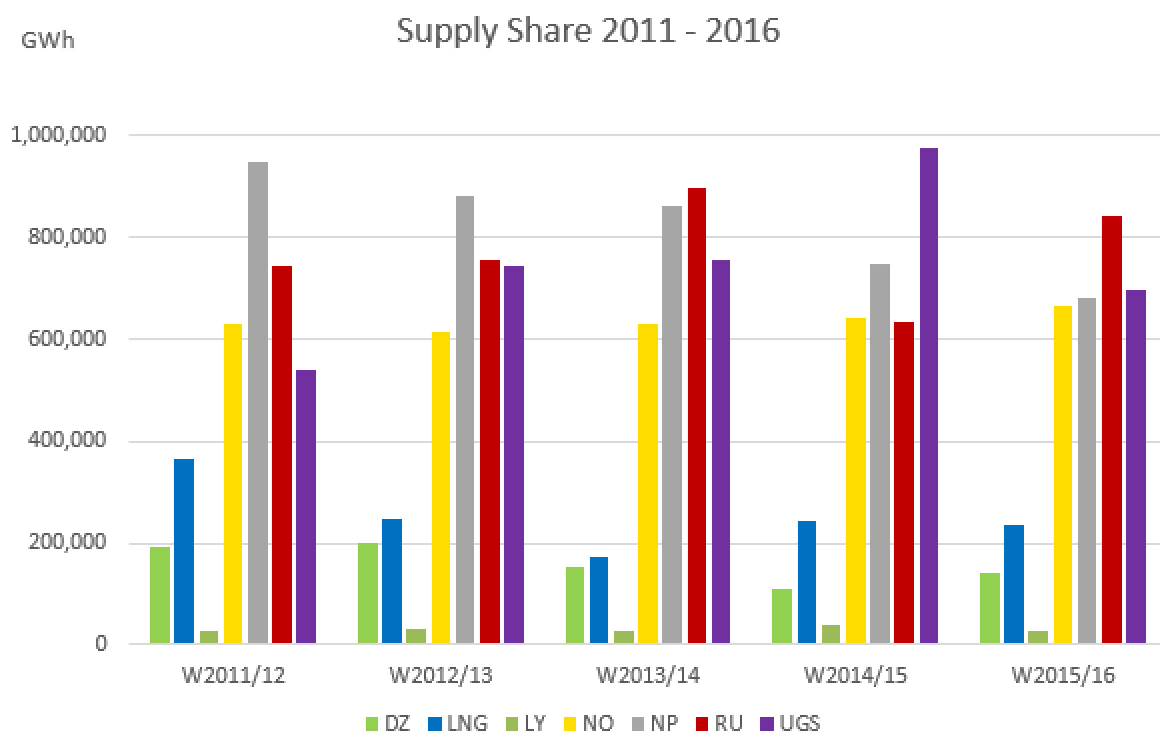


Figure 43 - Evolution of winter gas supplies 2011-16.