2017/2018

winter outlook

summer review 2017

29 November 2017

entsoe

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1 Executive Summary

The assessment at the pan-European level of electricity security of supply points out some risks for the upcoming winter in case of cold spells and low availability of the generation fleet.

There is no risk to Europe's security of supply to be expected under normal conditions. Under severe conditions, margins are expected to be tight in Great Britain, France, Belgium, Poland and Italy, but the risk of not having enough generation capacity to cover demand is contained in probability.

In case of over-generation (high variable renewable generation and low demand), there may be some curtailment needed in Ireland and in some bidding zones in the southern part of Italy.

Stress tests

Lessons have been learnt from last year's winter; 'stress tests' have been carried out as part of the present Winter Outlook.

Instead of considering situations that only happen in 1 year out of 10, the Winter Outlook 2017/2018 looks at worst-case situations that could occur in 1 year out of 20. Furthermore, ENTSO-E has analysed the risks associated with these extreme situations taking place simultaneously in all of Europe.

Added to these stress tests, the Winter Outlook 2017/2018 contains a qualitative analysis on the risk assumptions made by each transmission system operator (TSO), on risks associated with multiple outages and on risks linked to hydro reservoir levels.

Focus on hydro reservoirs

The hydro reservoir levels in Europe are generally back to historical average, except in Italy and Spain, where the levels are close to the historical minimum values. In France and Switzerland, after dropping to historical low values at the beginning of the year due to the cold spell, the hydro reservoir levels have recovered near to average values. In Austria, the October 2017 level is higher than the historical average after reaching the lowest situation last winter.

The Winter Outlook also analyses the trend in evolution of the generation sources in Europe. In 2017, there has been a continuous decommissioning of thermal power plants, which has been partly compensated by new commissioned renewable generation.

2 Introduction

2.1 Purpose of the Seasonal Outlooks

ENTSO-E and its member TSOs analyse potential risks to system adequacy for the whole ENTSO-E area, which covers 36 countries including Turkey.[1] The report also covers Kosovo*,[2] Malta, and Burshtyn Island in Ukraine, as they are synchronously connected with the electrical system of continental Europe. The data concerning Kosovo* are integrated with the data on Serbia.

System adequacy is the ability for a power system to meet demand at all times and thus to guarantee the security of the supply. The ENTSO-E system adequacy forecasts present the views of the TSOs on not only the risks to the security of supply, but also the counter-measures they plan, either individually or by cooperation.

Analyses are performed twice a year to have a good view regarding the summer and winter, the seasons in which weather conditions can be extreme and strain the system. ENTSO-E thus publishes its Summer Outlook before 1 June and its Winter Outlook before 1 December. ENTSO-E also publishes an annual mid-term adequacy forecast (MAF) that examines the system adequacy for the next 10 years.

Each outlook is accompanied by a review of what happened during the previous season. The review is based on qualitative information by TSOs to present the most important events that occurred during the past period and compare them to the forecasts and risks reported in the previous Seasonal Outlook. Important or unusual events or conditions of the power system as well as the remedial actions taken by the TSOs are also mentioned. The Summer Outlooks are thus released with Winter Reviews and the Winter Outlooks with Summer Reviews. This allows for a check of the past report analysis by the actual events with respect to system adequacy.

The outlooks are performed based on the data collected from TSOs and using a common methodology. Moreover, ENTSO-E uses a common database in its assessment, the Pan-European Climate Database (PECD), to determine the levels of solar and wind generation at a specific date and time. ENTSO-E analyses the effect on system adequacy of climate

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[1] TEIAS, the Turkish transmission system operator, is an ENTSO-E observer member.

[2] The designation Kosovo* is without prejudice to positions on status and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

conditions, evolution of demand, demand management, evolution of generation capacities, and planned and forced outages.

Furthermore, in the Seasonal Outlook, an assessment of 'downward regulation'[3] issues is performed. Downward regulation is a technical term used when analysing the influence on the security of a power system when there is excess generation. Such excess typically occurs when the wind is blowing at night, but demand is low, or when the wind and sun generation is high, but demand is comparatively low, such as on a sunny Sunday.

The Seasonal Outlook analyses are performed first at the country level and then at the pan-European level, examining how neighbouring countries can contribute to the power balance of a power system under strain. Additional probabilistic analyses are performed for countries where a system adequacy risk has been identified.

The calculations for this Winter Outlook were performed for each week between 29 November 2017 and 1 April 2018. The Summer Review examines the system adequacy issues registered between 31 May 2017 and 1 October 2017.

The aim of publishing this forecast is two-fold:

- To gather information from each TSO and share it within the community. This enables neighbouring TSOs to consider actions to support a system that may be at risk. Moreover, all TSOs share with one another the remedial actions they intend to take within their control areas. This information sharing contributes to increased security of supply and encourages cross-border cooperation.
- To inform stakeholders of potential risks to system adequacy. The goal is to raise awareness and incentivise stakeholders to adapt their actions towards reduction of those risks by, for instance, reviewing the maintenance schedules of power plants, the postponement of decommissioning and other risk preparedness actions.

If, after the final edition for publication of this Seasonal Outlook, an unexpected event takes place in Europe with a potential effect on the system adequacy, ENTSO-E cannot redo the whole modelling exercise or publish a full, updated version of the Outlook. Analyses considering all the latest events are performed on a weekly basis by the short- and medium-term adequacy (SMTA) experimentation, which is a setup between TSOs and regional security coordinators (RSCs). This experimentation aims to check and update short- and

[3] Assessment of potential generation excess under minimum demand conditions, cf. Appendix 2:

medium-term active power adequacy analyses in line with agreed ENTSO-E methodologies for time frames shorter than those of seasonal outlooks.

ENTSO-E's seasonal outlooks are one of the association's legal mandates under Article 8 of EC Regulation no. 714/2009.

2.2 The European Generation Landscape

Pan-European generation capacity study reveals consistent results of renewable generation capacity expansion compared to previous seasons. At the same time, phase-out of conventional power plants is observed. Although gas generation capacity decrease has been recorded compared to last Winter Season, gas generation capacity in two seasons (Winter 2015/2016 to Winter 2017/2018) has increased by approximately 3 GW.

The specific installed capacity of renewable generation capacity cannot replace the equivalent capacity of dispatchable generation one-to-one: wind or solar produce at a certain period only, and they are not always correlated to the consumption needs. Therefore, the risks of adequacy tensions may appear more often in the future.

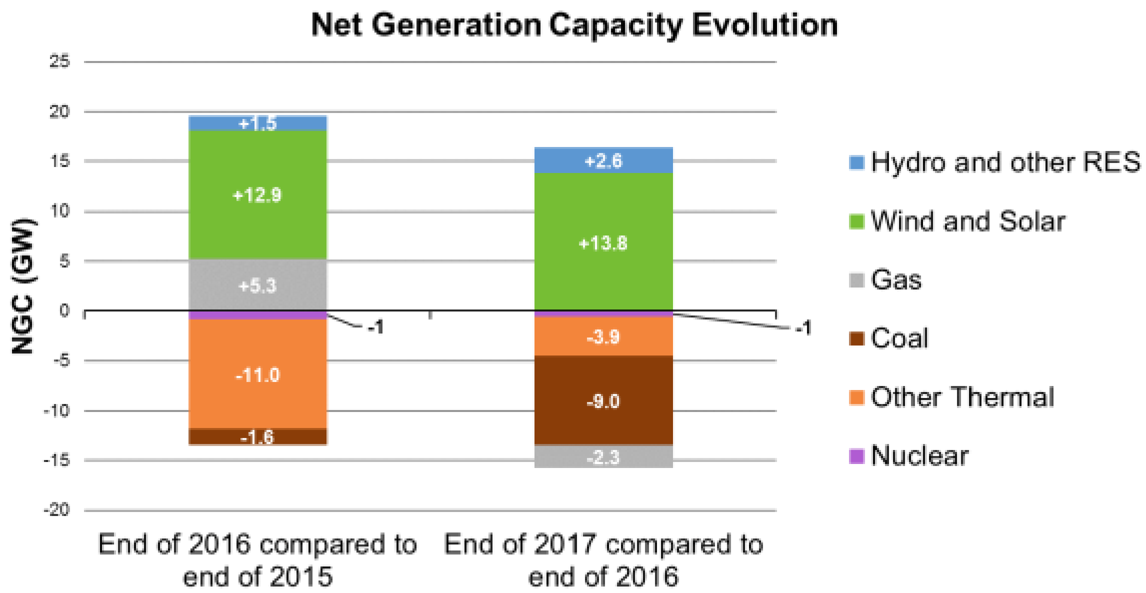


Figure 1: Evolution of net generating capacity per technology.

In the map given in Figure 2, national net generation capacities are displayed as numerical values in GW. Given that absolute values are not comparable on a pan-European level, a ratio of national net generation capacity and expected highest demand (under normal conditions) in a respective country at a pan-European synchronous peak hour has been derived. Countries are coloured according to this ratio; countries with a higher ratio appear in darker colour shades.

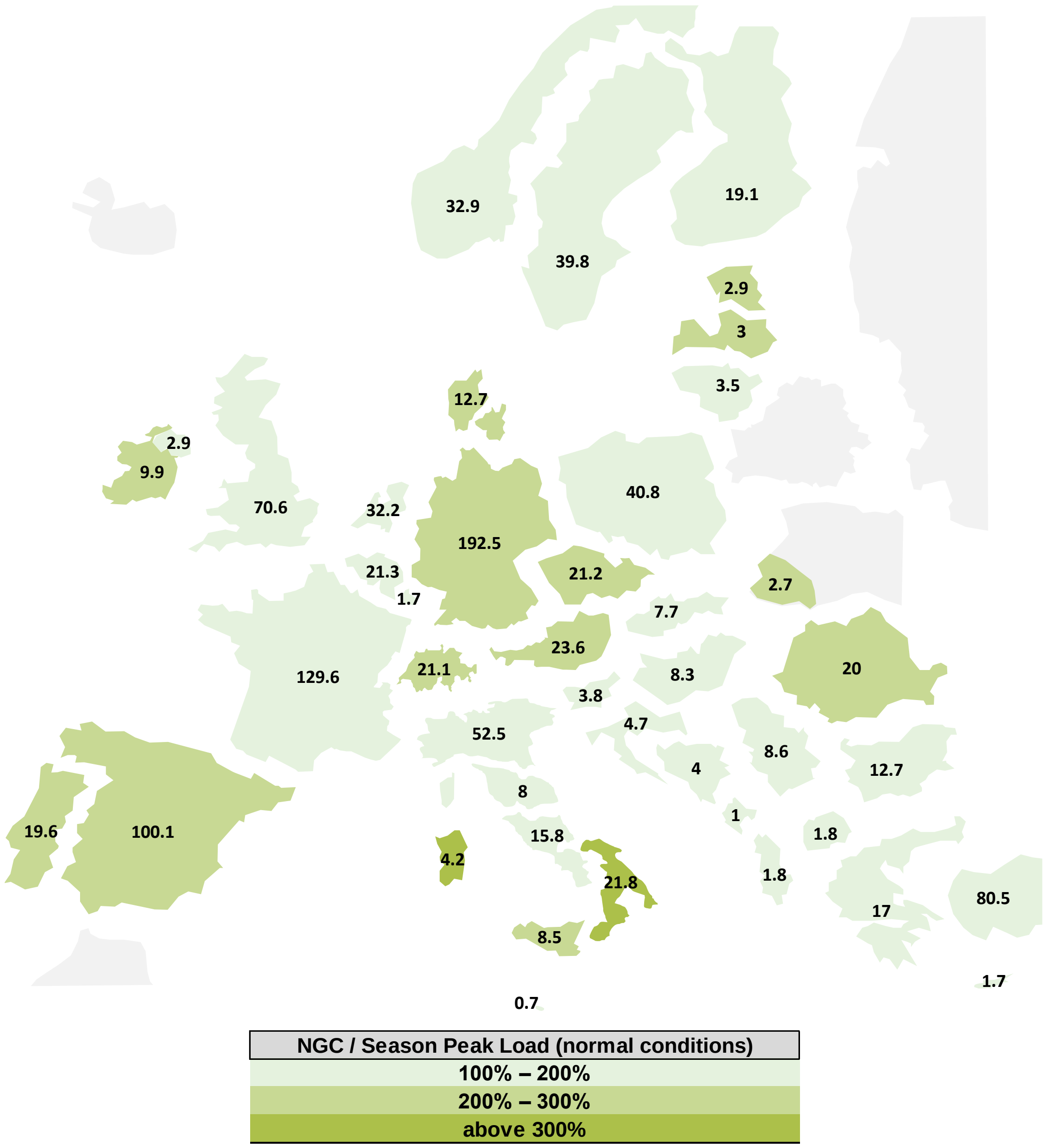


Figure 2: National net generating capacities (in GW) and its ratio to expected national peak load in the winter season.

3 Winter Outlook 2017/2018 – Upward Adequacy

In the Seasonal Outlooks, the term ‘adequacy’ means the ability of a system to cover its demand. The adequacy assessment consists in analysing the ability of available resources (generation, availability of imports and demand side response (DSR)) to meet the demand by calculating the ‘remaining capacity’ (RC) under normal conditions and severe conditions. Winter Outlooks also include another assessment for when there is an excess of generation (‘downward regulation’ cf. Appendix 2).

Following improvements in a previous seasonal outlook, Italy was modelled in six bidding zones—Northern (IT01), Central-Northern (IT02), Central-Southern (IT03), Southern (IT04), Sardinia (IT05) and Sicily (IT06)—in line with other adequacy studies.[4] This has been done to value achieved improvements for highest quality simulations and as a transitory step toward future simulations of pan-European system adequacy with all existing bidding zones (e.g. Sweden, Norway and Denmark).

An additional change compared to the last seasonal outlook is that strategic reserves (out of market generation capacity and demand side response (DSR)) are disregarded in simulations and only considered in sensitivity simulations found in Section 3.4.

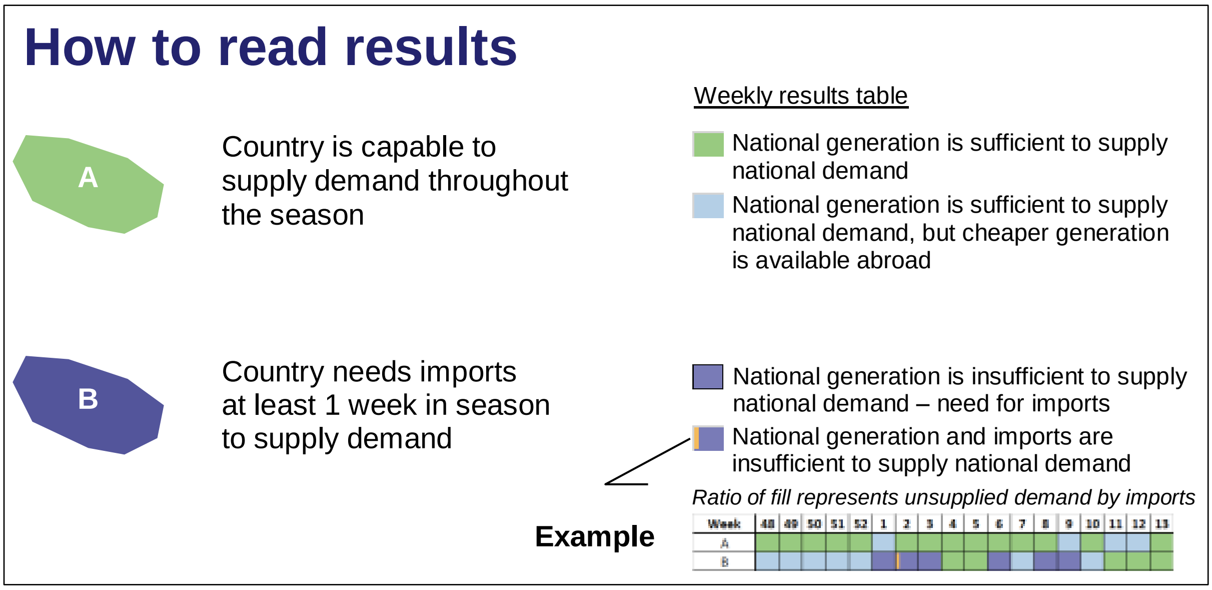
3.1 How to Read the Results

Results in figures displaying maps in Section 3 present reliably available generation capacity capability to supply peak load in the coming season under study (normal or severe condition). If reliably available capacity (RAC) in the country is sufficient to supply expected demand throughout whole season the country is coloured green. Otherwise the country is coloured purple (even if it faces issues only in one reference point of the study period).

Later in this outlook, there are tables displaying the results of simulations considering import and export capabilities on a weekly basis. The country cell in a specific week is coloured green if it has excess RAC to meet demand. Countries that are fully coloured purple can cover their deficit with imports in case of a lack of national resources. A partial orange fill has been used for countries that cannot fully cover their deficit by imports due to insufficient cross-border capacities or lack of resources in the power system. The portion of the cell that is coloured in orange reflects the portion of the deficit that cannot be covered with imports: the ratio of unsupplied demand after consideration of import potential to missing resources if the country were isolated.

[4] As in ENTSO-E MAF assessments.

In addition, a simplified merit-order approach[5] was considered. Countries in specific weeks that do not require imports from an adequacy perspective, but could import from a market perspective are coloured in light blue.



3.2 Adequacy Under Normal Conditions

As shown in Figure 3, generation capacities and available market-based DSR are sufficient to supply demand in all of Europe throughout the winter season under normal conditions, with only a few countries requiring import contribution.

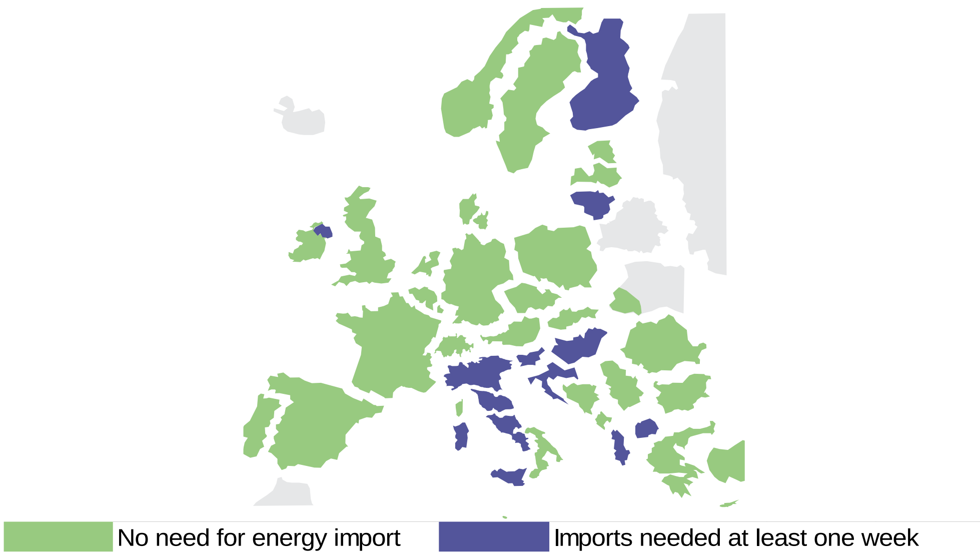
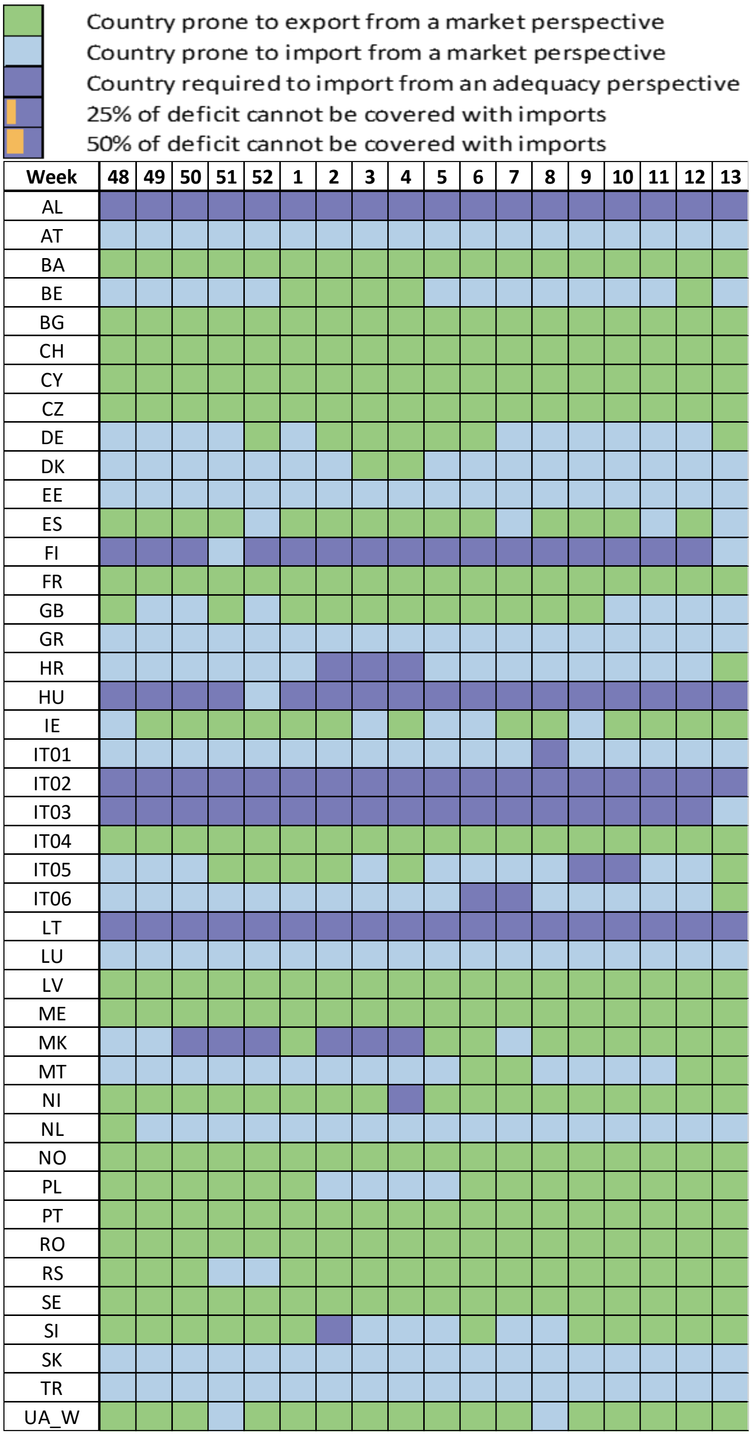


Figure 3: National adequacy under normal condition.

[5] The merit-order approach is only based on assumption (Appendix 2:). It may not represent real market situations.

Table 1 depicts weekly results displayed in weekly resolution, thus providing further insights. Some loaded periods can be identified for some countries in January 2018: the second week in Slovenia; the second to fourth weeks in Croatia; and the fourth week in Northern Ireland. At the same time, structural reliance on interconnection contribution could be identified in some other countries: Albania, Finland, Hungary, Italy (some parts) and Lithuania.

Table 1: Adequacy at synchronous peak time under normal conditions.



3.3 Adequacy Under Severe Conditions

Following the January 2017 cold wave and outcomes of its dedicated report,[6] ENTSO-E decided to investigate more severe situations starting with the current Winter Outlook. Firstly, all of Europe is assumed to undergo a 1 in 20 year cold wave simultaneously. Secondly, all of Europe is assumed to have overall very low wind conditions (Percentile P5, cf. Appendix 2:3.1). Hence, this Winter Outlook could be seen as a stress test for Europe's electricity grid and any comparison with past Seasonal Outlooks should be made in consideration of the aforementioned fundamental changes.

Figure 4 presents the results of the simulations for the system under severe conditions. It is observed that the results are comparatively different from the corresponding results under normal conditions. In particular, the combination of increasing demand and potential lower generation availability leads to more countries in need of importing to ensure adequacy.

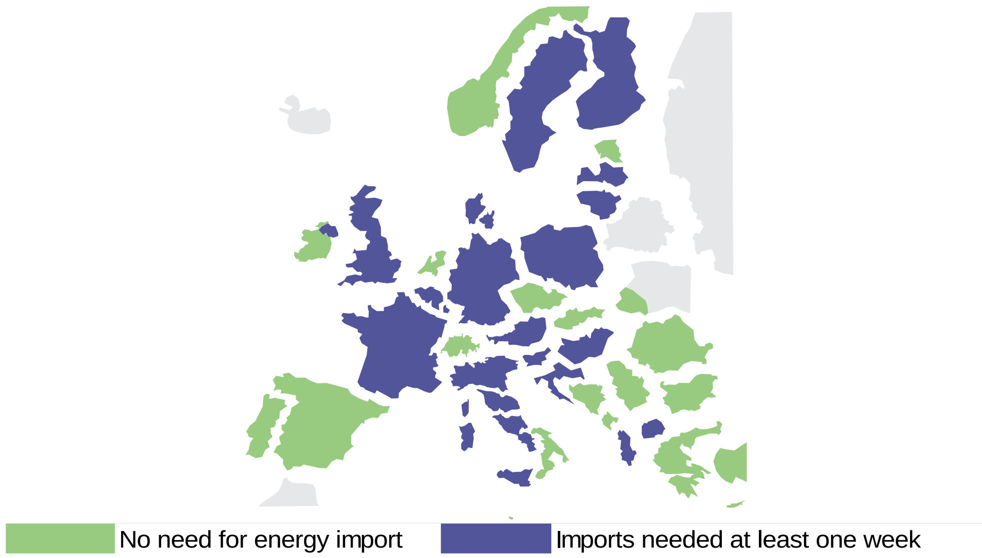
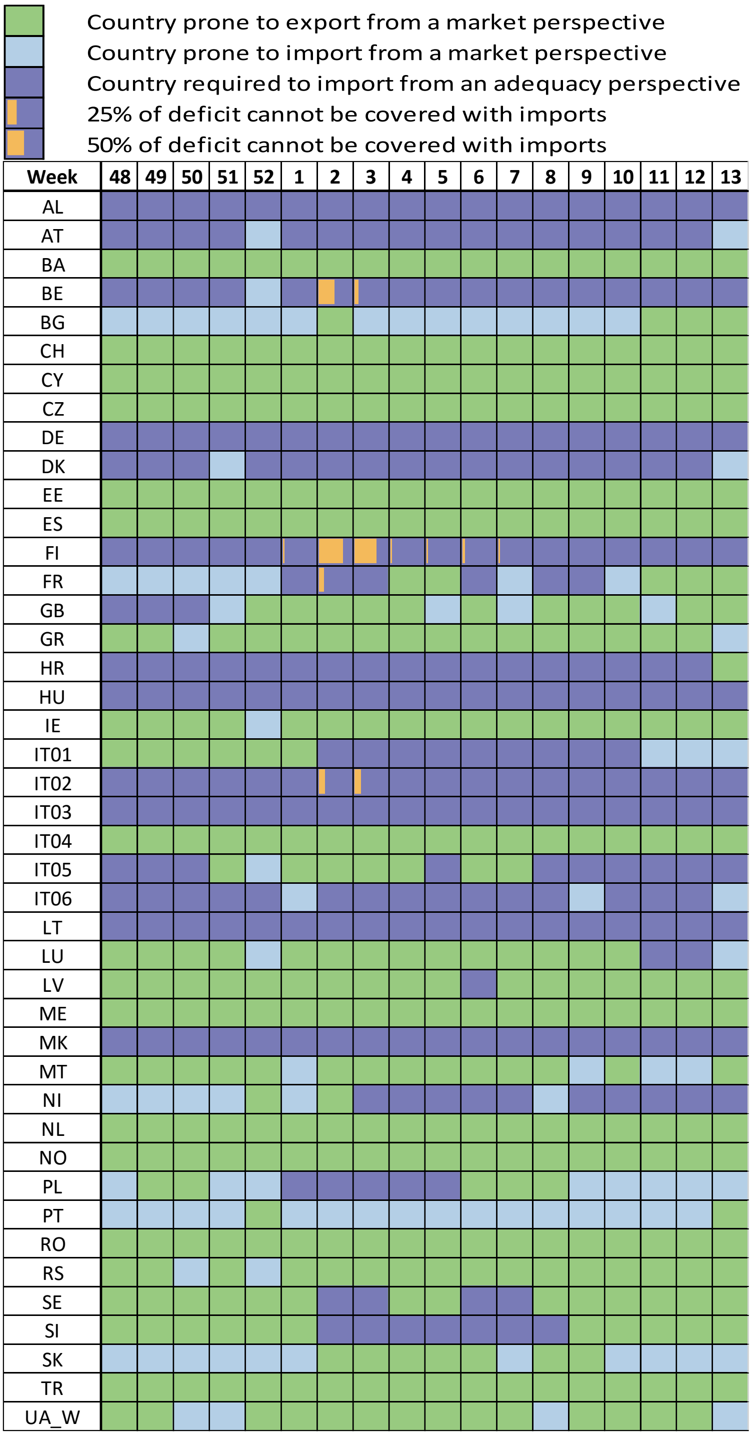


Figure 4: National adequacy under severe conditions.

Results on a weekly basis presented in Table 2 indicate that Belgium, Finland, France and Italy (Central-Northern) could face adequacy issues in weeks 2 and 3 in 2018. Regarding Finland, where weeks 1–7 are highlighted at risk. It has to be mentioned that the potential contribution of imports from Russia has been neglected in our simulations (the disregard of strategic reserves should also be kept in mind).

[6] Managing Critical Grid Situations – Success & Challenges

Table 2: Adequacy at synchronous peak time under severe conditions.



A more detailed analysis of the simulation results identifies that interconnectors between Spain, Ireland, Sardinia, Central-Southern Italy, Bosnia and Herzegovina, Serbia and Romania with the rest of Europe in weeks 2 and 3 are congested (cf. Figure 5[7]). Due to this, the available spare generation capacity and DSR from these regions and the regions

[7] A snapshot of week 2 results is given; the results of week 3 are analogous

connected to them are inaccessible for the rest of Europe. The total reliably available resources inside the isolated region are insufficient to supply the total demand of this region. This finding suggests that the results presented in Table 2 are only one of many possible solutions to the optimization problem, which means that the adequacy issue could be distributed in a different way inside of this large isolated region or possibly shared between countries based on the solidarity principle (respecting interconnection constraints).

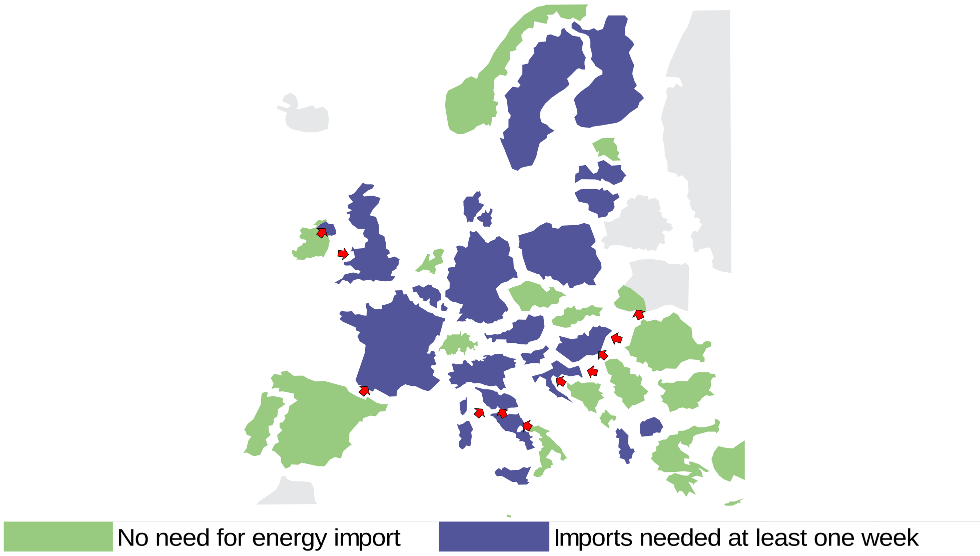


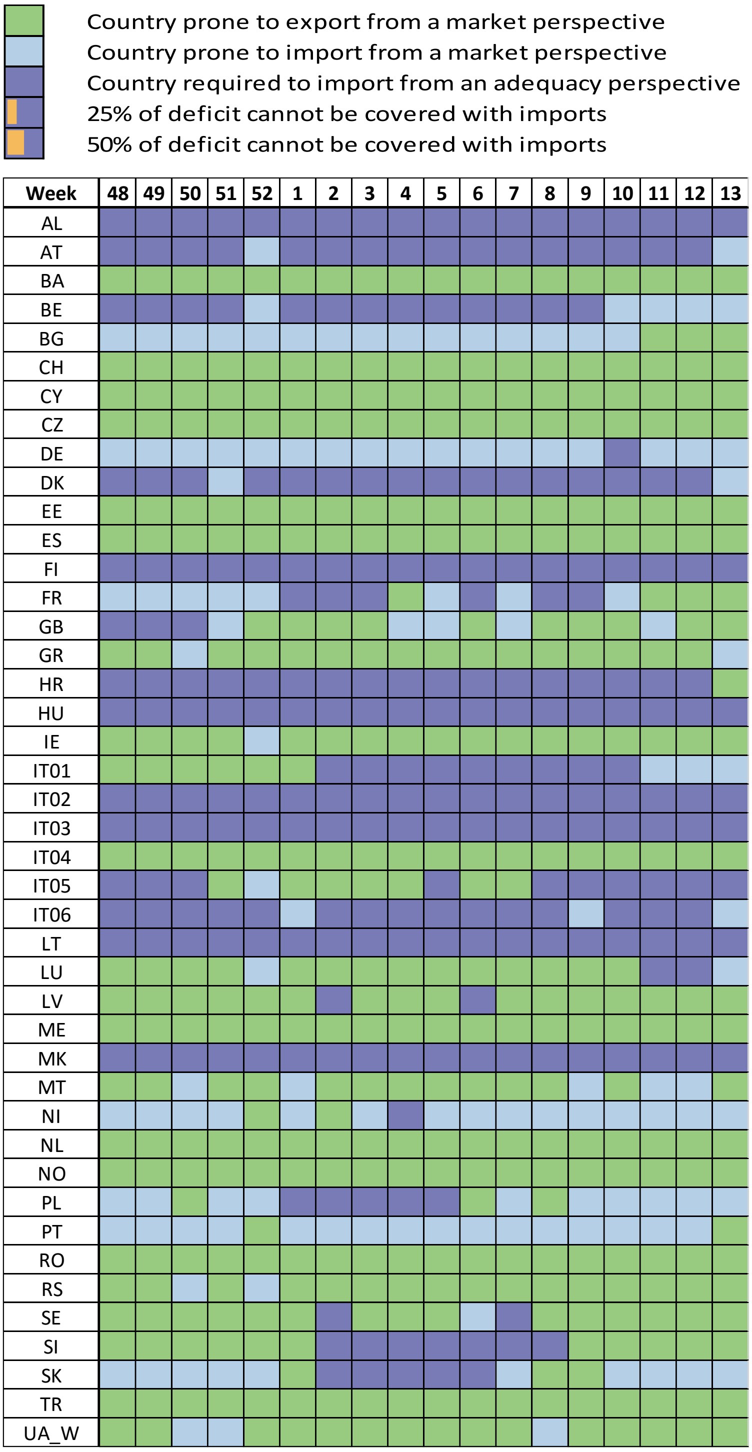
Figure 5: Regional isolation under severe conditions in week 2.

3.4 Sensitivity Analysis under Severe Conditions Considering Existing Strategic Reserves

The sensitivity study assessed whether available strategic reserves would be sufficient to solve adequacy issues in Europe under severe conditions identified in Section 3.3. By this study ENTSO-E aims to be neutral towards strategic reserves (or any other capacity mechanism). The main purpose is only to assess if physically available capacity would be sufficient to cope with adequacy challenges under severe conditions, which can be considered as a stress test.

The results presented in Table 3 suggest that generation capacity and available interconnections in European electricity system would be sufficient to cover demand even during severe conditions, provided the strategic reserves are considered available and can be shared between countries. This assumption cannot always represent the decisions that will be actually made, given the different regulatory and legal framework of strategic reserves in the different countries. The conclusions of this paragraph should only be interpreted subject to the aforementioned assumptions.

Table 3: Adequacy at synchronous peak time under severe conditions considering strategic reserve contribution.



3.5 Probabilistic Sensitivity Analysis

The adequacy study presented in prior sections suggest that under normal condition no adequacy issue is expected, while under simultaneous severe conditions across Europe there is demand supply potential risk. Therefore, a probabilistic sensitivity analysis assesses the expected probability of inadequacy risk during critical periods (weeks 2 and 3). The probabilistic analysis has been performed only for week 2 in 2018, while the results of the probabilistic analysis in week 3 of 2018 are expected to be analogous, but in lower order of magnitude.

This study uses historical values of climatic variables and assesses their impact on pan-European adequacy (cf. Appendix 2:). Because climatic conditions across Europe are not extreme simultaneously, but at the same time, climatic conditions in a specific country can be worse than assessed in the study under severe conditions, modification in scope of countries with potential inadequacy risk could be spotted compared to the list of countries identified in Section 3.3.[8]

Probabilistic simulations were performed on a pan-European scale. These simulations excluded out of market resources (e.g. strategic reserves). The results in this section are presented for countries with a risk of adequacy issue, but the impact of simultaneous climatic conditions in the rest of the analysed system cannot be neglected. Moreover, the electricity system is highly interconnected; therefore, the adequacy issue cases cannot be interpreted as independent events across Europe. A network-wide result analysis suggests there is around 6% probability to have at least one hour with adequacy issue in at least one country on a typical Wednesday evening in the second week of January 2018. This lack of capacity could happen in one or more hours in the week, especially if the cause is a long cold spell. It is crucial to indicate that the average risk for the whole winter could be higher: the current approach focuses on the most critical period, which is expected in week 2.[9]

Results presented in Figure 6–12 suggest that the probability of adequacy issues in given countries ranges from about 1%–4% on a typical Wednesday evening in the second week of January 2018. Some interesting insight can be identified by analysing figures; the modelled regions at risk could be grouped according to expected adequacy issue dependency on climatic parameters in the corresponding regions:

- Belgium and Finland – if temperature and wind factor are low
- France and Italy (only Northern and Central-Northern)[10] – if temperature is low

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[8] Additional countries have been identified due to some extreme climatic data value combination.

[9] Cf. Appendix 2:. The future target methodology strives to implement detail hourly probabilistic simulations

[10] As interconnection between those zones is significant and usually not constraining (meaning supply issues could be redistributed between those zones), the results have been aggregated into one graph.

- Great Britain, Lithuania and Poland – dependency on climatic conditions is limited (adequacy issues exist under low temperatures when resource availability in neighbouring countries is limited or inaccessible due to saturated interconnections)

The results of adequacy in Belgium presented in Figure 6 suggest there is a 1.3% probability of an adequacy issue on a typical Wednesday evening in the second week of January 2018. The vast majority of adequacy issue cases are observed if low temperature and wind factor are observed. Should the temperature not fall below -10°C or wind factor be above 0.3, an adequacy issue in Belgium is unlikely.

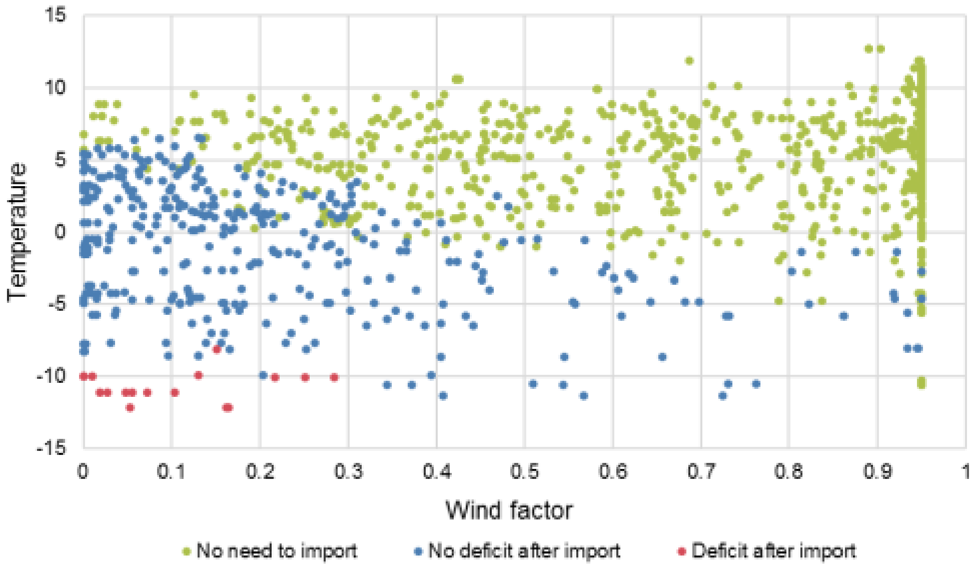


Figure 6: Probabilistic sensitivity analysis – week 2 in Belgium.

Figure 7 depicts an adequacy scatter plot for Finland, which indicates the probability of adequacy issue of 4.4% on a typical Wednesday evening in the second week of January 2018. A high probability of adequacy risk could be observed if temperatures in Finland fall below -25°C and the wind factor stays under 0.2. The reader should be reminded that the potential contribution of imports from Russia is not considered in the simulations

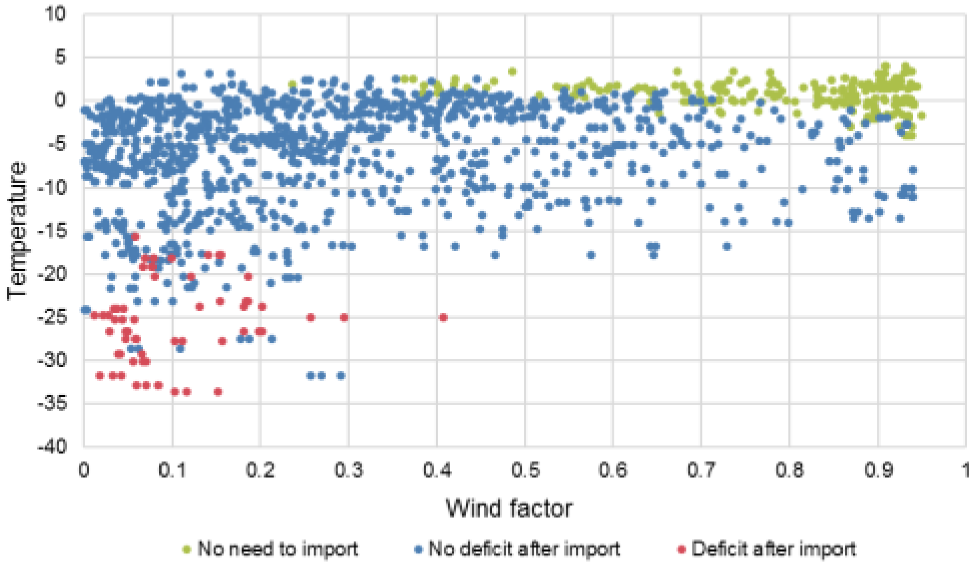


Figure 7: Probabilistic sensitivity analysis – week 2 in Finland.

In France, the nuclear generation availability is back to average compared to very low availability last year. Yet, the margins are tighter than two years ago with the shutdown of more than 4 GW of fossil oil plants in 2017. As demand in France is very sensitive to temperature, the risk of adequacy issue is expected under low temperatures. Analysis suggests there is a 3.5% probability of adequacy risk on a typical Wednesday evening in the second week of January 2018. Yet, the sensitivity analysis performed in this report uses historical values of climatic variables to assess the load. This historical database of 34 years includes two years with very intense cold waves (1985 and 1987), giving extreme loads in the simulations and leading to most of the points with deficit after imports (see Figure 8). In its national analysis published in November, to arrive at the best possible estimate of winter-related risks, RTE uses different weather scenarios delivered by Météo-France, which adjusts historical weather conditions according to climate change. This database shows that extreme events, like the very intense cold waves in 1985 and 1987, are less likely to happen in the coming years. RTE's national analysis suggests a 2% probability of adequacy risk for week 2; a similar risk persists in week 3.

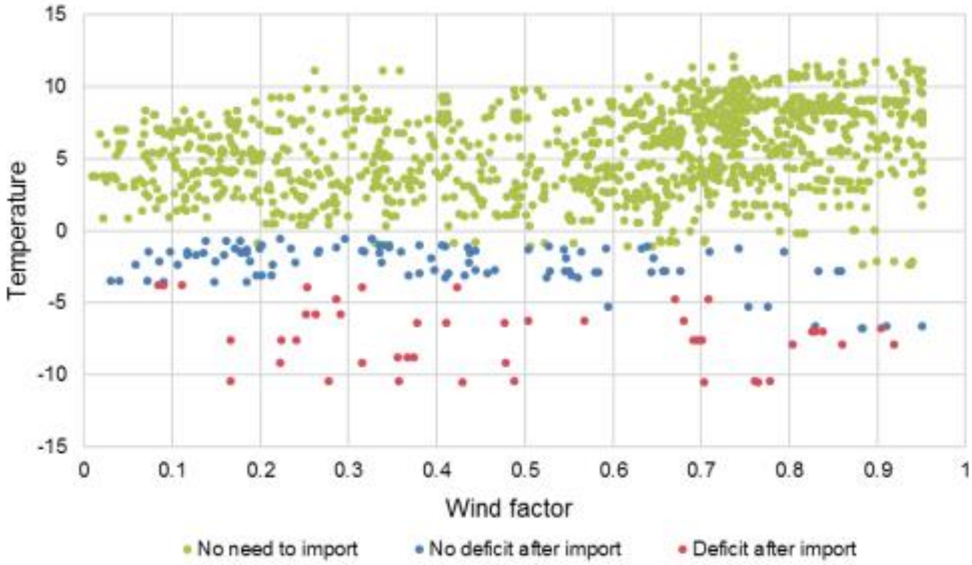


Figure 8: Probabilistic sensitivity analysis – week 2 in France.

The adequacy issue probability in Great Britain is only 1.3% on a typical Wednesday evening in the second week of January 2018. Cases of inadequacy cannot be linked directly to temperature or wind factor only. It seems that conditions in neighbouring countries impact adequacy in Great Britain. However, from Figure 9 it can be concluded that the supply of demand is not at risk if the temperature does not fall below 0°C or the wind factor stays above 0.4.

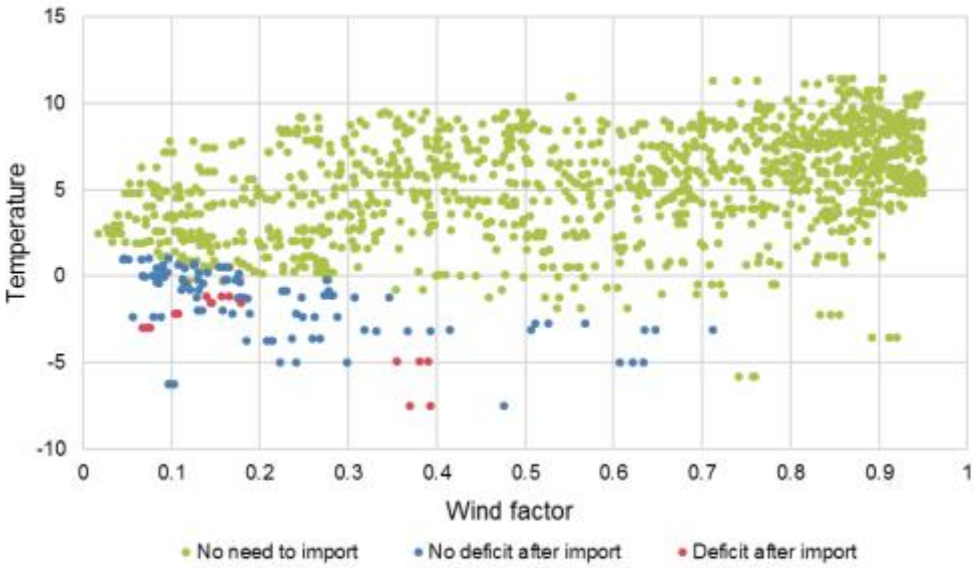


Figure 9: Probabilistic sensitivity analysis – week 2 in Great Britain.

The probabilistic simulation results suggest that the adequacy issue could be expected mainly in Northern and Central-Northern parts of Italy. As interconnection between those zones are significant and usually not constraining (meaning, supply issues could be redistributed between those zones), the results have been integrated into one graph. The probability of potential issues reaches 2% on a typical Wednesday evening in the second week of January 2018 and could be expected if the temperature falls below -4°C, while the need for import is observed if the temperature is below 6°C.

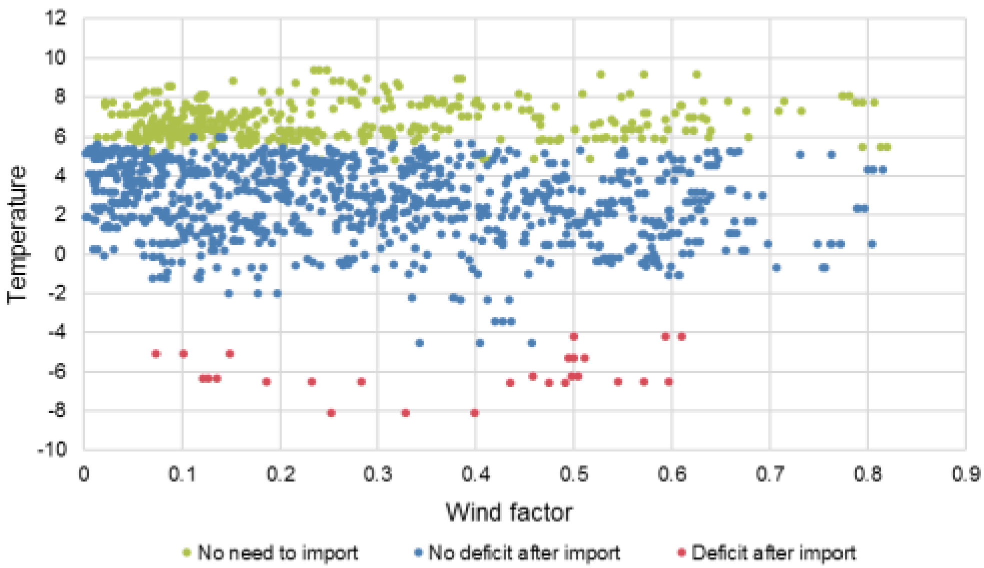


Figure 10: Probabilistic sensitivity analysis – week 2 in Italy (merged Northern and Central-Northern zones).

Figure 11 suggests that Lithuania highly relies on the import potential and would have sufficient generation capacity only in case of high wind factor and high temperatures. Distributed scatter plot points of deficit after imports indicate that adequacy highly depends on the situation in neighbouring countries. The probability of deficit reaches 2.3% on a typical Wednesday evening in the second week of January 2018 and is more likely if the temperature would fall below -10°C. It is important to keep in mind that potential imports from Russia (Kaliningrad) and Belarus were not considered in the present simulations.

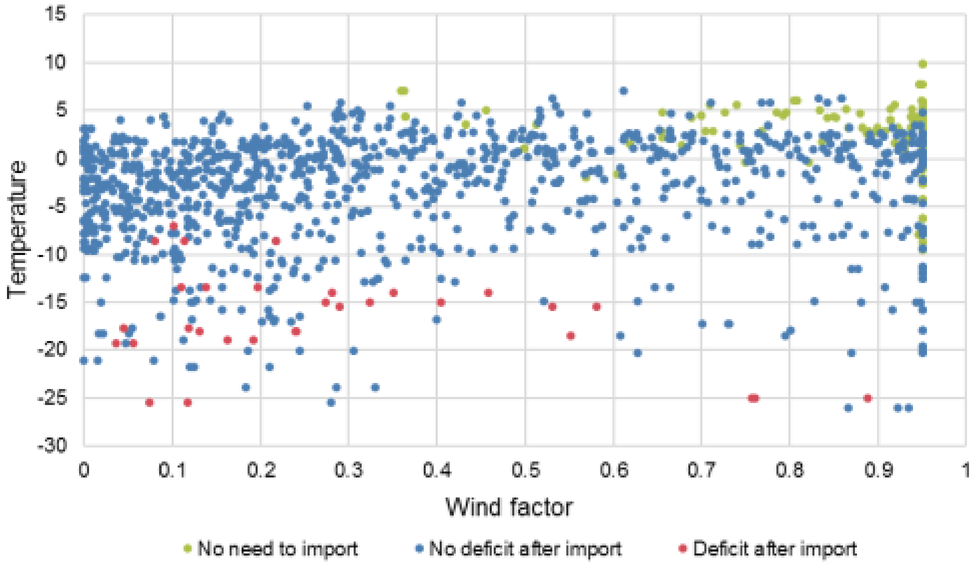


Figure 11: Probabilistic sensitivity analysis – week 2 in Lithuania.

The probabilistic sensitivity simulation results of Poland are given in Figure 12. In most cases Poland has sufficient capacity to supply demand and imports are likely needed only if wind capacity falls below 0.3. The risk of supply disruption reaches only 1.1% on a typical Wednesday evening in the second week of January 2018. As in the case of Lithuania, points of deficit after import are mostly related to dependency on the situation in neighbouring countries from which Poland could import.

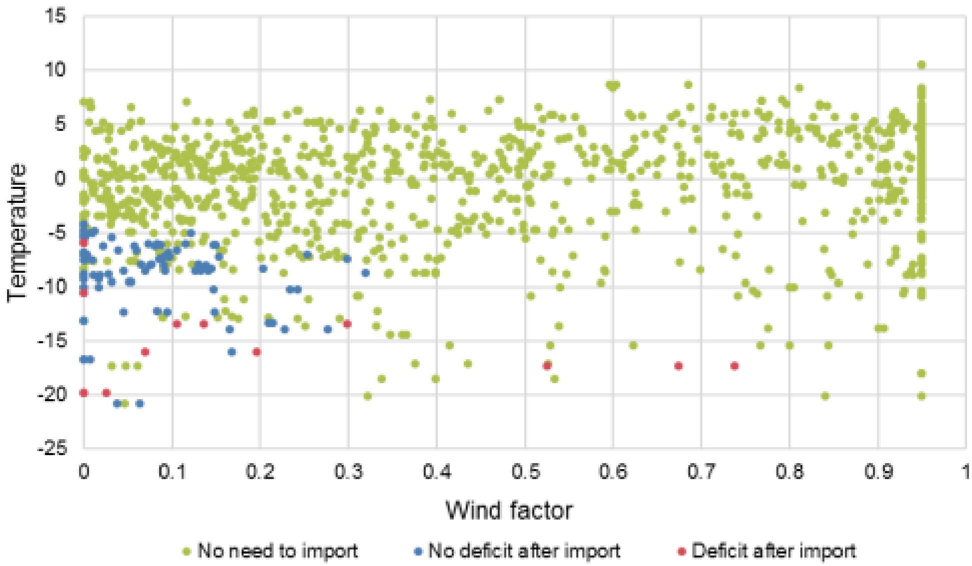


Figure 12: Probabilistic sensitivity analysis – week 2 in Poland.

4 Winter Outlook 2017/2018 – Downward Regulation Results

With increasing renewable generation and, in parallel, decreasing dispatchable generation in Europe (cf. Figure 1), the probability of encountering issues relating to an excess of inflexible generation also grows. During certain weeks, some countries need to export excess inflexible generation to neighbouring countries.

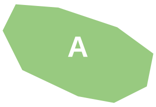
The downward regulation margins are assessed for, respectively, windy Sunday nights (very low load and high wind) and Sunday daytime with high PV generation. Variable generation values have been chosen as 95th percentile values of data samples taken from the Pan-European Climate Database (cf. Appendix 2:).

4.1 How to Read the Results

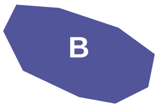
Results in figures displaying map in Section 4 presents off-peak demand capability to absorb energy from inflexible and variable generation. Countries are coloured green if the expected demand at the reference point is sufficient to absorb all energy from variable and inflexible generation. Countries are coloured purple if generation surpasses the expected demand, meaning the country needs to export excess energy.

Later in this outlook, the results of simulations considering import and export capabilities on a weekly basis are displayed in tables. The country cell in a specific week is coloured green if demand is sufficient to absorb all energy from inflexible and variable generation. Country cells coloured purple in a specific week have a surplus of energy that can be exported abroad. However, if the possibility to export energy surplus is insufficient (due to interconnection constraints or downward regulation issues in the neighbouring country), the cell is partially coloured orange. The ratio of orange fill represents which part of the generation surplus has to be curtailed; the generation capacity to be curtailed is divided by the sum of inflexible and variable generation, which is subtracted by demand.

How to read results



Country is capable of absorbing energy from inflexible and variable generation throughout the season



Country needs to export excess generation at least 1 week in season

Weekly results table

Demand is sufficient to absorb Inflexible and variable generation

National demand is insufficient to absorb inflexible and variable generation – need to export

National generation and exports are insufficient to absorb inflexible and variable generation

Ratio of fill represents ratio of power to be curtailed

Example

Week	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11	12	13
A																		
B																		

4.2 Daytime Downward Regulation

Daytime reference time point is considered as 11:00 CET for weeks 48–52 of 2017 and weeks 1–12 of 2018, while 11:00 CEST of week 13 in 2018. The results displayed in Figure 13 suggest that demand is sufficient to absorb the energy generated from variable and inflexible generation in most of Europe throughout the winter season.

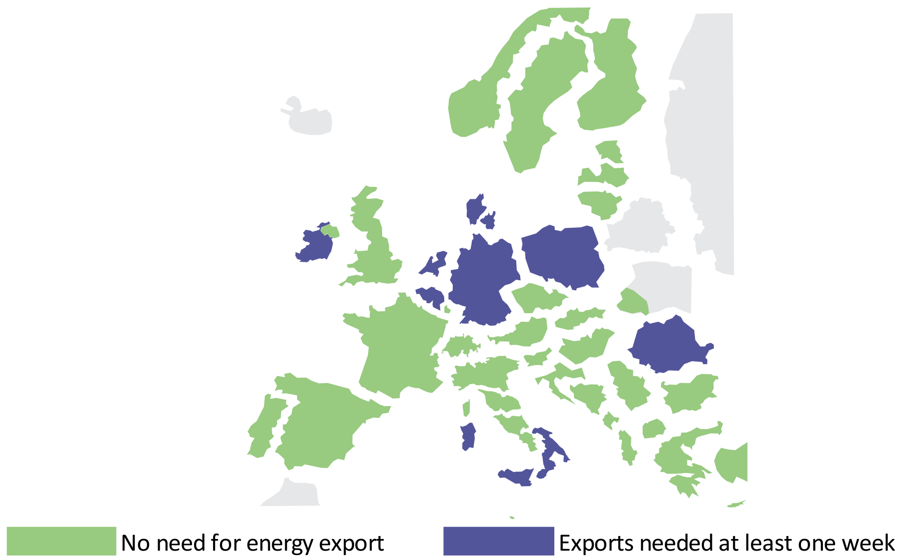
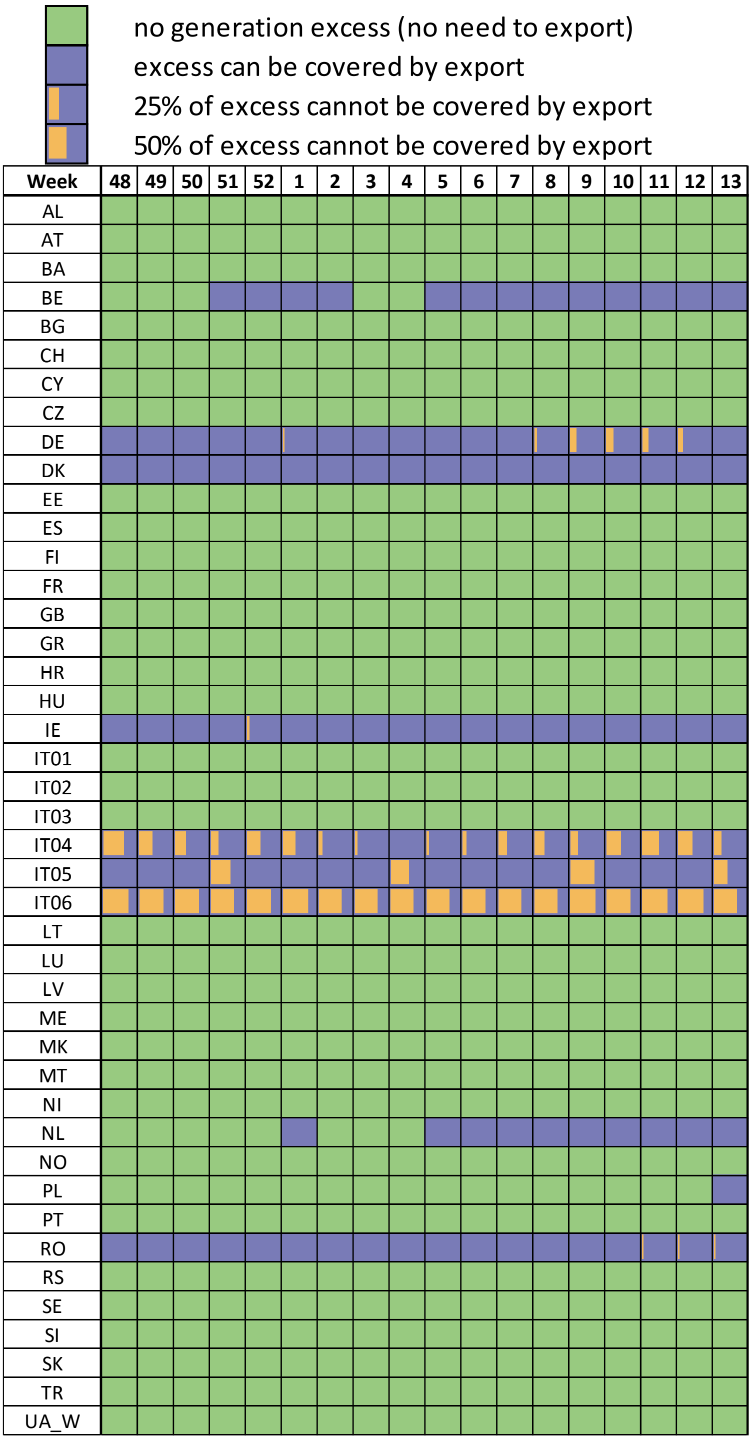


Figure 13: Daytime national downward regulation adequacy.

The weekly results display that only Belgium, Netherlands, Denmark and Poland would be able to export excess variable and inflexible energy, while some energy should be curtailed in the rest of countries facing downward regulation issues. However, in most of the countries, the ratio of excess energy to be curtailed is rather low and limited to some specific weeks (e.g. Ireland would have to curtail a small fraction of excess energy and only in week 52 in 2017).

However, more structural curtailments could be observed in Italy (Southern Italy, Sicily and Sardinia).

Table 4: Daytime downward regulation adequacy.



4.3 Night-time Downward Regulation

The night-time downward regulation adequacy corresponds to Sunday early morning (5:00 CET for weeks 48–52 of 2017 and weeks 1–12 of 2018, while 5:00 CEST of week 13 in 2018). The results presented in Figure 14 suggest that all countries having excess energy during the daytime would have variable and inflexible generation energy excess in the night-time (except for the Netherlands). Some additional countries are identified as well: Finland, FYRO Macedonia, Northern Ireland, Slovenia, Spain and Sweden.

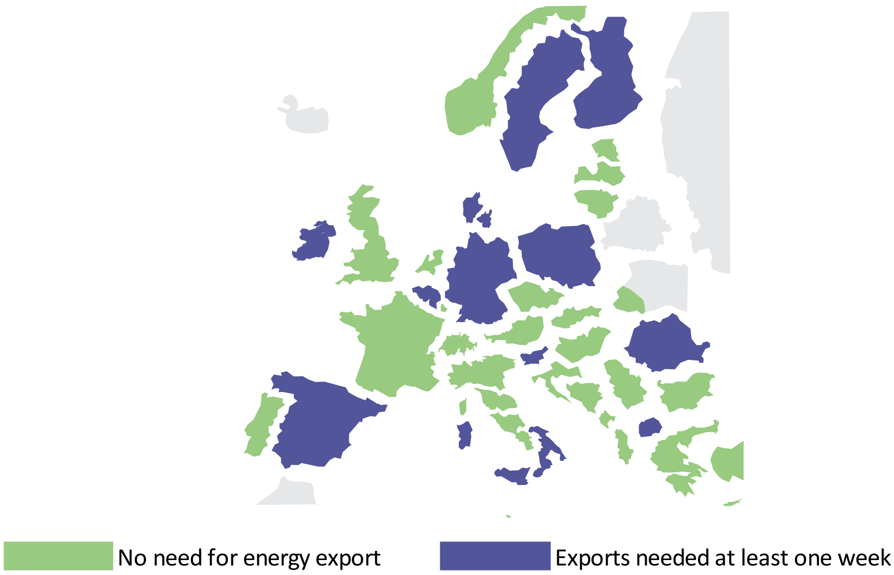
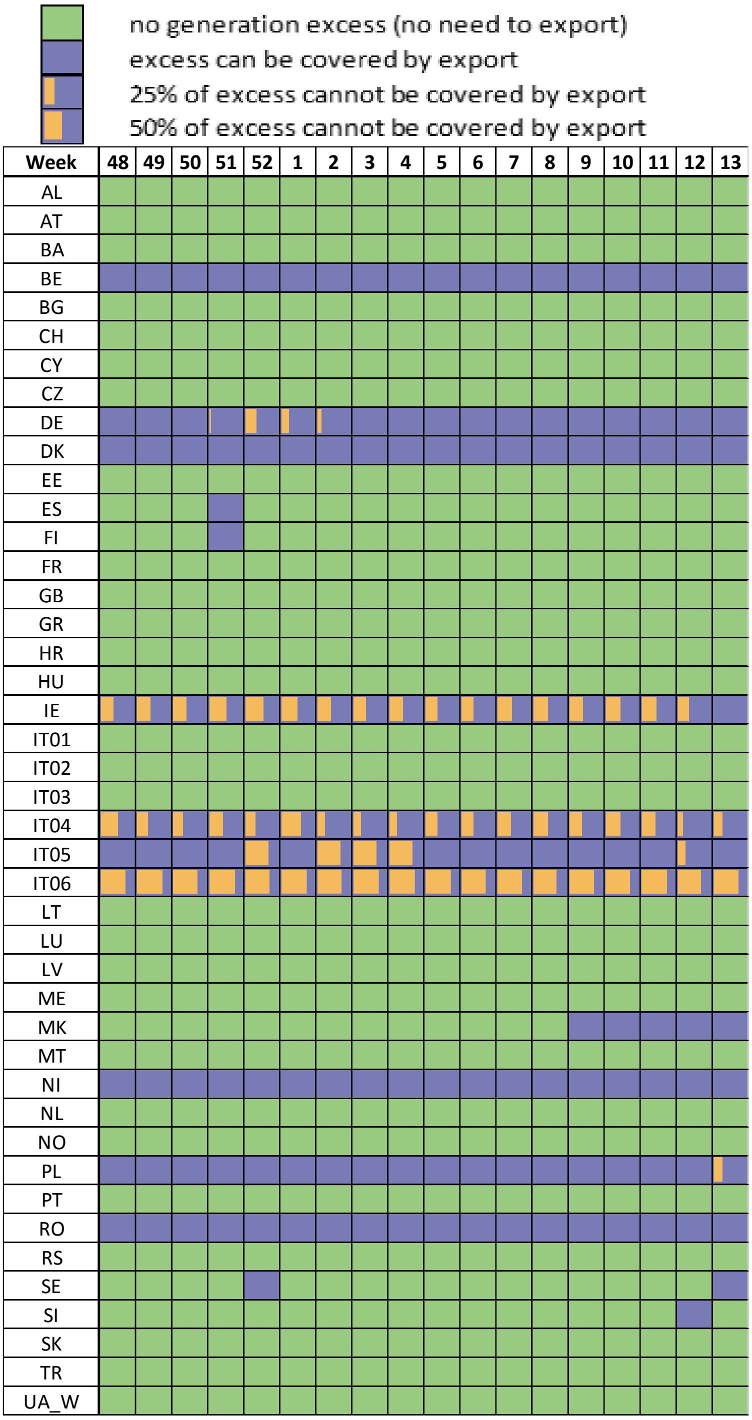


Figure 14: Night-time national downward regulation adequacy.

The weekly results in Table 5 suggest that most of the countries would have the capability to export energy throughout the season. As in the daytime case, some excess energy would have to be curtailed in some regions of Italy. Furthermore, Ireland may also have to curtail excess energy on a structural basis in case of high wind during the night.

Table 5: Night-time downward regulation adequacy.



5 Stress Tests and Risk Assessment

Several qualitative risk assessments were performed in light of lessons learnt from past January cold spell and to pave the way for future implementation of Risk Preparedness draft regulation.

5.1 Qualitative Assessment of Main Risks for Security of Supply

A TSO targeted qualitative survey was launched in July 2017 to perform risk mapping in European countries. Two key parameters were identified: severity of the risk and frequency of the risk. No precise historical data analysis has been requested, as the purpose of this survey was to identify the perception of TSOs on specific risks and to set up a general picture of risks across Europe. This assessment is not only based on a TSO's historical experience of past incident records, but also considers potential future threats (e.g. cyber-attacks).

Risk frequency ranges have been predefined to:

- Rare risks (less than 1 occurrence in 10 years)
- Often risks (more than 1 occurrence in 10 years, but less than 1 occurrence per year)
- Very often risks (more than 1 occurrence per year)

Risk severities were classified into 4 scales (Scale 0–Scale 3) according to the Incident Classification Scale working group methodology.[11] However, Scale 0 has been considered as a low importance risk and, therefore, was disregarded in qualitative study.

Analysed risks were classified into two groups: natural risks and other risks (or technical and human error risks). Natural risk classification is mainly based on the Organization for Security and Co-operation in Europe's report[12] with minor modifications, whereas other risks were based on the main concerns of TSOs and the risks listed in the European Commission Risk Preparedness Regulation proposal.[13]

The overview of survey responses on natural risks presented in Table 6 suggests that strong winds and storms are the most pronounced risk. However, the most severe risk is a cold wave on a pan-European scope. This finding acknowledges the importance of the adequacy study performed in this Winter Outlook. Moreover, snow slides and icings (risk following snow slides

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[11] Incident Classification Scale Methodology

[12] Protecting Electricity Networks from Natural Hazards

[13] Proposal for a Regulation of the European Parliament and of the Council on risk-preparedness in the electricity sector

in severity) are considered as risk that may cause dire consequences. This finding highlights the importance in assessing multiple outages of generation and transmission assets employing probabilistic simulations, which is considered one of the most important improvements for future Seasonal Outlooks. An example of generation asset multiple outage probabilistic analysis in Bulgaria is presented in Section 6, whereas the impact of unexpected transmission asset outage in Italy is presented in Section 6.2.

Table 6: Pan-European qualitative study on natural risks result overview.

Most frequent natural risks for European TSOs	Most severe natural risks for European TSOs
1. Strong winds and storms	1. Cold waves
2. Lightining	2. Strong winds and storms
3. Icings	3. Snow slides

The general results on technical and human error risks are given in Table 7. The occurrence of asset outages supports the importance of performing a probabilistic assessment of asset availability, whereas the fuel supply risk indicates the importance of gas disruption risk analysis.

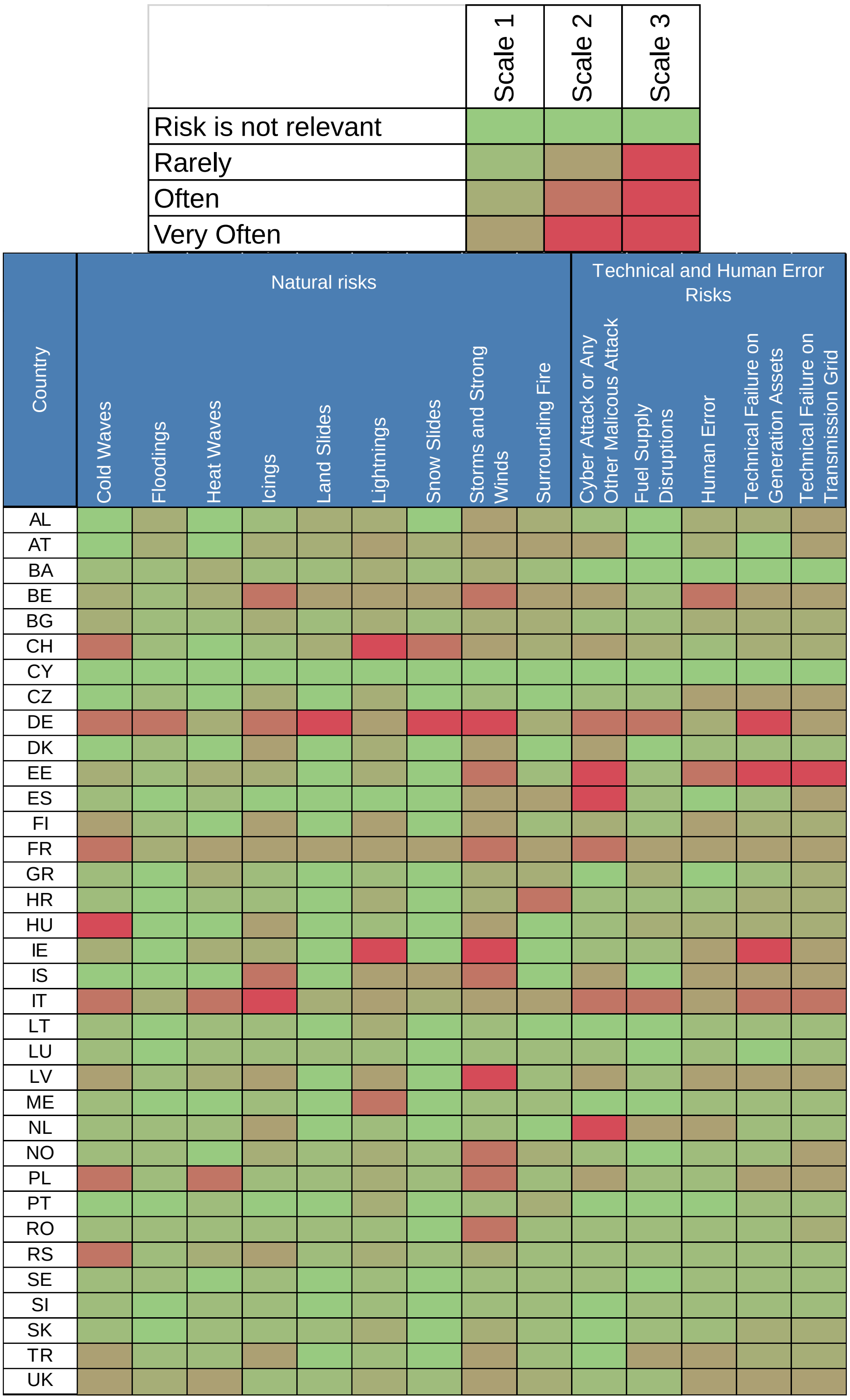
Table 7: Pan-European qualitative study on technical and human error risks result overview.

Most frequent technical or human risks for European TSOs	Most severe technical or human risks for European TSOs
1. Failure on transmision grid assets	1. Cyber or malicious attacks
2. Failure on generation assets	2. Fuel supply disruptions
3. Human error	3. Human error

Table 8 provides a detailed overview of each risk in all countries[14] is presented. However, the reader should keep in mind that results representation is based on the best estimates of TSOs, and it reflects the perception of each risk.

[14] FYRO Macedonia’s TSO did not reply to the survey; therefore, it does not appear in the results

Table 8: Risk perception by country (source: TSOs).



Added to risk mapping, the responses to existing national and regional measures have been performed, which indicate that TSOs are in general satisfied about existing measures, but would see the most potential in improvements to mitigate cyber and malicious attack risks on national and regional level.

5.2 Overview of Hydro Reservoir Levels

In addition to the system adequacy study presented in this report, it is highly relevant to offer an overview of the current reservoirs levels in major hydro-generating countries, highlighting potential risks. Hydro generation is taken into account in the adequacy analysis, yet only through a deterministic approach assuming power availability (GW) at one synchronous peak time in week. The information presented in this section aims to give additional qualitative insight into energy (GWh); the current reservoir levels and their past evolution this year are compared to historical levels.

Reservoir levels at the beginning of 2017 were relatively low in Italy, France, Spain, Switzerland and Austria, while remaining in average levels in Norway. However, the summer period resulted in reservoir levels increase of all mentioned countries, apart from Italy and Spain. This can be perceived as an indicator of overcoming potential risks for the coming winter associated with low reserves, because reservoir levels on a pan-European scale are currently in comparatively average levels.

More specifically, the cases of Italy, France, Spain, Switzerland, Austria and Norway are discussed below, followed by the corresponding graphs.

The reservoir levels in Italy have been comparatively low from the beginning of the year. Figure 15 shows that reservoir levels set a new lowest bound compared to historical data at the first two months of the year. Until October, the reservoir levels remained considerably lower compared to the corresponding values of 2016.

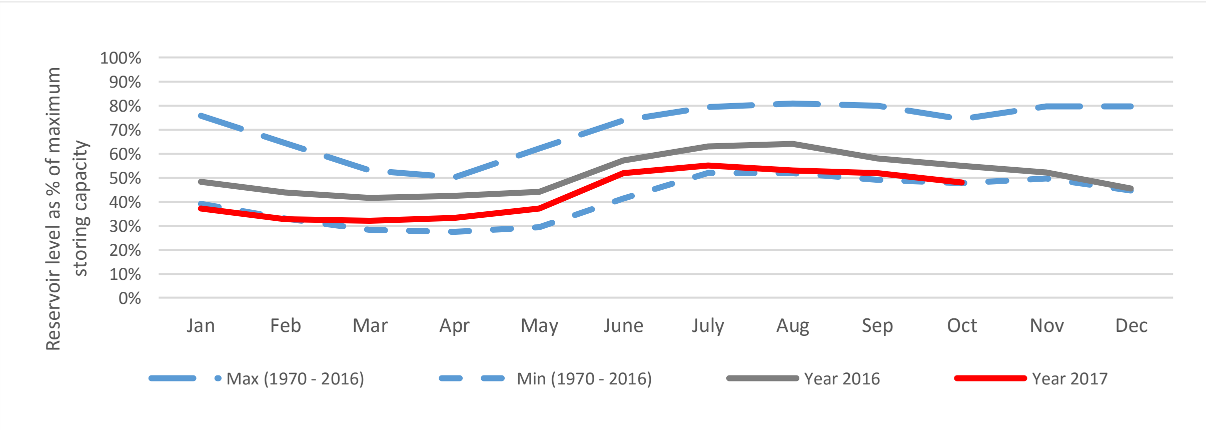


Figure 15: Reservoir levels in Italy.[15]

In France, the reservoir levels are close to average according to the latest available data, as plotted in Figure 16. Reservoir levels at the beginning of 2017 were considerably lower than

[15] Based on data published by Terna.

the recorded minimum values since 1997. From July until October, the reservoir levels followed an increasing trend, remaining below the average historical values, but approaching average. The global low reservoir level in France is attributed to the low levels of rainfall compared to previous years.[16]

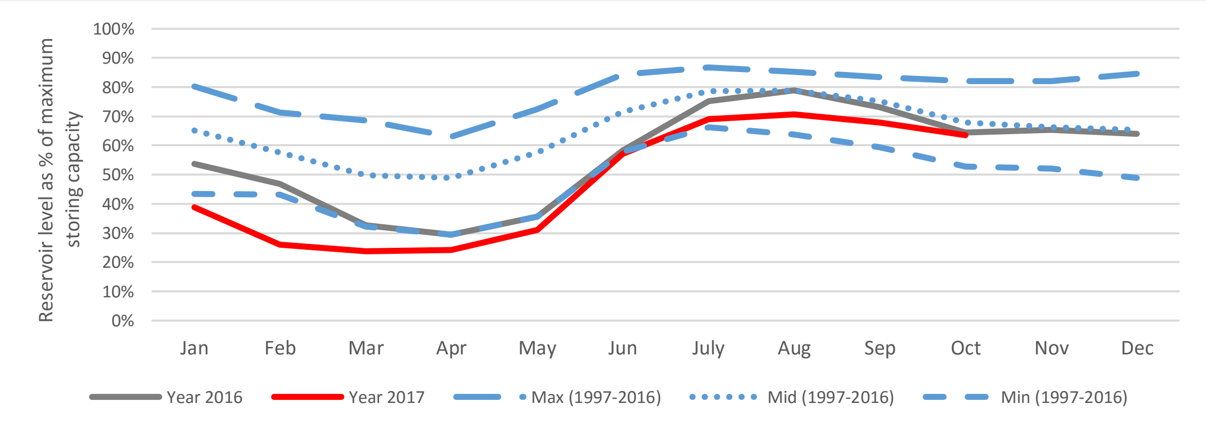


Figure 16: Reservoir levels in France.[17]

The reservoir levels in Spain are low for the year 2017. Figure 17 shows that the curve referring to the current year is lower than the average recorded levels since 1990. It is also considerably lower than last year's reservoir levels and close to historical minimum levels.

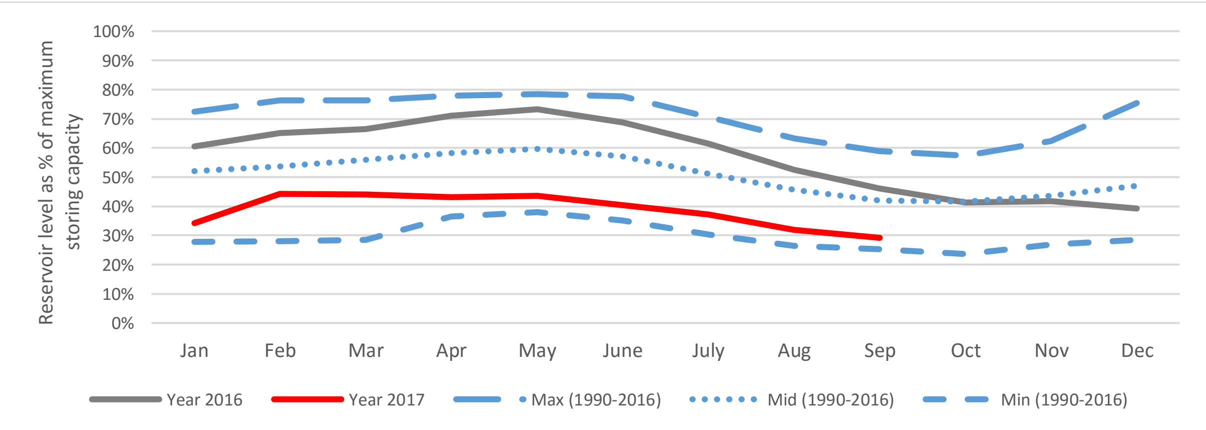


Figure 17: Reservoir levels in Spain.[18]

Reservoir levels in Switzerland at the beginning of the year were close to lowest recorded levels, but following the start of summer 2017 an increasing trend appeared and the levels approximated the recorded average values.

[16] Indicated by RTE in its monthly reports '[Major electricity trends for the month](#)'.

[17] Procured Based on data published by [RTE](#).

[18] Based on data published by [REE](#).

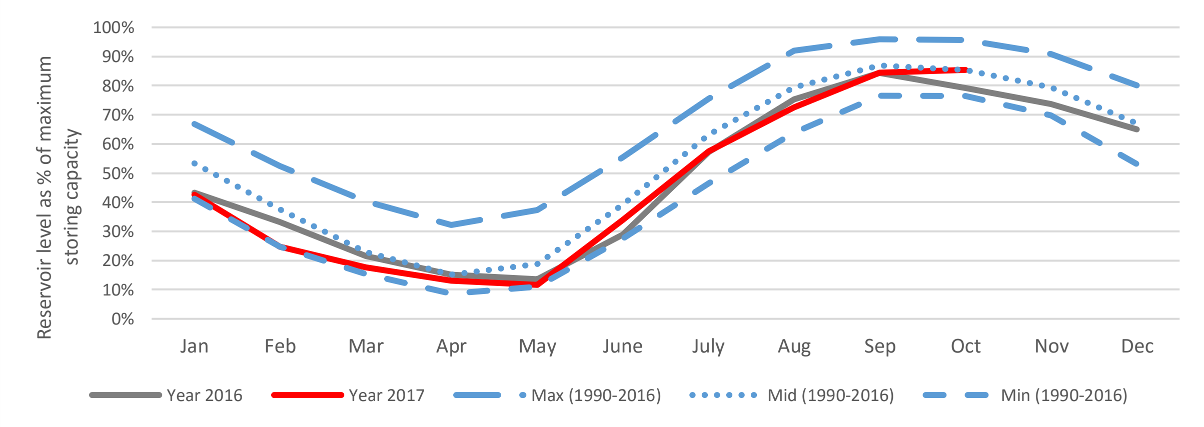


Figure 18: Reservoir levels in Switzerland.[19]

Similar to the hydro reservoir levels of Italy, France and Switzerland, Austria's levels were at historical lows at the beginning of the year. However, from May they were characterized by an increasing trend, and by the end of August were considerably higher than last year, approximating the recorded maximum values since 2001.

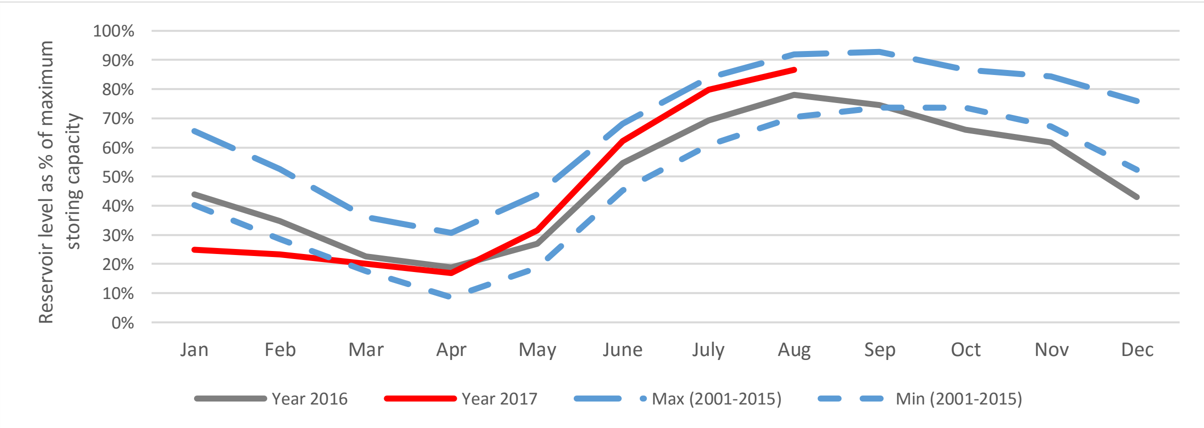


Figure 19: Reservoir levels in Austria.[20]

On the other hand, hydro reservoir levels in Norway for 2017 remain in average levels throughout the year 2017, as observed by Figure 20. The curve of the current year, until the beginning of October, follows the average values of historical measurements between 1990 and 2016.

[19] Swiss Federal Energy Ministry (BFE)

[20] Regulator for electricity and gas markets in Austria (E-control). The statistical data considers reservoir level in the 'Obere-Ill Lünersee' unit, which is assigned to the German transmission grid operator 'TransnetBW'.

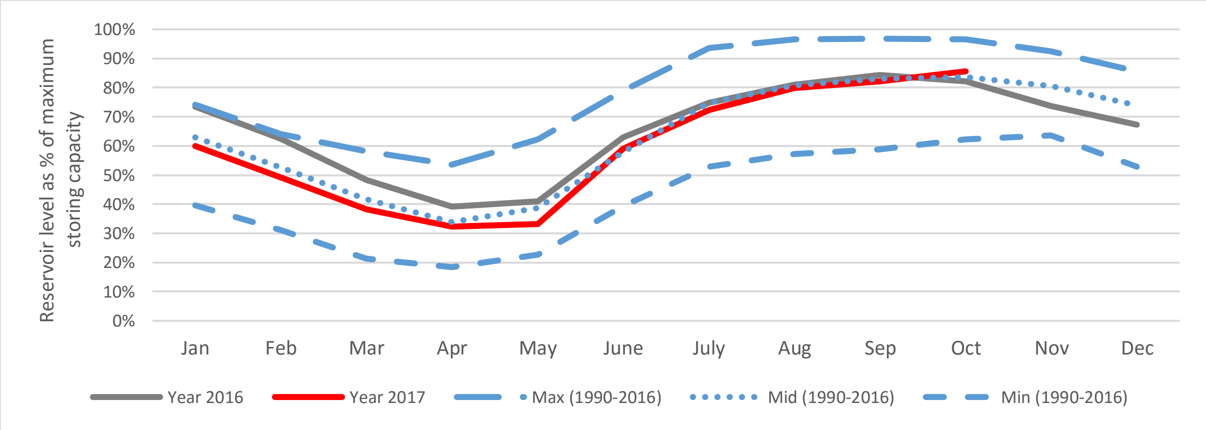


Figure 20: Reservoir levels in Norway.[21]

5.3 Gas Disruption Risk Analysis

In the three previous Winter Outlooks, a gas disruption sensitivity analysis was performed to respond to the risks that could occur because of supply route disruption through Ukraine. All previous analyses indicated, and the present analysis confirms, electricity system robustness against this disruption.

ENTSOG's gas disruptions scenarios are assessed this year in the Union-wide simulation of supply and infrastructure disruption scenarios (Security of Supply report). According to the Gas Regulation (2017/1938), it 'shall be repeated every four years unless circumstances warrant more frequent updates'. The number of gas disruption scenarios is extended to different regions and risks compared to the studies performed so far. Considering these changes and that the current draft electricity Risk Preparedness Regulation aims to include fuel shortage risks, the sensitivities related to the impact of gas shortages on electricity might be addressed in framework other than the Seasonal Outlook in future. However, in this report, Ukraine's route disruption impact is assessed in continuity with the previous Winter Outlook studies.

In November 2017, ENTSOG issued a first edition of the Union-wide Security of Supply Simulation,[22] in which the association simulates supply and infrastructure disruptions under severe winter demand. The Ukrainian route gas supply disruption is simulated for 2 months, and the impact of a peak day and a cold spell are also assessed. The study concludes that the same countries are at risk for notable gas demand curtailment as those countries

[21] Norwegian Water Resources and Energy Directorate (NVE).

[22] Union-wide Security of Supply simulation report.

presented in last year's gas Winter Supply Outlook,[23] and the conclusions presented in last year's electricity Winter Outlook[24] could be also drawn this year.

The European Electricity System is thus confirmed to be robust, even in the event of a high demand situation with a simultaneous interruption of gas transit through Ukraine. As ENTSOG's outcomes suggest, the South-East Europe region would possibly be exposed to a gas curtailment risk under the corresponding scenario. In this region, ENTSO-E analyses show that the electricity security of supply would be maintained for two reasons:

- Electricity systems are well interconnected and some non-affected neighbouring countries can support the electricity supply by exporting more; and
- Some gas fired generations could be switched to substitute fuels or expected unavailable gas fired generation capacity is of low order magnitude.

Table 9: Gas demand curtailment under Ukraine–Russia gas supply disruption.[25,26]

Country	Gas demand curtailment risk		
	Reference disruption case	1-day Design Case (peak demand)	2-week Cold Spell
Bulgaria	25% to 85%	25% to 85%	25% to 85%
Greece	No gas curtailment	5 % to 25 %	No gas curtailment
FYRO Macedonia	25% to 85%	25% to 85%	25% to 85%
Romania	5% to 25%	25% to 85%	5 % to 25 %

[23] Winter Supply Outlook 2016/2017 & Winter Review 2015/2016 - ENTSOG

[24] Winter Outlook Report 2016/2017 and Summer Outlook Review 2017 - ENTSO-E

[25] A gas curtailment of 10% is considered to have a negligible impact on the electricity sector.

[26] ENTSOG expertise suggests that gas supply curtailment risk in FYRO Macedonia would be comparable to the situation in Bulgaria.

6 Multiple Outages – Study Cases

Adequacy is highly affected by the outages in the power system, and in some cases, it may be the main reason of adequacy issues (especially in extreme cases of multiple outages). Generation capacity reduction, according to the forced outage rates, represents expected available generation capacity, which is representative for general adequacy studies. However, a probabilistic analysis could provide additional insight into more specific system operation states. Two specific examples are presented to give some understanding. Section 6.1 presents a case study of Bulgaria's probabilistic generation capacity availability. Section 6.2 presents the potential impact of higher unavailable transmission capacity in Italy for adequacy.

6.1 Generation Outages – Example of Bulgaria

Generation outages have been considered in Seasonal Outlook reports in a deterministic manner, representing the potential unavailability of power capacity under normal and severe conditions. However, the recent cold wave in January 2017[27] raised concerns about the risk assessment of multiple outages of generation units. Under this context, a probabilistic assessment of the risk in Bulgaria has been performed. This analysis is presented in this section as a case study and a potential future improvement for assessing the risk of generation outages.

Table 10 presents information about the considered nuclear and lignite generation units in Bulgaria. The reflected 'Forced outage rate' for each unit is derived from a statistical analysis of forced outages in Bulgaria. The 'Adjusted forced outage rate' consists of pure estimates of forced outage rates under stressful circumstances (such as a cold wave), which are in keeping with the ones used in the Winter Outlook study.

[27] Managing Critical Grid Situations – Success & Challenges

Table 10: Thermal generation units in Bulgaria.

Unit index	Installed capacity, MW	Forced outage rate (FOR), %	Adjusted forced outage rate (FOR), %	Unit type
1	1050	3.16%	5.00%	Nuclear
2	1050	3.16%	5.00%	Nuclear
3	343	4.20%	9.00%	Thermal lignite
4	343	4.20%	9.00%	Thermal lignite
5	177	4.20%	9.00%	Thermal lignite
6	162	4.20%	9.00%	Thermal lignite
7	172	4.20%	9.00%	Thermal lignite
8	172	4.20%	9.00%	Thermal lignite
9	225	4.20%	9.00%	Thermal lignite
10	225	4.20%	9.00%	Thermal lignite
11	227	4.20%	9.00%	Thermal lignite
12	227	4.20%	9.00%	Thermal lignite
13	227	4.20%	9.00%	Thermal lignite
14	227	4.20%	9.00%	Thermal lignite
15	227	4.20%	9.00%	Thermal lignite
16	227	4.20%	9.00%	Thermal lignite
17	190	4.20%	9.00%	Thermal lignite
18	190	4.20%	9.00%	Thermal lignite
19	100	4.20%	9.00%	Thermal lignite
20	100	4.20%	9.00%	Thermal lignite

A probabilistic analysis was performed because forced outages of each unit are considered independent events. In Figure 21, the inverse cumulative distribution function is built using statistical and adjusted forced outage rates for normal and severe conditions, respectively. The figure represents the probability of specific or higher outage level.

The results suggest that it is unlikely that the total outage rates would exceed 2,000 MW, under both normal and severe conditions. However, the probability of having outages under normal conditions is above 50%, whereas under severe conditions, considering the increased forced outage rate values, would be slightly higher than 80%.

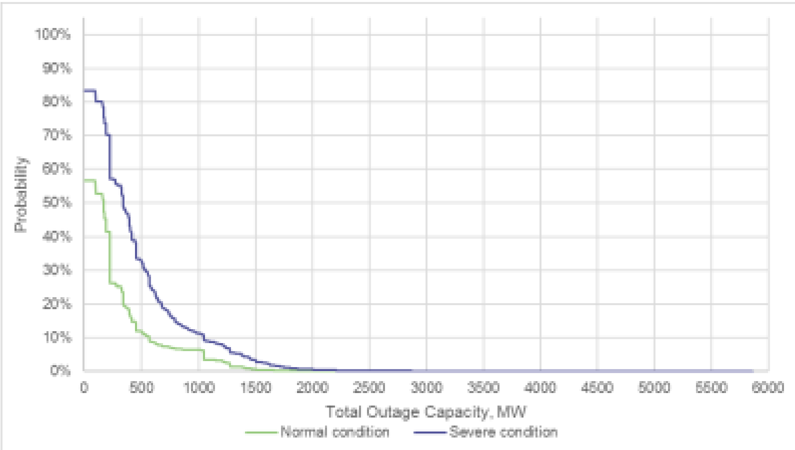


Figure 21: Inverse cumulative distribution function of thermal generation capacity outage in Bulgaria.

This analysis aims to be an example of multiple outage risks. Further insight on inter-dependency between forced outage rates and climatic conditions is extremely complex to capture. The Seasonal Outlook methodology will be continuously improved, keeping the challenging full probabilistic approach as the target.

6.2 Transmission Outages – Example of Italy

In regional electricity markets, transmission interconnections play an important role in contributing to adequacy. They allow different bidding zones to share (part of) their generation capacity, reducing the global amount of capacity required at the pan-European level for guaranteeing system adequacy. Hence, a sound regional adequacy assessment must properly take into account the availability of interconnections to correctly simulate the possibility to cope with local necessity using external generation capacity.

The current Seasonal Outlook methodology performs a modelling of interconnection availability in the form of expected available net transfer capacities (NTCs): on each border and for each simulated time stamp a given NTC value is defined according to a best expectation approach. While in a strongly meshed grid this approach can be acceptable, forced outages of interconnection lines can drastically reduce available transmission capacities on low meshed areas, affecting in a significant way adequacy assessment results. Because forced outages can be properly modelled only in a fully probabilistic methodology (due to their random behaviour and low probability of occurrence), this topic is considered one of the important evolutions expected in future ENTSO-E adequacy methodology for Seasonal Outlooks.

To provide an example of the possible impact of interconnections forced outages on system adequacy, a case study considering forced outages in the Italian grid is provided here below. In particular, this case study applies an NTC reduction between Central-Southern Italy (IT03) and Central-Northern Italy (IT02) bidding zones, in line with January 2017 events,[28] to the severe conditions assessment of week 2.

The results of this case study show a decreased margin for the area composed by bidding zones IT01 and IT02: in case of full NTC from bidding zones IT03 to IT02, this area has a final negative margin (after import) of about -0.3 GW, while in case of an NTC reduction on IT03-

[28] Heavy snowfalls in the central part of Italy caused the trip of three 400 kV Overhead Lines connecting the north and the south, thereby reducing the transmission capacity between the two areas.

IT02 border this negative margin falls to -1.5 GW, imposing the activation of an increased amount of remedial actions to balance the system.

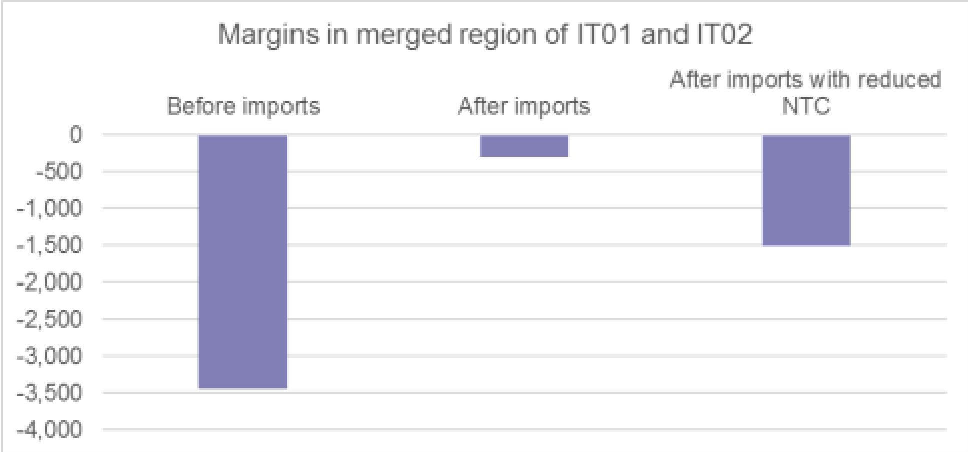


Figure 22: Severe conditions upward regulation adequacy – outage test case.

The deterministic approach for modelling NTC considers the best update of expected unavailability of the transmission asset. The above example indicates that some more severe system states could occur and can have potential impact on adequacy. This shows a need to investigate improvements of cross-border transmission capacity modelling, considering the risk of lower transmission capacity in severe conditions.[29]

[29] Independently from the challenging target to shift from net transfer capacity (NTC) modelling towards Flow Based approach, results of this section show a need to consider the risk of lower capacity in severe conditions

7 Summer Review 2017

The summer review is based on the qualitative information submitted by ENTSO-E TSOs in September 2017 to represent the most important events that occurred during summer 2017 and to compare them to the study results reported in the previous Seasonal Outlook. Important or unusual events or conditions in the power system and the remedial actions taken by the TSOs are also mentioned. A detailed summer review by country appears in Appendix 1.

7.1 General Comments on Past Summer Climate

Summer 2017 had mainly moderate climate conditions with monthly temperatures relatively higher than normal temperature values.[30] Demand was close to or slightly higher than the seasonal average in most of the member countries, as expected in the Summer Outlook Report 2017. There were a few exceptions, however, such as extremely hot weather in Croatia at the beginning of August 2017 and Switzerland experienced its third hottest summer since the measurements began in 1864. Meanwhile, a couple of countries had cooler temperatures, such as Estonia and Latvia, and the latter just experienced the coldest summer by air temperature since 2000.

Due to dry weather throughout the summer, some countries, such as Albania, Estonia, Greece, Portugal, Slovakia and Spain, had lower precipitation than the average, which led to less hydro generation than expected. In Norway, Latvia, Lithuania and Switzerland, however, the higher precipitations triggered more outputs from their respective hydropower plants (HPPs).

7.2 Specific Events and Unexpected Situations During the Past Summer

Several isolated issues regarding the transmission network can be mentioned:

- Due to the high number of outages (planned and unplanned), a voltage imbalance issue occurred in the northern regions of Czech Republic at the end of May: the unloaded lines generated more reactive power and some areas experienced a lack of compensation capabilities. The situation was handled by shutting down some of the unloaded lines and activating extra generating capacity. A similar situation happened in Germany, where remedial actions had to been taken to ensure voltage stability

[30] Source: summer review comments by ENTSO-E member TSOs.

during weekends because of longer non-availabilities of two nuclear power plants in southern Germany.

- During the summer period, several forest fires took place in Greece and Portugal, affecting the transmission capacity and posing difficult challenges to the system operation. A strong hurricane hit the north-west part of Poland on 11–12 August 2017. Wind speed reached the highest level in 38 years, clocking up to 150 km/h. A few transmission lines were damaged. Extreme weather in Hungary, such as a local tornado, damaged six 400 kV towers of an interconnection line with Croatia. However, these events did not affect the security of supply.
- As a result of half of the installed nuclear power capacity being on maintenance, there was an increased need for import to the south of Sweden (more specifically, SE3 and SE4) in August and September. Extended maintenance for some nuclear power plants further worsened the situation and led to a rather strained situation and high prices in Sweden, Denmark and Finland for some hours, in combination with limitations on interconnections. The low nuclear power production also caused unusually low levels of inertia for the Nordic synchronous area.
- In Great Britain, there was one localised downward margin issue due to a local constraint within Scotland in June. Great Britain's lowest afternoon demand day was 9 April 2017. On this day, daytime low residual demand (reduced by embedded solar generation) was lower than the overnight demand for the first time ever.
- With low levels of hydroelectric production, renewable sources (plus imports) in Portugal supplied only 31% of electricity consumption. Natural gas units stood out for the remaining 69% consumption, setting the record of the highest monthly production value ever in July and in August. The high utilization of thermal power units is also associated with the high energy exports to Spain.

7.3 Interconnector Capacity Limitations in Lithuania

In summer 2017, the local generation in Lithuania was 3% lower than in the previous summer. One reason was the growth in allocated capacity of the Lithuania–Sweden HVDC interconnector that led to a larger amount of imported electrical energy. The other reason was lower fossil fuel generation due to the higher price of fuel for generation.

Import capacity from neighbouring countries to the Lithuanian grid was restricted during most of the summer period because of the reduced capacity of the Estonia–Latvia interconnection. The main reasons for the restrictions were higher ambient temperature and maintenance activities on the interconnection lines.

Another interconnection limiting capacity from neighbouring countries was Belarus–Lithuania. Higher capacity limitations lasted until week 30 due to the reconstruction of the Belarussian grid and maintenance activities on the interconnection lines.

Moreover, in the beginning of the summer period during weeks 16–17 and 19–21, the import volume from Kaliningrad region to the Lithuanian grid significantly decreased because of maintenance activities in Kaliningrad Thermal Power Plant.

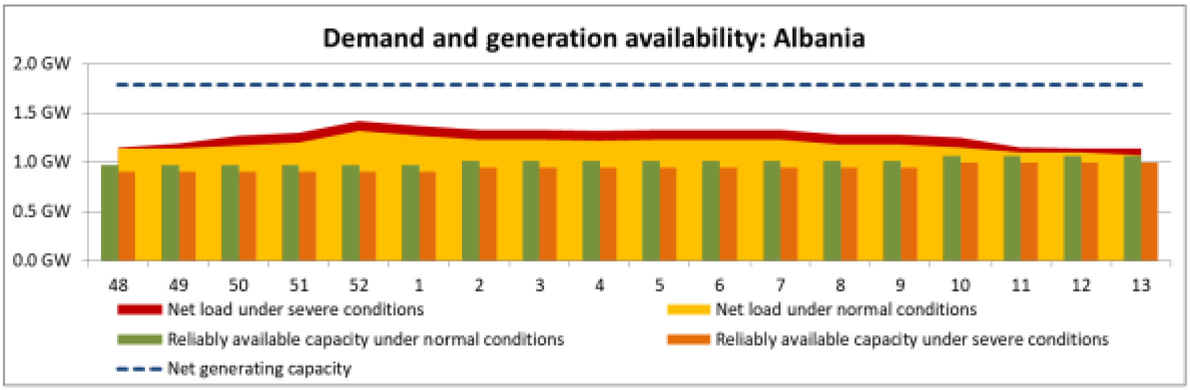
Furthermore, during weeks 27 and 30, the importing and exporting capacity of the Lithuanian grid was reduced by an unplanned outage of NordBalt HVDC interconnection.

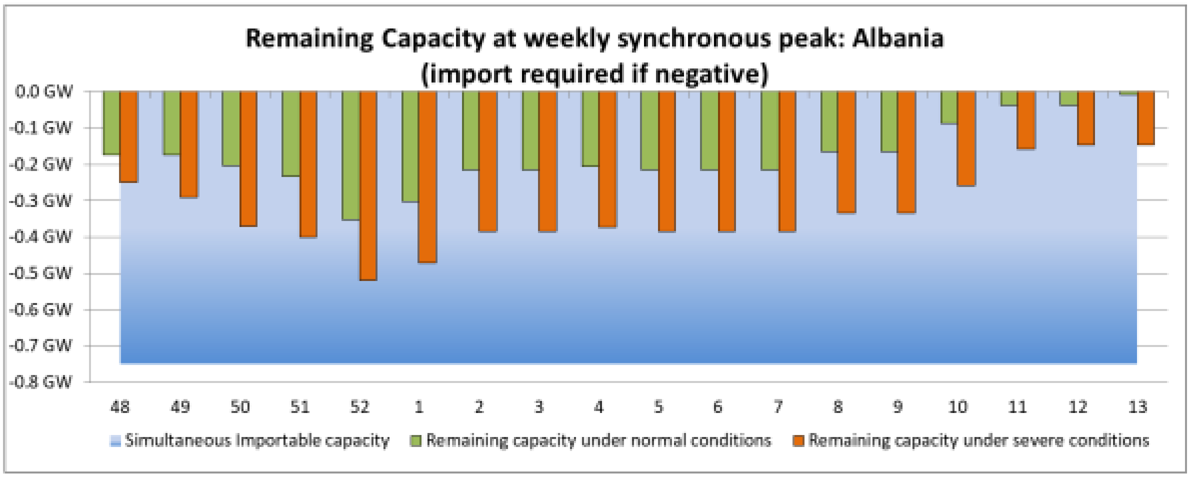
Appendices

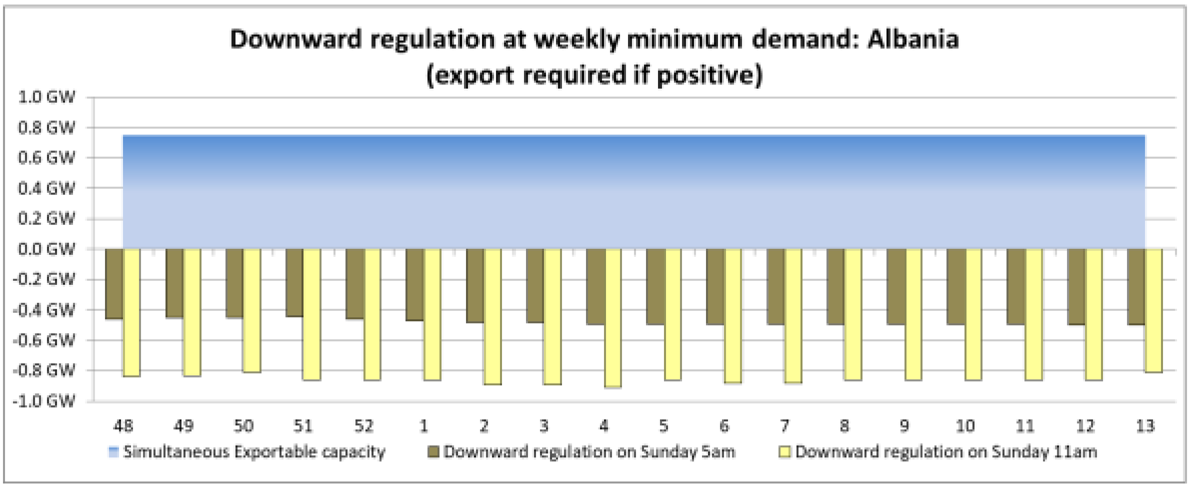
Appendix 1: Individual Country Comments on the Winter Outlook and Summer Review

Albania: Winter Outlook 2017/2018

Regarding Winter 2017/2018, Albania does not foresee any unexpected event or issue that could threat system adequacy. Hydro generation and the import contracts mainly will fulfil system adequacy. The maintenance schedule is reduced to a minimum, providing enough capacity for import, or in the case of high hydro levels for export. The import levels will be around 300–400 MW through firm import contracts.







Albania: Summer Review 2017

General comments on past summer conditions

The most critical period remains during the months of July and August, depending on the temperatures, and due to the important maintenance schedule of units and transmission elements in that period. Considering the low inflow on hydro generation during the summer period, the distribution system operator (DSO) company had to cover most of the load through import contracts. Import was necessary to cover the DSO load and to prevent further decrease of reservoir levels during the summer. The transmission system was able to accommodate all flows through the interconnector, thereby utilizing the available capacity. This summer the temperatures were relatively higher compared to 2016, which caused a slight consumption increase compared to the previous year. No exceptional event occurred during the summer.

Austria: Winter Outlook 2017/2018[31]

The pumped storage plants (PSPs) have come to a minor change in the installed capacity. The PSPs of the ‘Kraftwerksgruppe Obere Ill-Lünersee’, which are installed in Austria, but are assigned to the German control block, are now considered by the German TSOs and are included in German dataset. The affected amount of power is approximately 1.7 GW. Nevertheless, it is assumed this capacity is considered as firm import for Austria as well as firm export from Germany in case of generation adequacy issues in Austria.

As mentioned in the Summer Outlook Report 2017, calculation of the PSPs’ availability has been adapted to meet the energy constraints of this type of power plant.

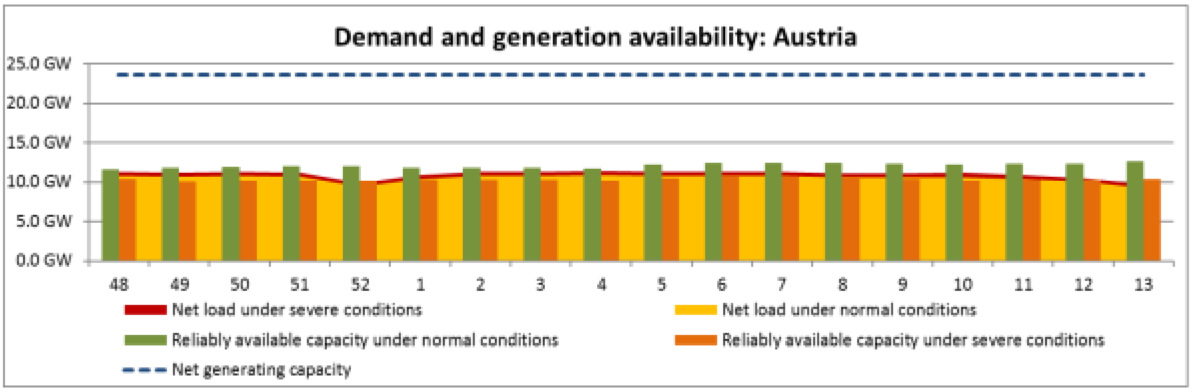
The new approach assumes that the plants only generate during peak time (Mo.–Fr. 8:00–20:00), which leads to a time frame of 60 h/week of generation.

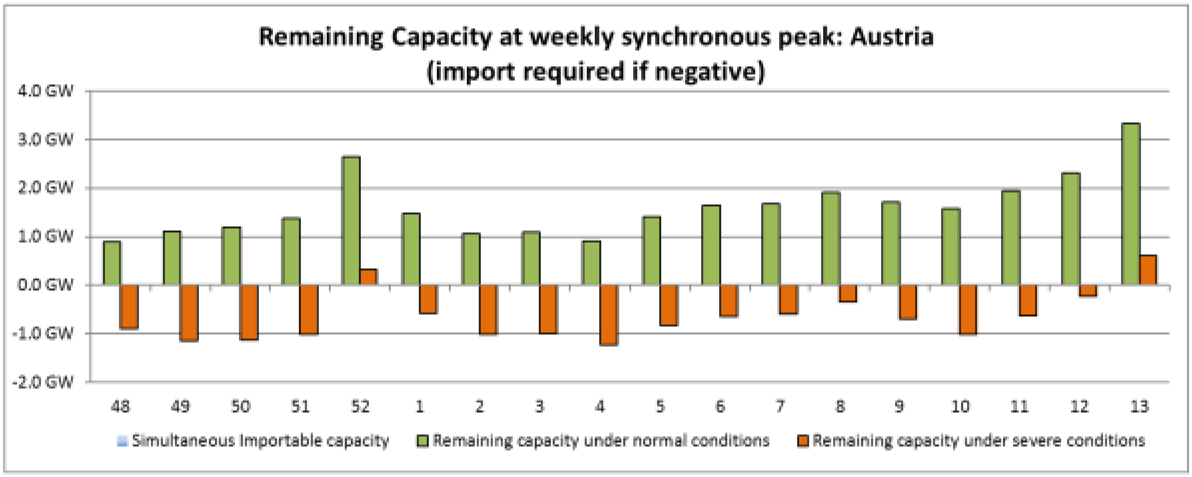
Referring to the generated energy of Austrian PSPs in a normal year and in a dry year (normal conditions / severe conditions) the reliable available power of PSPs was calculated by dividing this energy by 60 h for each week.

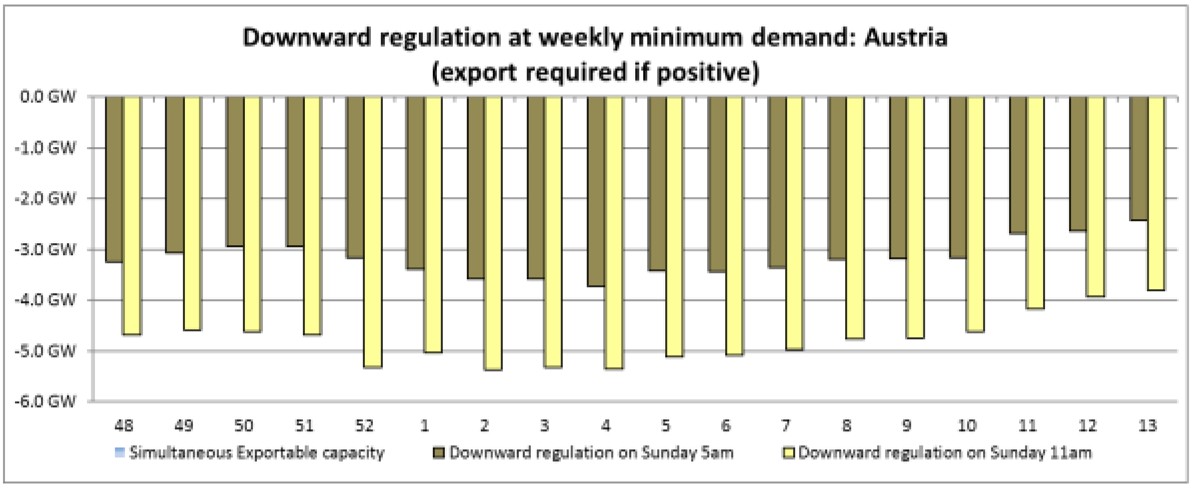
This approach considers the seasonal inflow and the sustainable exploitation of a PSP.

As there is still a common market between Austria and Germany, infinite NTC values were considered at this border.

[31] NTC in graphs is not represented because an infinite interconnection is considered with at least one country.







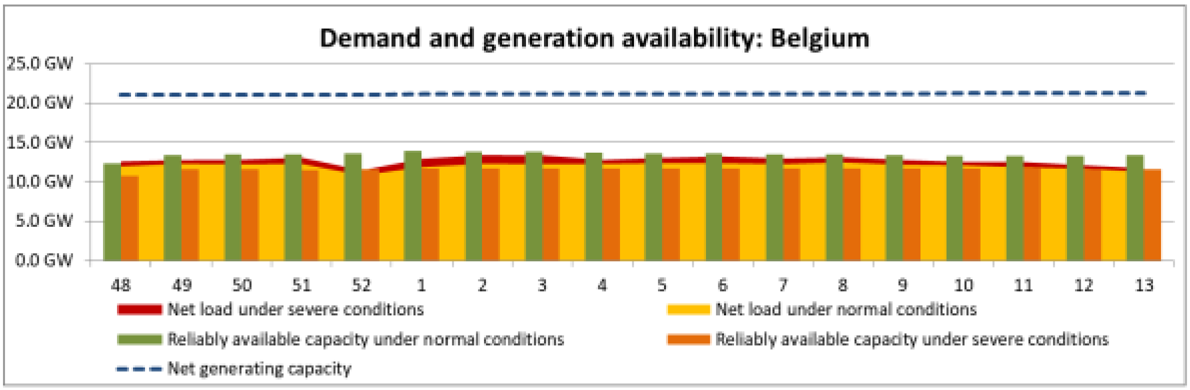
Austria: Summer Review 2017

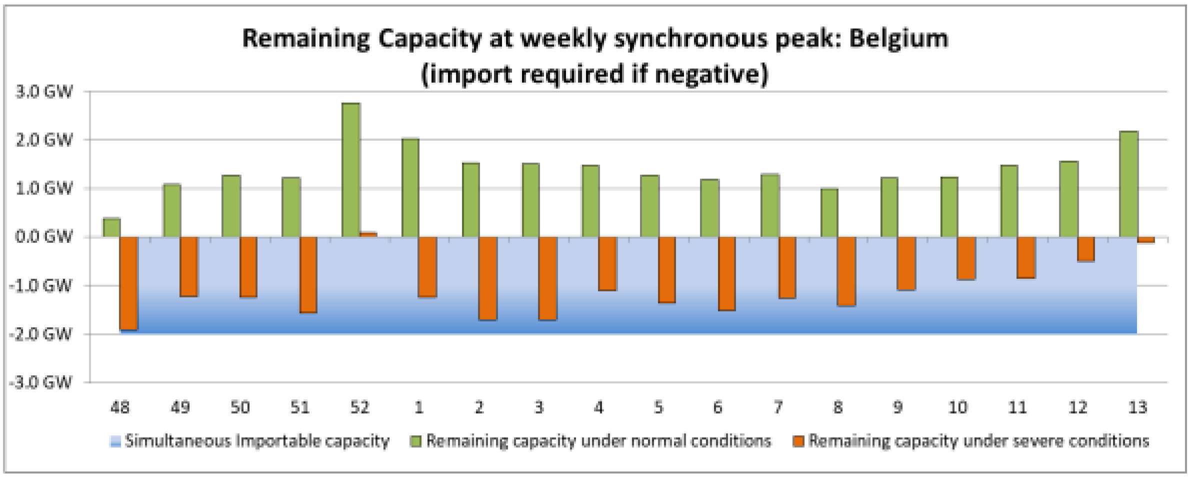
General comments on past summer conditions

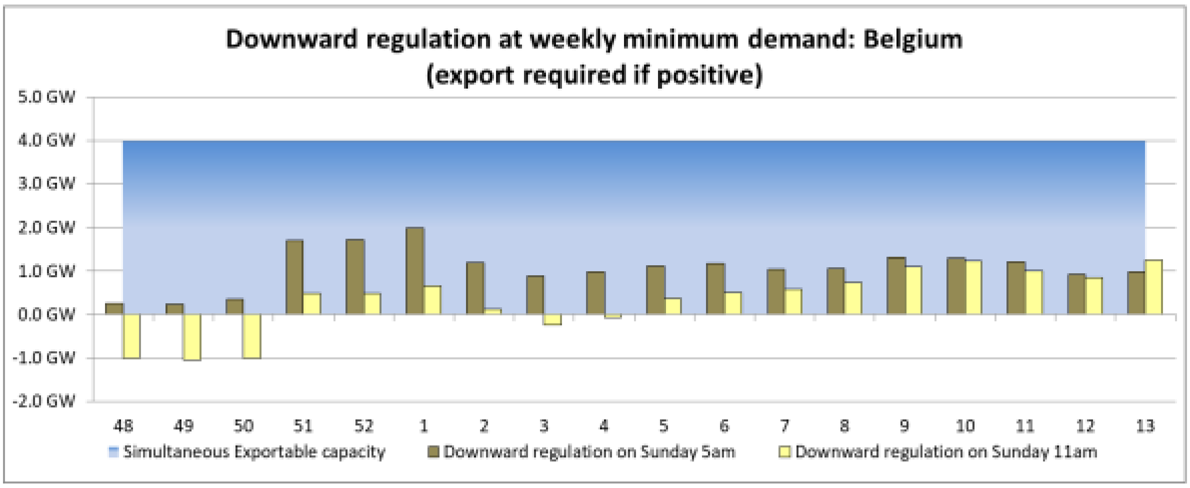
Summer 2017 was the third hottest in history. From June to August, the temperature in Austria was 2°C above the long-term average. Eleventh of the hottest summers since the beginning of metering in 1767 were detected during the last 17 years! Thus, sunshine was intense as well (18% above the average). Furthermore, precipitation was 2% higher than the average.

Belgium: Winter Outlook 2017/2018

The Belgian power system expects no adequacy issues for winter 2017/2018. Due to a better availability of the production park compared to winter 2016/2017, the balance between generation and consumption should be ensured. However, in a severe winter situation, Belgium still strongly depends on imports to cover the demand. The forecasted NTC value of 2,000 MW corresponds to the LTA (year) inclusion in the flow-based market coupling methodology. For winter 2017/2018, Belgium still has 725 MW of strategic reserves contracted in case of scarcity situations (at the moment of data collection, the best estimate of the volume was 900 MW). The strategic reserves are not taken into account in the graphs, which improves the situation for Belgium. On the other hand, the graph does not cover the absolute peak load of Belgium (only synchronous peak of EU), which is typically 600 MW higher.







Most critical periods for maintaining adequacy margins and counter-measures

The months December and January are the most stressful, with high import needs. In December, the trigger is a known unavailability of a nuclear unit, while in January the trigger is mainly the high consumption level. In the case of a simultaneous import need in France, such as due to a cold wave, the high import level for Belgium is not guaranteed.

In this case, Belgium has 725 MW of strategic reserves available to secure its adequacy. During the stressful period, no works are planned on the network that could limit the import capacity. On top of this, 'Ampacimon modules' (dynamic line rating) are installed on our interconnection lines which, depending on positive weather conditions (wind and temperature), increases the nominal power of the interconnection lines.

Most critical periods for downward regulation and counter-measures

Regarding incompressibility issues, the period around the holidays, in particular Christmas Day, has an increased risk of oversupply.

Belgium: Summer Review 2017

General comments on past summer conditions

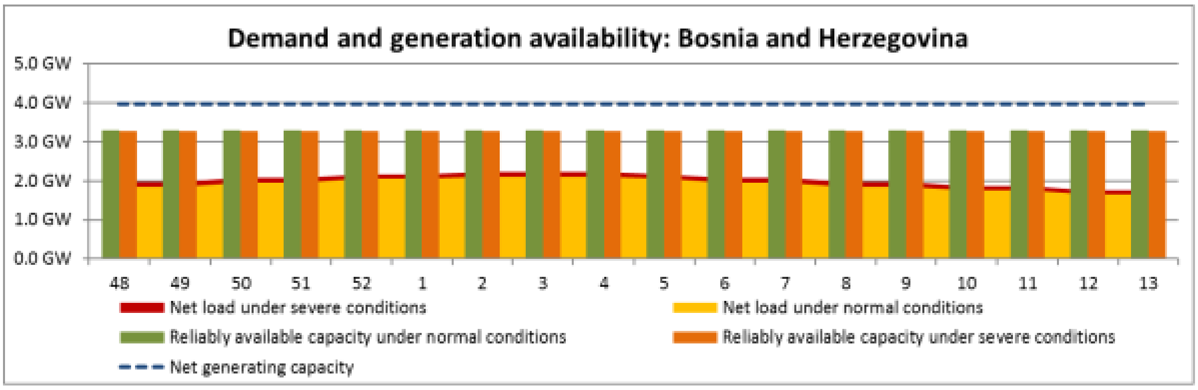
Belgium did not encounter any problems of incompressibility during summer 2017.

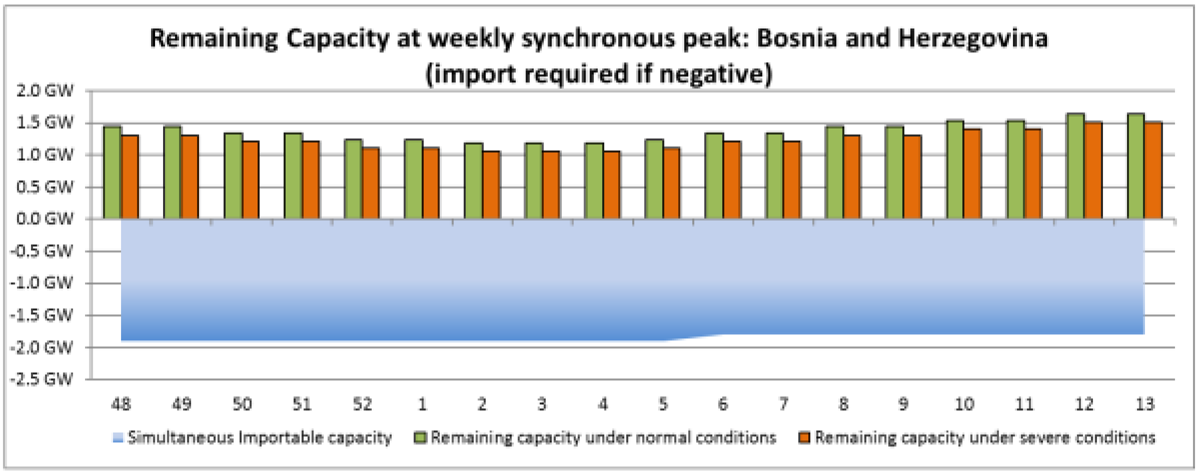
Specific events and unexpected situations that occurred during the past summer

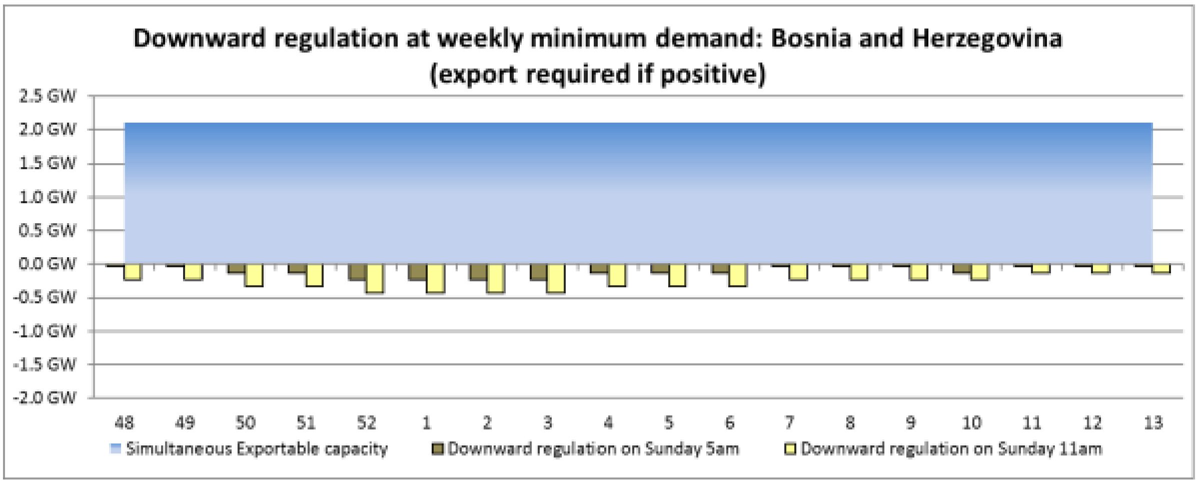
During summer 2017, Elia had to cope with an unplanned outage of a Phase Shifter Transformer (PST) in Zandvliet and some long planned outages of 380 kV lines, which temporarily impacted the import capacity.

Bosnia and Herzegovina: Winter Outlook 2017/2018

Regarding power system adequacy in Bosnia and Herzegovina for the winter 2017/2018, we do not expect any problems. We predict that in the next winter period our consumption would stay at approximately the same level as last year; a positive power balance is expected.





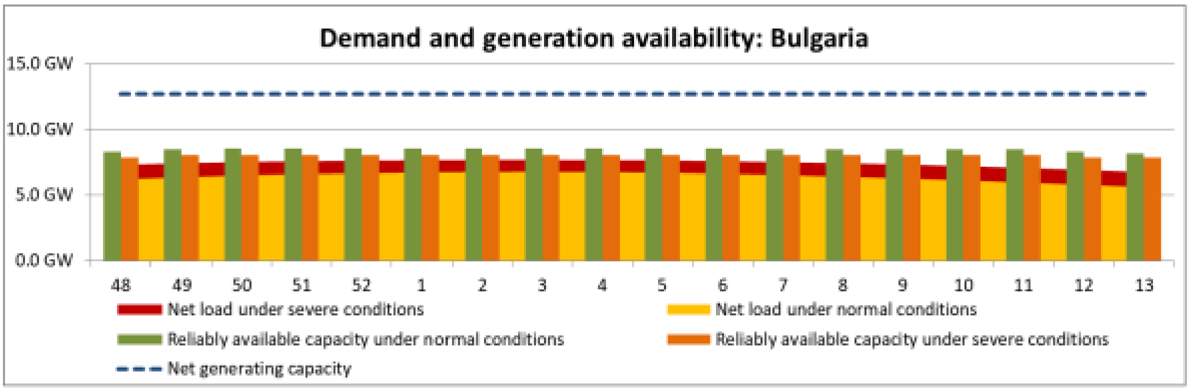


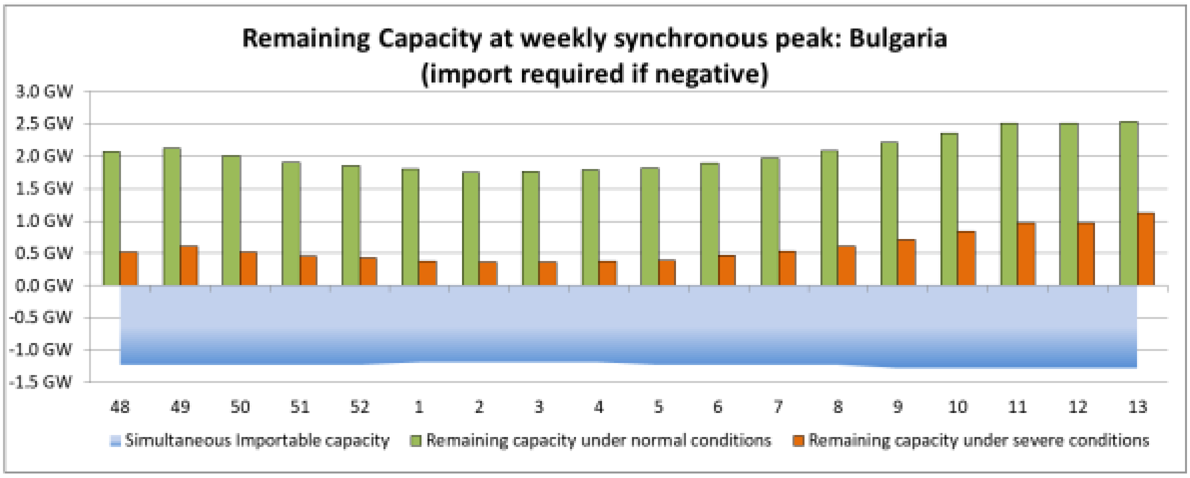
Bosnia and Herzegovina: Summer Review 2017

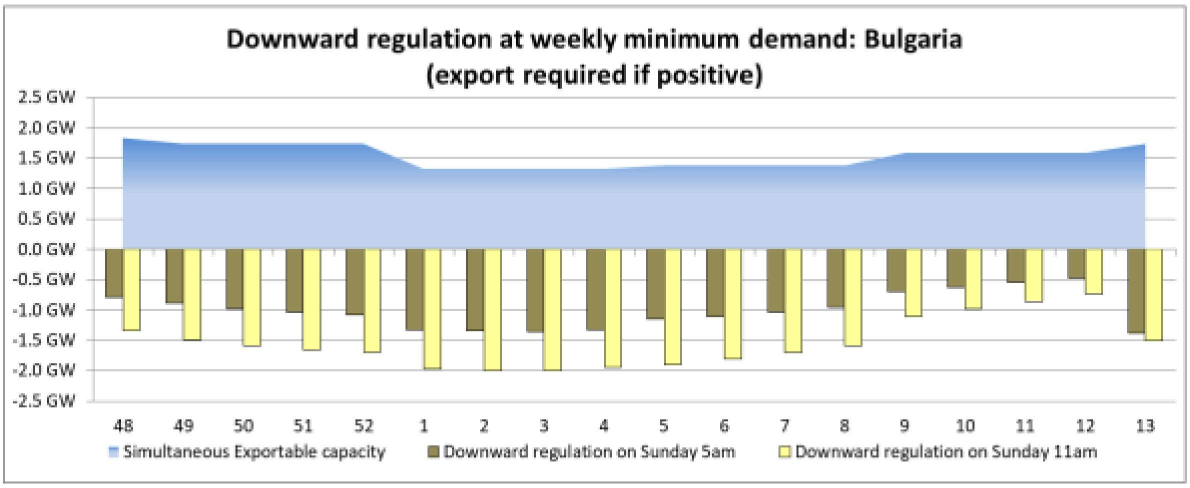
During summer 2017, there were no unexpected situations that affected the power system in Bosnia and Herzegovina. The minimum load of 876 MW was registered on 11 June at 6:00, while the maximum load of 1,705 MW was registered on 31 August at 21:00. Monthly power balances were positive during this period.

Bulgaria: Winter Outlook 2017/2018

Considering the unfortunate series of circumstances from the past winter, measures are being taken to prevent or at least mitigate contingencies. The maintenance programme continues and will be fulfilled completely according to schedule. Furthermore, all providers of strategic (cold) reserve have assured the ESO (Bulgarian TSO) that counter-measures are taken to ensure that last winter's events will not be repeated and all facilities will be ready for operation. Hydro generation during summer 2017 was at a minimum to save water resources to reach the target levels in the reservoirs for the upcoming winter period. Nevertheless, the hydrological data indicates this year is shaping up as dry.







Bulgaria: Summer Review 2017

General comments on past summer conditions

No adequacy issue was identified in Bulgaria during the last summer season.

Specific events and unexpected situations that occurred during the past summer

None.

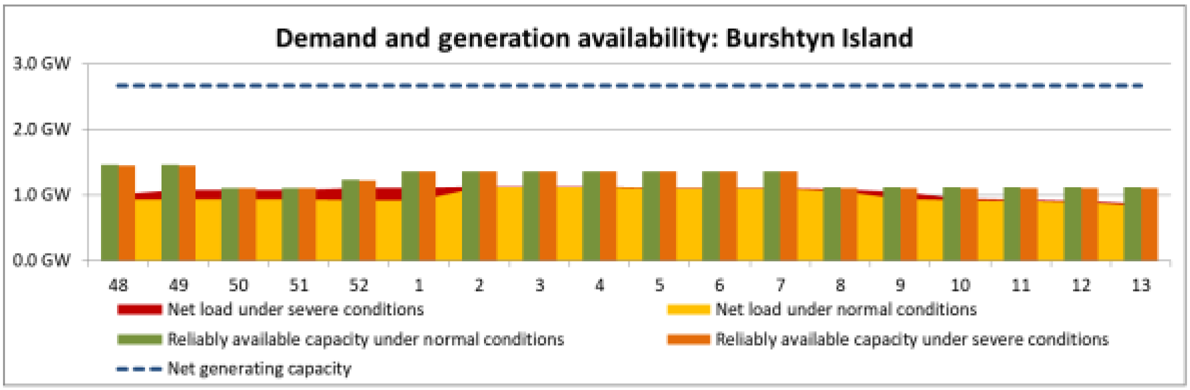
Burshtyn Island: Winter Outlook 2017/2018

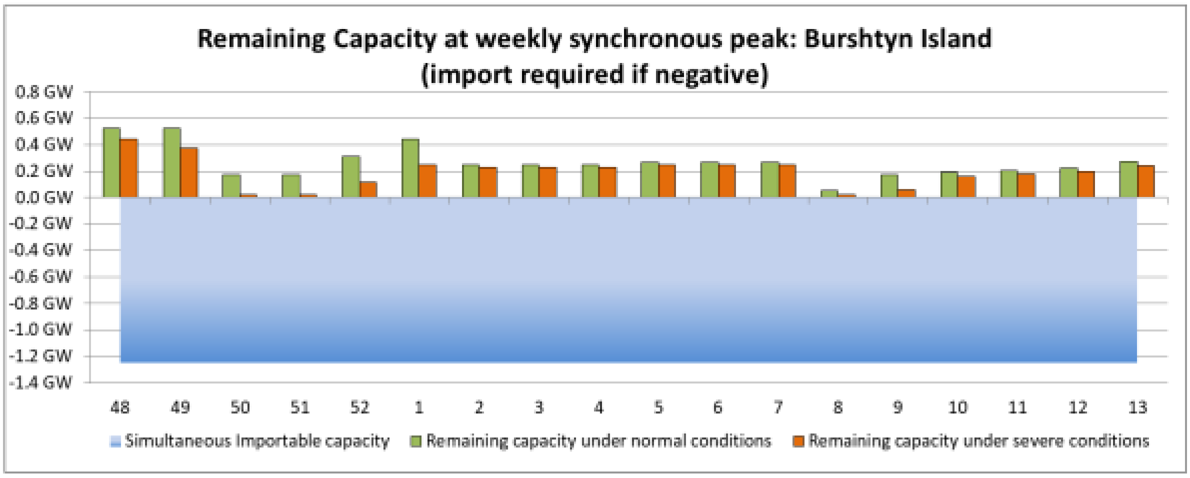
Most critical periods for maintaining adequacy margins and counter-measures

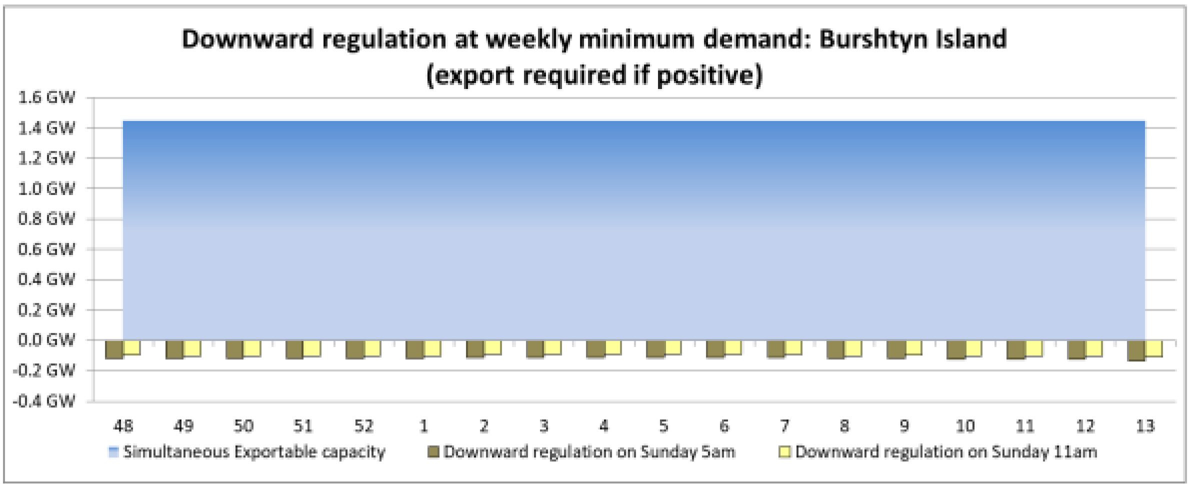
No adequacy issue is expected in Burshtyn Island for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.







Burshtyn Island: Summer Review 2017

General comments on past summer conditions

No adequacy issue was identified in Burshtyn Island during the last summer season.

Specific events and unexpected situations that occurred during the past summer

None.

Croatia: Winter Outlook 2017/2018

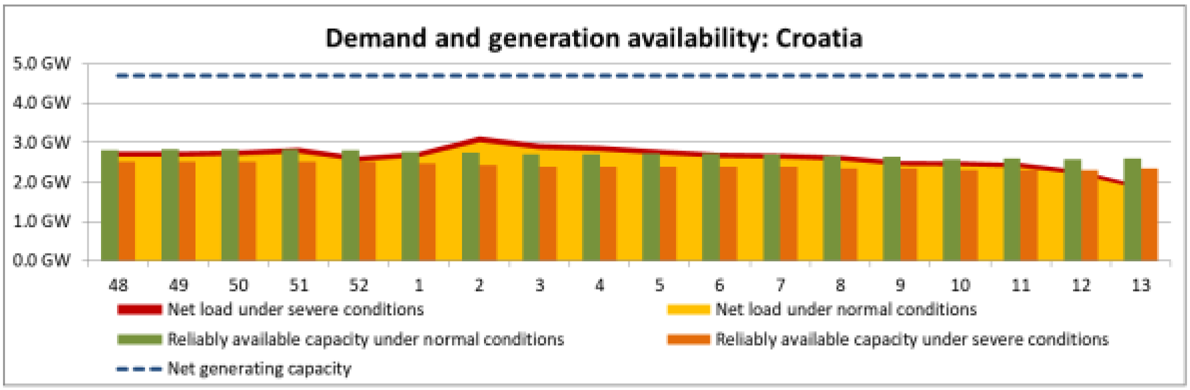
The Croatian transmission system operator (HOPS) does not expect any unusual issue during winter 2017/2018. The amount of imported electricity will depend on weather conditions, and first of all on the water inflows to hydro storages.

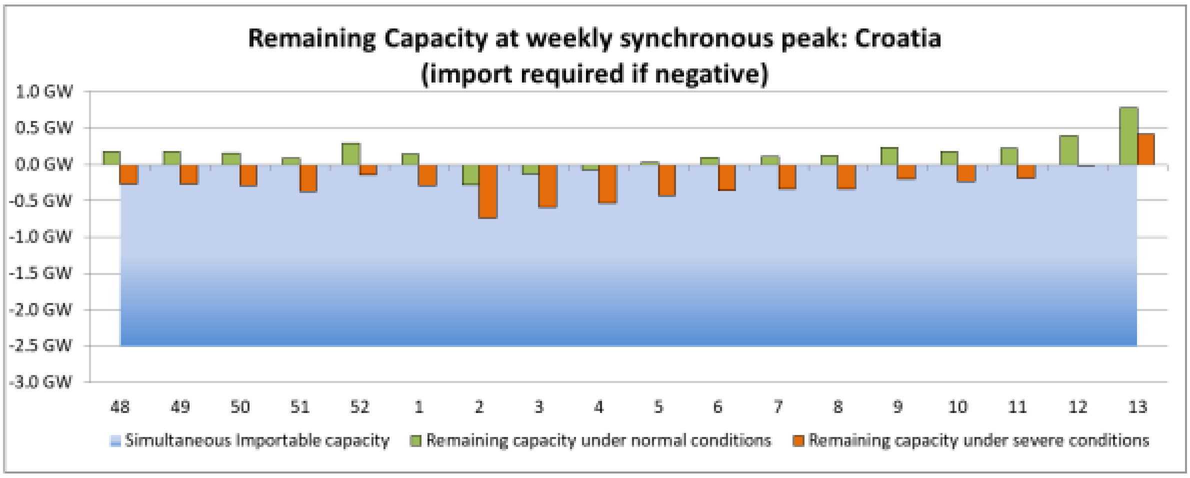
Most critical periods for maintaining adequacy margins and counter-measures

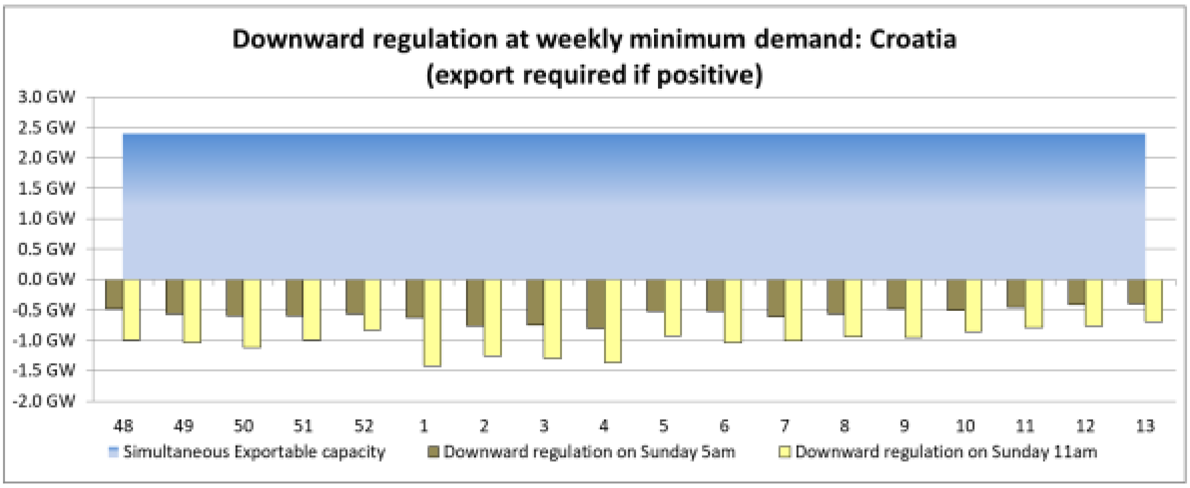
The most critical periods are those with extremely low temperatures.

Most critical periods for downward regulation and counter-measures

Problems with downward regulation are not expected.







Croatia: Summer Review 2017

General comments on past summer conditions

Due to extremely hot weather, the consumption of electricity in the Croatian power system increased, especially at the beginning of August 2017. Consequently, the import of electricity reached its highest values.

Specific events and unexpected situations that occurred during the past summer

There were no specific events or unexpected situations.

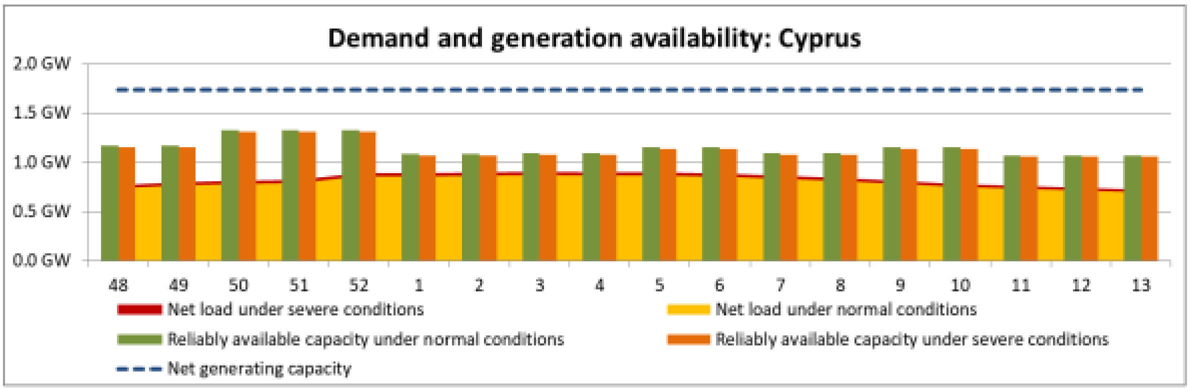
Cyprus: Winter Outlook 2017/2018

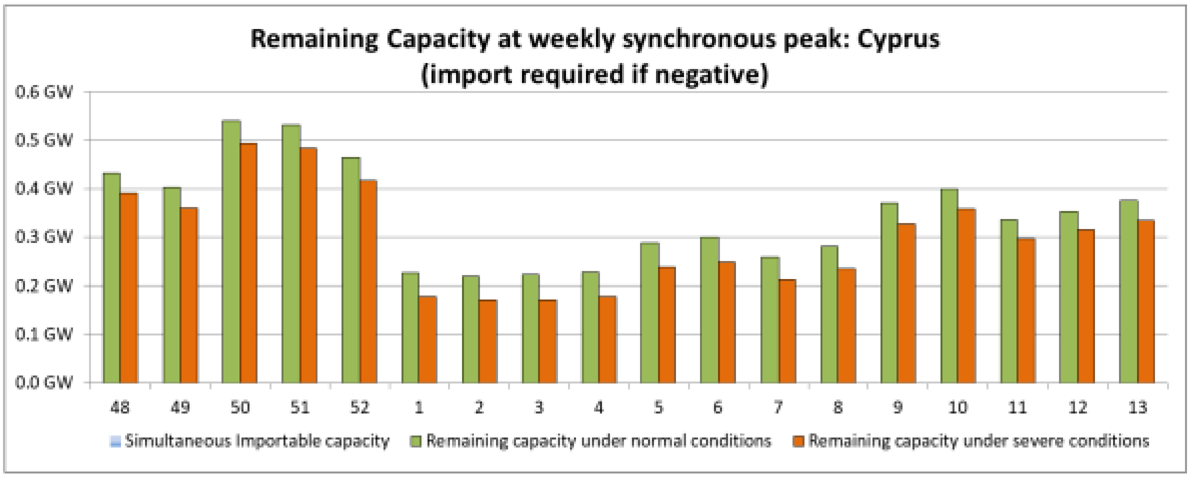
Most critical periods for maintaining adequacy margins and counter-measures

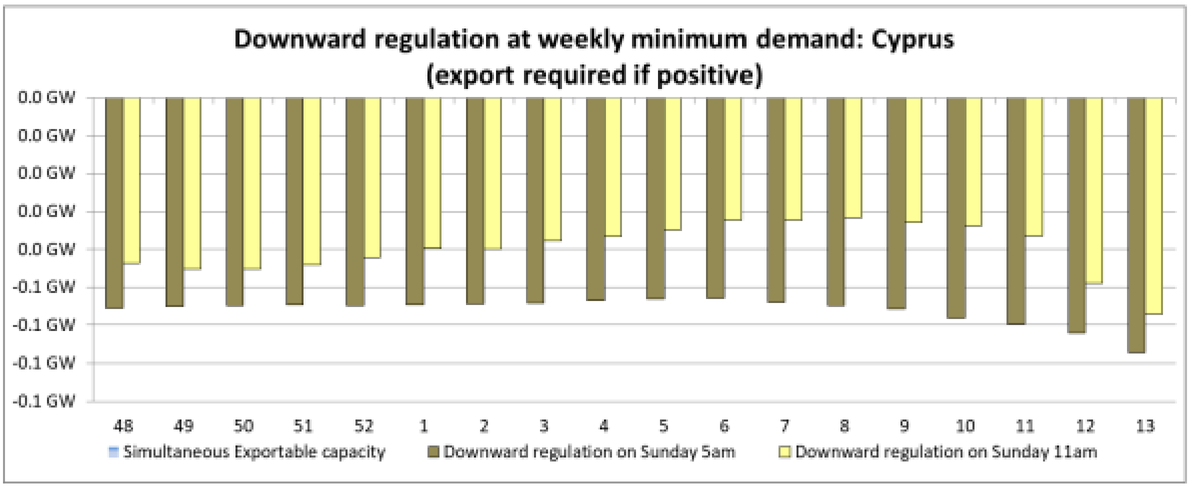
No adequacy issue is expected in Cyprus for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.







Cyprus: Summer Review 2017

General comments on past summer conditions

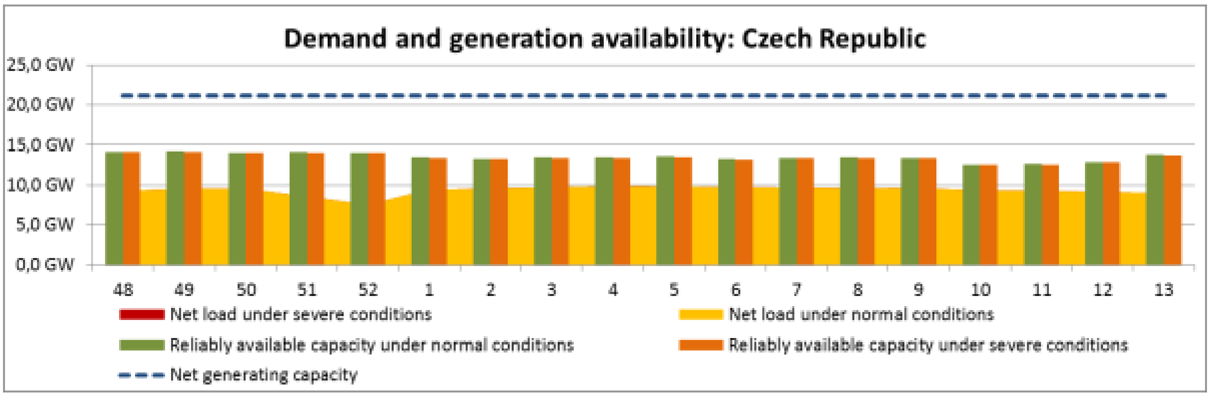
No adequacy issue was identified in Cyprus during the last summer season.

Specific events and unexpected situations that occurred during the past summer

None.

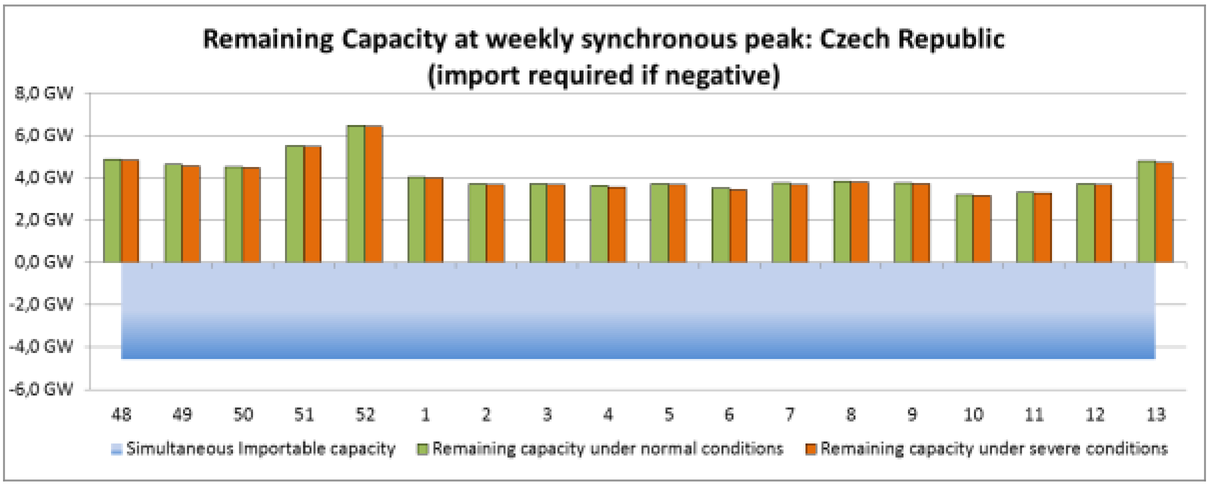
Czech Republic: Winter Outlook 2017/2018

CEPS (Czech Republic TSO) is not expecting any generation or system adequacy problems during the upcoming winter period. The national Net Generating Capacity is slightly lower due to the partial decommissioning of an old lignite power plant. However, a new modern overcritical steam block will be put into operational mode. Renewable energy sources (RES) installed capacity continues to stagnate. Compared to last winter, we expect the Wednesday peak load to be slightly lower. Overall, a slightly higher number of outages are planned. Thanks to the Phase Shifting Transformers (PSTs) installed at the Czech Republic–Germany border, the NTC values for import are noticeably higher, and the export capabilities are more stable throughout the period.



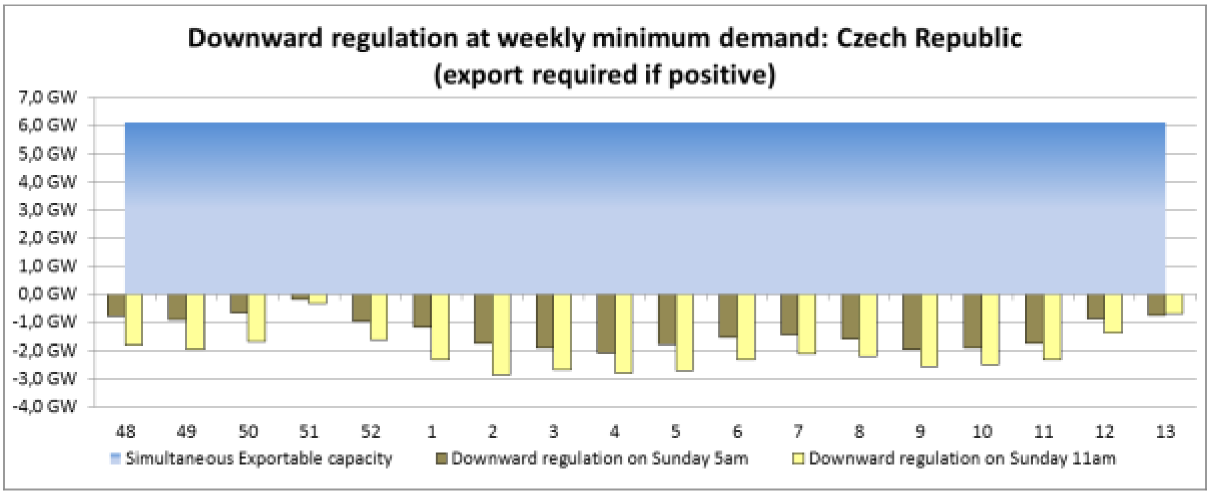
Most critical periods for maintaining adequacy margins and counter-measures

We do not expect any upward adequacy issues.



Most critical periods for downward regulation and counter-measures

We do not expect any downward regulation problems, not even the need for export during the Christmas period when the load is typically low.



Czech Republic: Summer Review 2017

General comments on past summer conditions

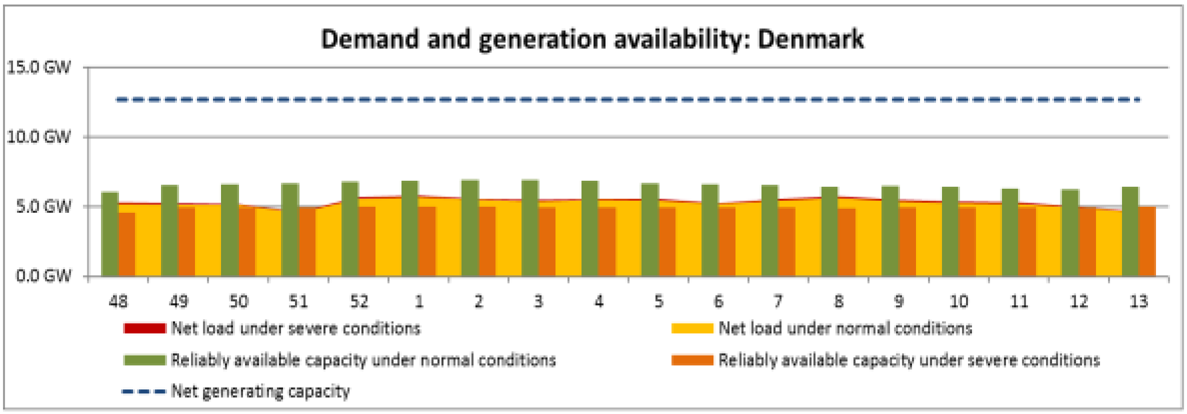
The prices in 4M Market Coupling were considerably higher in July and August compared to 2016. The average temperature in this summer period was 1.07°C above normalized temperature.

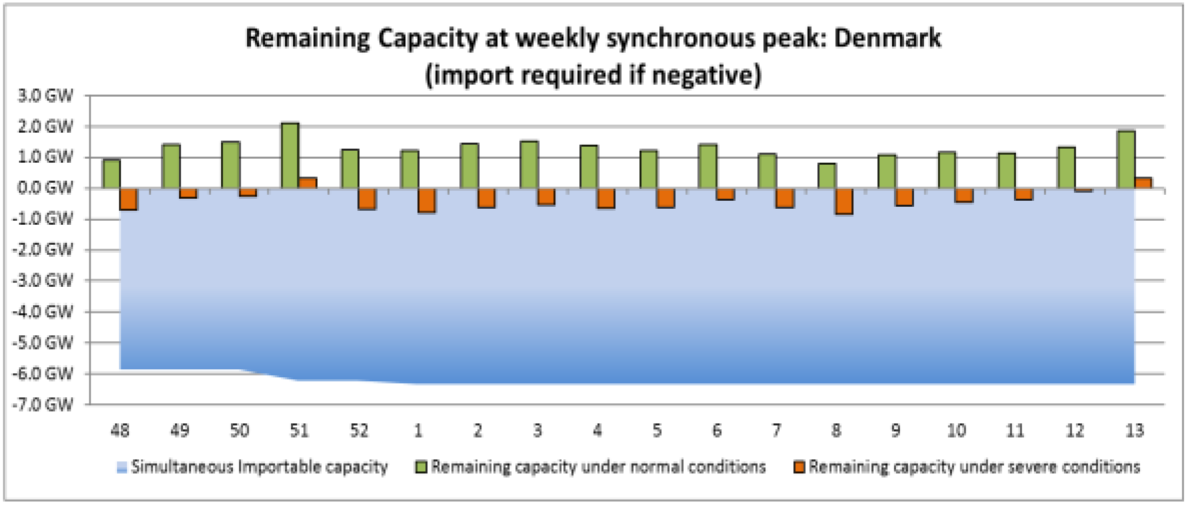
Specific events and unexpected situations that occurred during the past summer

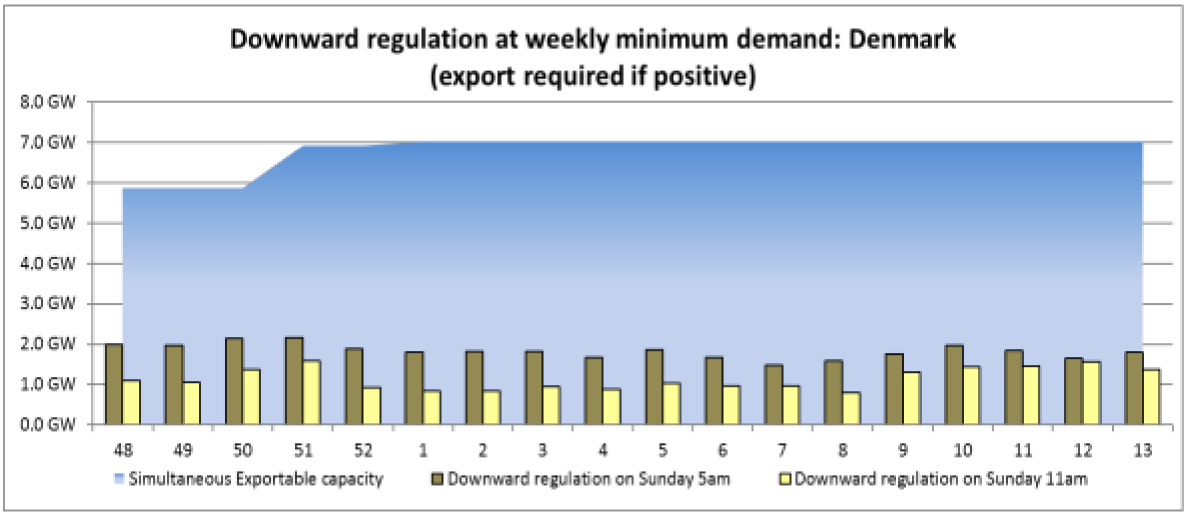
A high number of outages (higher than planned) caused a voltage imbalance in the northern regions at the end of May. The unloaded lines generated more reactive power, and some parts experienced a lack of compensation capabilities. The situation was handled by shutting down some of the unloaded lines and activating extra generating capacity. There were both domestic and international re-dispatches of 4,500 MWh in total (that is, circa 205 MW in average power for 22 hours) on 3–4 August 2017 caused by power issues in the central Bohemian region. The international re-dispatch happened at the Czech Republic–Austrian (CEPS–APG) border. In July 2017, the last two of four PSTs (Czech Republic–Germany) at the ‘Hradec u Kadaně’ substation were commissioned.

Denmark: Winter Outlook 2017/2018

Energinet expects a stable winter. The power situation seems fine. The expected power plant outages are at a minimum and also the restriction on the connections to Germany and Sweden/Norway. There are some grid outages that affect the capacity, but generally it looks reasonable.







Most critical periods for maintaining adequacy margins and counter-measures

In October and November there are some restrictions due to work on the border connection between Sweden and Denmark (SE4–DK2). The expectation is that it will not cause any adequacy problems.

Due to the load flow conditions and wind in feed in the North of Germany, the capacity on the Danish–German border (TTG–Energinet) can vary between 320 MW and 1,500 MW (DE→DK1) and 320 MW and 1,640 MW (DK1→DE).

Most critical periods for downward regulation and counter-measures

Energinet does not expect any problems with downward regulation. Normally there will a large amount of downward regulation, especially if there is a lot of wind production.

In periods with high wind production, Energinet expects counter-trade on the Danish–German border (TTG–Energinet) because of the high amount of wind production in the northern part of Germany.

A new agreement that gives a guaranteed capacity to the market will also increase the amount of counter-trade on the Danish–German border, especially in periods with a high amount of wind production.

Energinet will down regulate the counter-trade amount in DK1 and DK2.

Denmark: Summer Review 2017

General comments on past summer conditions

The power balance in Denmark and the Nordics has been stable and sufficient during the summer. However, the prices have increased due to the higher cost of coal and lower wind production. This has caused prices to increase in most parts of Europe.

During August and September, Energinet and 50Hertz were forced to reduce the capacity between DK2–DE due to an error on the Kontek cable.

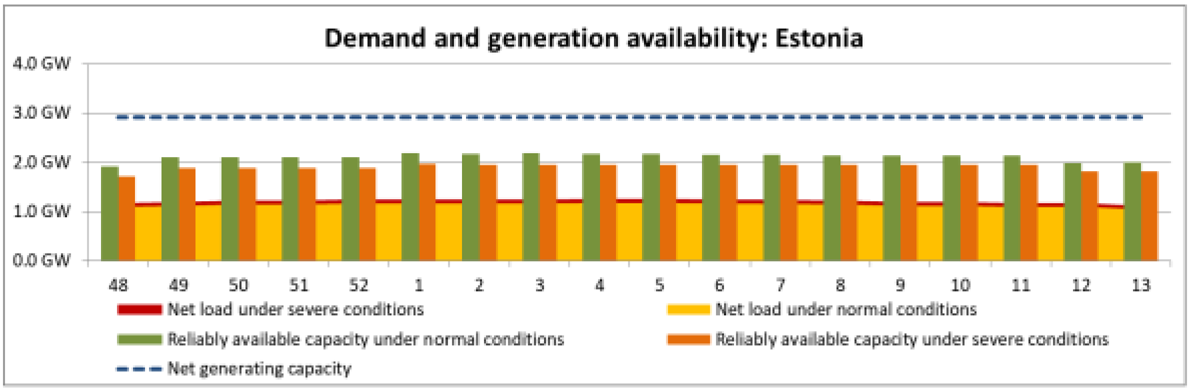
The capacity between Energinet and Statnett (DK1–NO2) also was reduced between August and October due to an error on the Skagerrak cable.

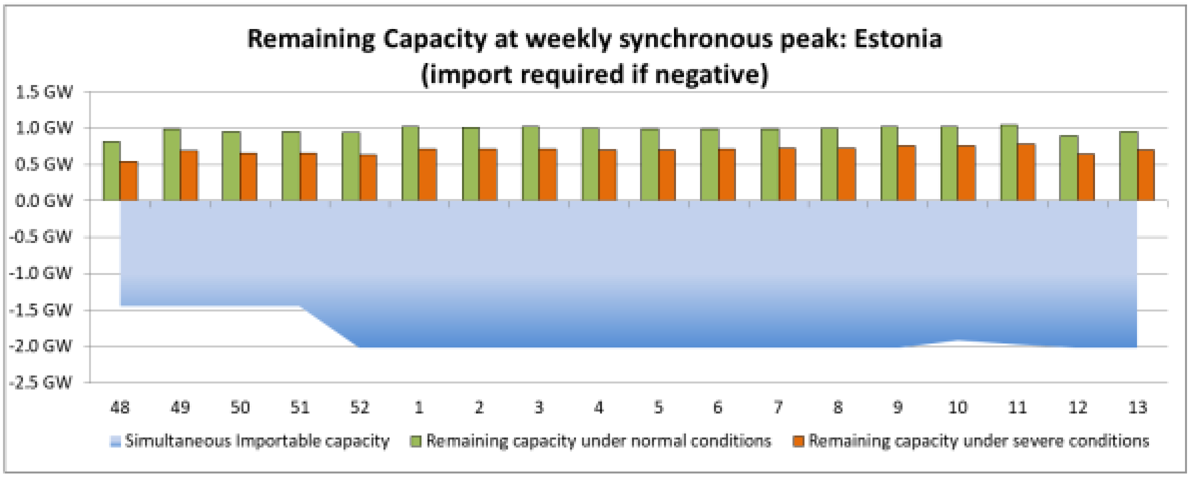
Specific events and unexpected situations that occurred during the past summer

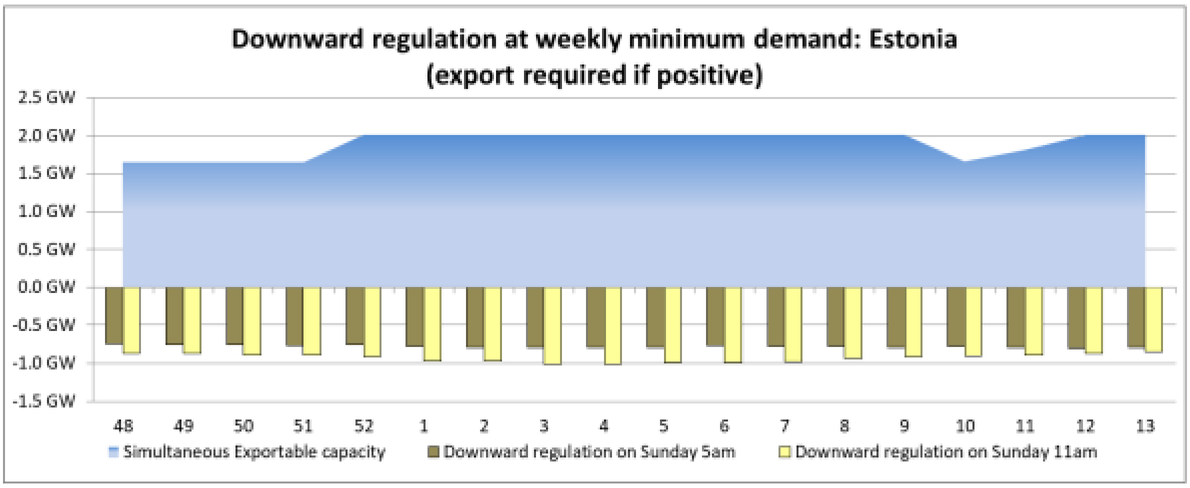
The Danish Ministry of Energy, Utilities and Climate and the Federal Ministry of Economic Affairs and Energy of the Federal Republic of Germany, together with the Danish Energy Regulatory Authority and Bundesnetzagentur, have signed a Joint Declaration that ensures a minimum amount of day-ahead capacity for trade between Western Denmark (DK1) and Germany. The Joint Declaration aims to gradually increase the capacity between Western Denmark (DK1) and Germany available to the day-ahead market by securing a minimum of available hourly import and export capacity in each hour on the interconnector. The Joint Declaration was launched with a pilot project on 3 July, and will until 2020 increase the minimum capacities in a stepwise approach. Currently, the Joint Declaration only specifies minimum capacities until the end of 2020.

Estonia: Winter Outlook 2017/2018

The coming winter 2017/2018 is expected to be normal with no extraordinary circumstances. Generation capacity in Estonia is considered sufficient to cover peak loads during the winter season, and the power balance is expected to be slightly positive. However, the low energy prices in northern countries favour the import from Finland. The highest peak load is commonly expected in the second half of January or in the first half of February.







Most critical periods for maintaining adequacy margins and counter-measures

Transmission capacity between Estonia and neighbouring systems will be smallest during weeks 48–51, when maintenance works in Estonian and Latvian networks are planned and transmission capacity between Estonia and Latvia is limited. The second time when the transmission capacity is smaller than usual is week 10, when there is planned maintenance in the Estonian grid, which also limits the transmission capacity between Estonia and Latvia.

The exchange capacity between Estonia and Finland will be at a maximum. The capacities may be reduced for some periods due to some maintenance works in the Estonian grid.

Most critical periods for downward regulation and counter-measures

No critical periods are expected and probably will not be a problem.

Estonia: Summer Review 2017

General comments on past summer conditions

The average temperatures of the summer months were slightly lower than usual—about 15°C. The highest measured temperature this summer was 30.8°C in August, and the lowest temperature was –1.1°C in June. The amount of precipitation was slightly lower than average.

Specific events and unexpected situations that occurred during the past summer

There were no significant events concerning generation, demand or transmission.

Finland: Winter Outlook 2017/2018

As in the previous winters, Finland is a deficit area during peak demand hours. The electricity demand strongly depends on outside temperature. The most critical situation is in January and in February when the coldest temperatures are typically reached.

Compared to the previous winter, the situation has remained quite the same. The peak load estimate in severe weather conditions is slightly increased to 15.2 GW based not only on new industrial consumption, but also constant increase of heat pumps in households.

The available generation capacity without peak load reserve (Finnish strategic reserve) is expected to be the same, 11.3 GW, as in the previous winter. Including peak load reserve, the generation capacity has increased by 0.4 GW. Two new combined heat and power plants (CHPs) have been installed, but meanwhile some of existing power plants have been transferred to the peak load reserve arrangement. Wind power capacity also has increased by 0.5 GW, but that has only a minor influence on the estimated available generation.

The 3.2 GW deficit is expected to be met with import from neighbouring areas. However, in the case of a major power plant or interconnection failure in cold period, there is a risk for a power shortage.

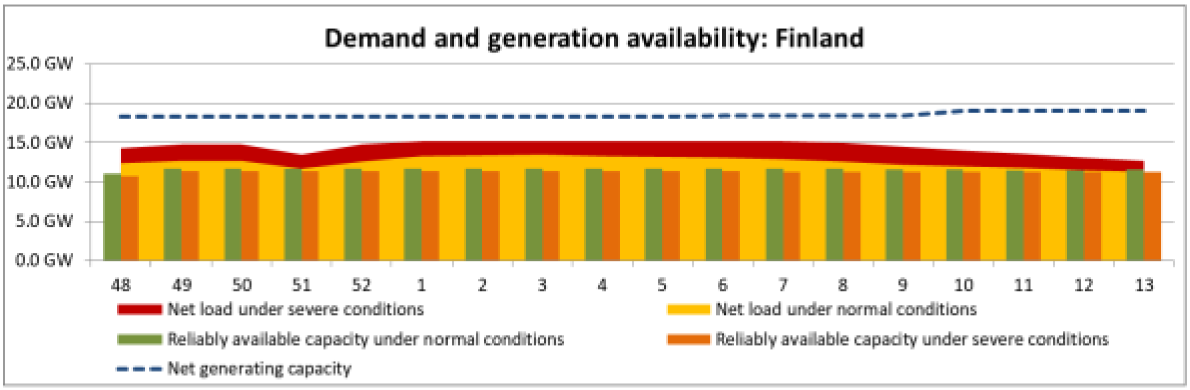
Most critical periods for maintaining adequacy margins and counter-measures

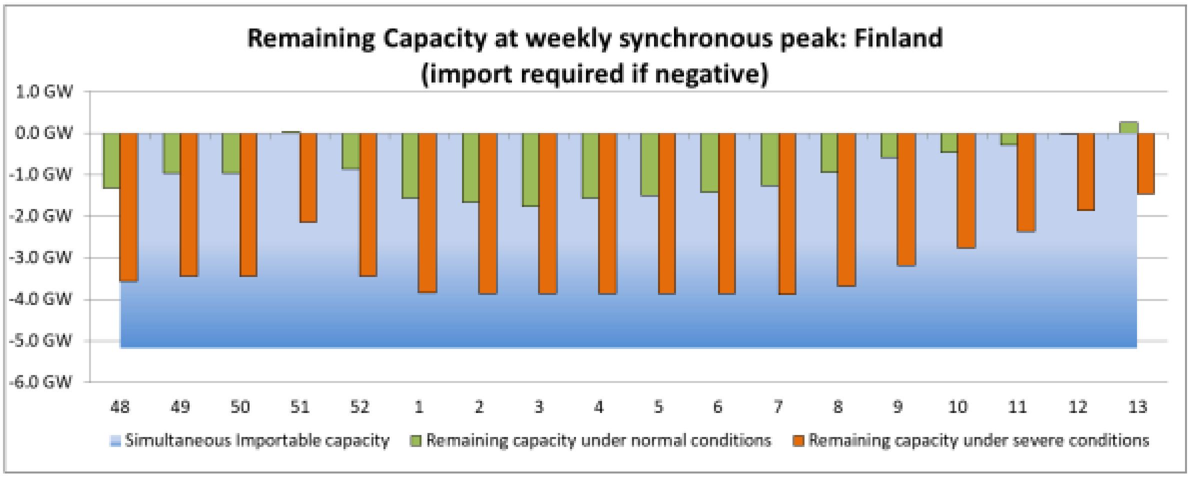
Import is needed to cover the demand during peak hours. The maximum deficit in severe conditions, considering strategic reserves, is 3.2 GW in weeks 1–7. The import capacity on interconnections, 5.1 GW, is sufficient to meet the deficit.

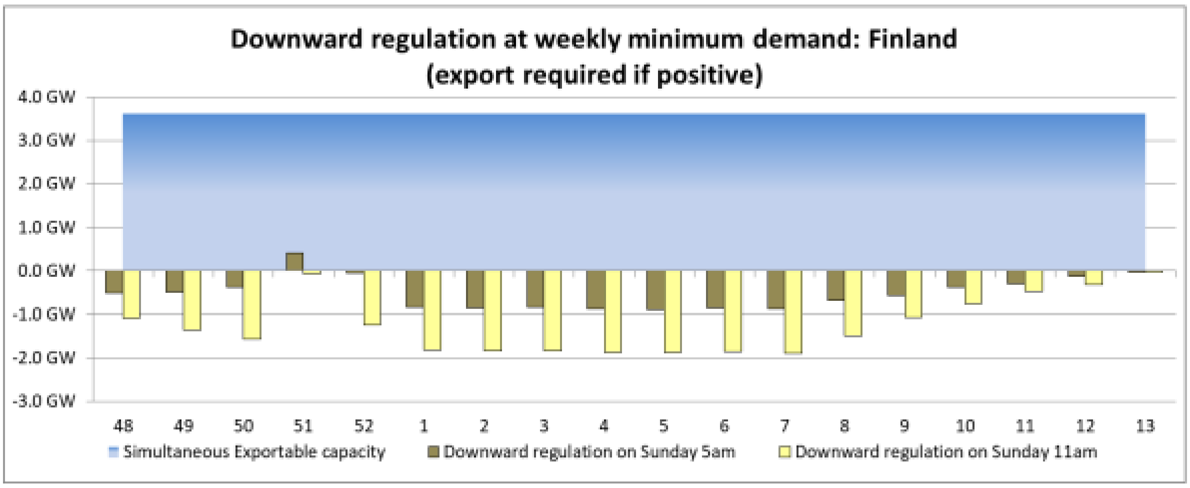
The required amount of import is expected to be available from neighbouring areas also in severe weather conditions. However, it should be noted there are uncertainties with Russian import due to the impact of capacity payments on the Russian electricity markets.

Most critical periods for downward regulation and counter-measures

During the coming winter, Finnish installed wind capacity will reach 2.0 GW. Hence, in the coming winter during minimum demand and maximum wind conditions, there is a risk for oversupply situations where down-regulation or export is needed to balance the system.







Finland: Summer Review 2017

General comments on past summer conditions

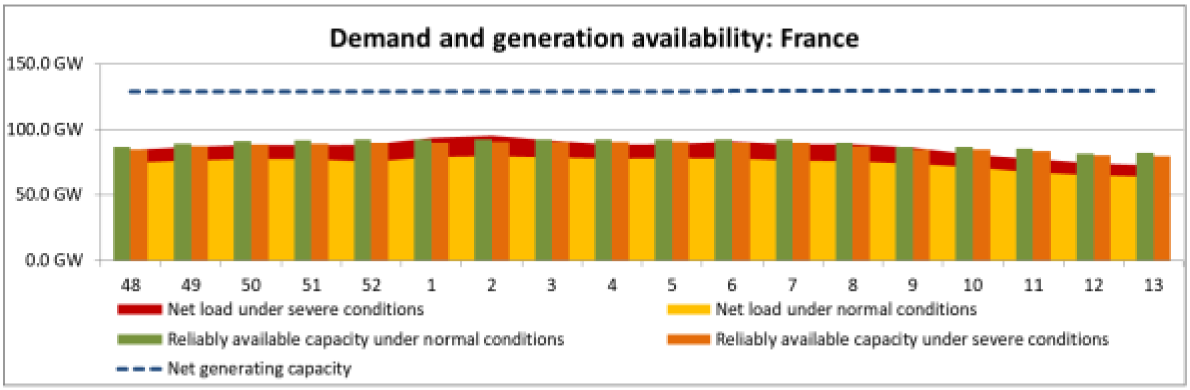
There was neither adequacy problems nor deviations from expectations during summer 2017.

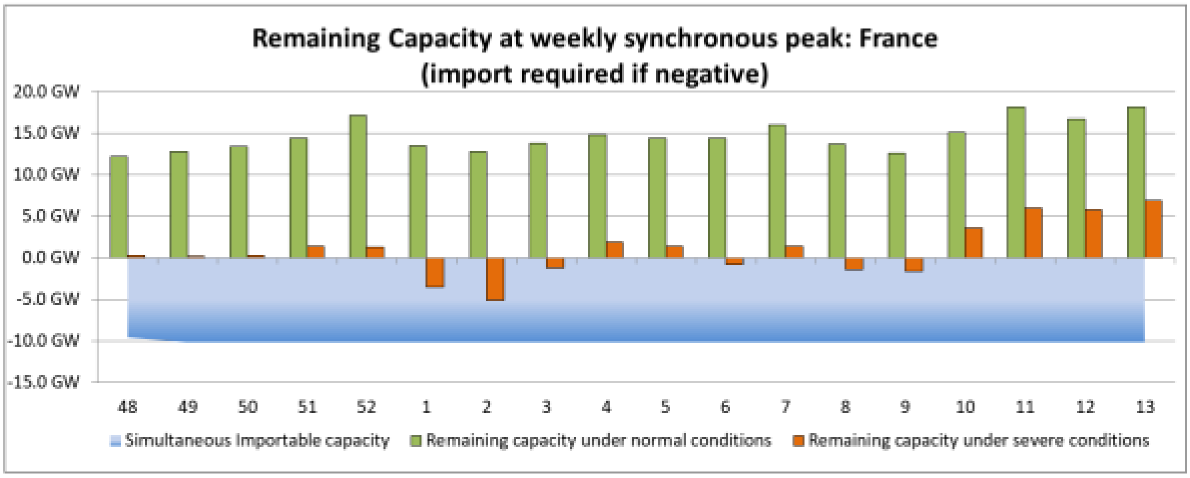
Specific events and unexpected situations that occurred during the past summer

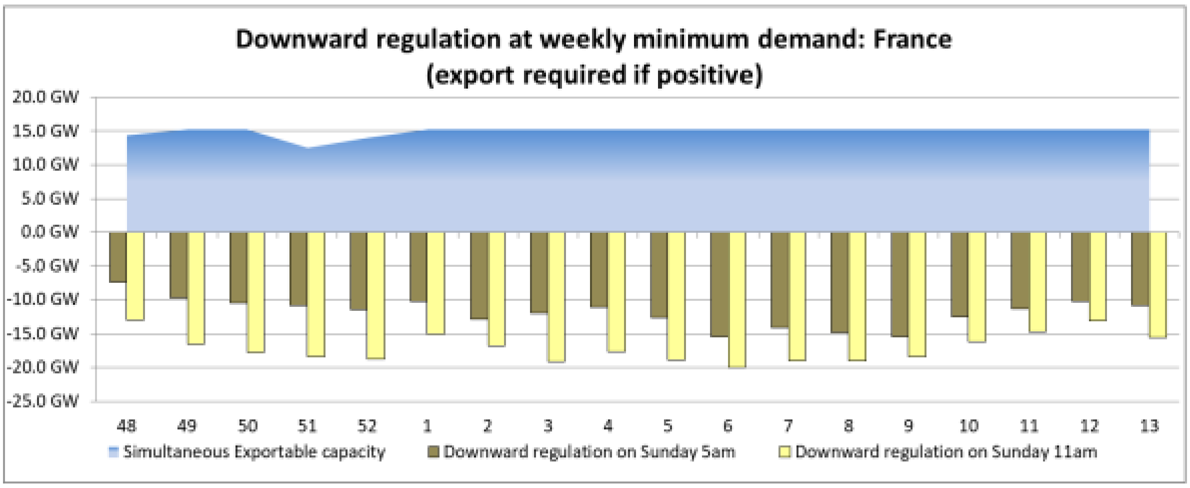
Several overhauls of both production units and transmission lines were carried out in summertime as predicted. All incidents were managed with normal system operation procedures.

France: Winter Outlook 2017/2018

This winter, France expects the situation to be better than last year, as the nuclear maintenance plan is back to the average availability of the last 10 years. Yet, the margins are tighter than two years ago with the shutdown of more than 4 GW of fossil oil plants in 2017.

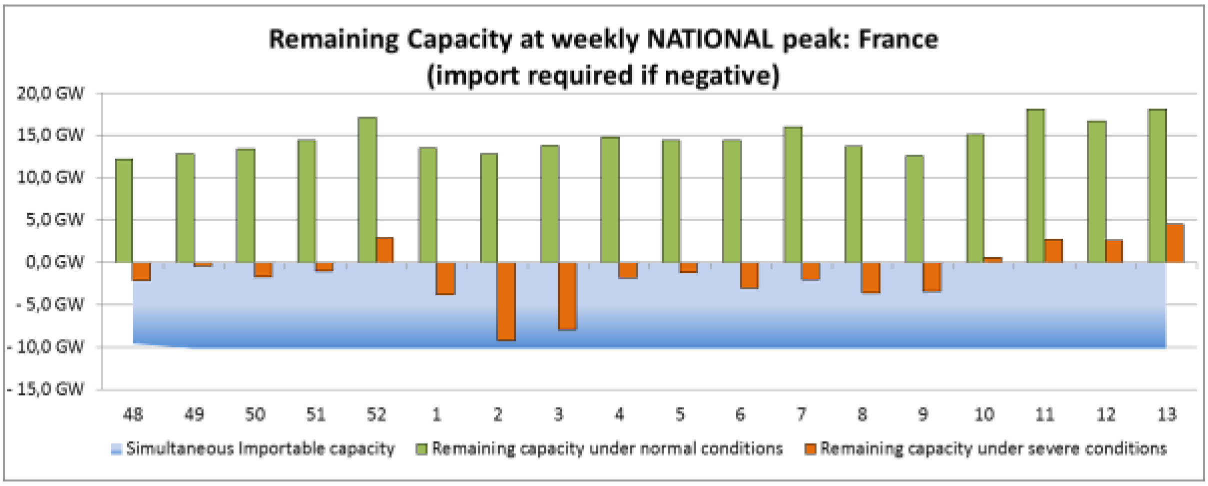






Most critical periods for maintaining adequacy margins and counter-measures

French adequacy greatly depends on weather conditions, as a drop of national temperature by -1°C can lead to an increase of the load by 2.4 GW. In severe conditions (20-year cold wave), the most critical periods for adequacy should be early January (weeks 1–3), with a need for 5 GW imports to cope with a 97.5 GW load at pan-European synchronous peak time (19:00 CET). Readers should bear in mind that under most severe conditions and due to the dependence on weather conditions, the French load can be volatile within the same week. Daily P95 value of national peak demand in France could reach 100.5 GW in week 2, which would raise the need of imports to 8 GW. Moreover, these minimal needs for imports will not fully meet the French requirements for upward margin.[32] To fulfil these, the need for imports would reach 9.5 GW in week 2, as shown in the graph below.



The current winter outlook study uses an NTC model, in which a country that has enough generation capacity can export the fixed NTC value to a corresponding neighbouring country. Yet, the flow-based allocation model used in actual operations is much more volatile than the NTC model. It could significantly reduce the ability to import up to 10 GW.

Mid-November, EDF publicised additional delays for the 4 nuclear units in Tricastin to be back in operation. Yet, the four units should be running at the beginning of January 2018 to cope with the most risky period under severe conditions.

[32] The methodology of this study does not take into account the requirements for the Replacement Reserve (RR).

In case of an adequacy issue, RTE can use exceptional and emergency demand-side management, something not assessed in this study. Moreover, RTE can drop the voltage for several hours by -5% to lower the load and to maintain adequacy. Eventually, in the worst and unlikely case, RTE could curtail load locally in a preventive way to secure the system.

Most critical periods for downward regulation and counter-measures

No critical period is expected for downward adequacy.

France: Summer Review 2017

General comments on past summer conditions

Summer 2017 started with a very hot month of June and a heat wave on 18–22 June. These hot temperatures persisted over all the country during the first three weeks of July, followed by a general cool down. Another episode of heat wave hit the south of France by the beginning of August, with temperatures superior to 20°C at night and often more than 35°C during the day, reaching 40°C locally. These temperatures locally exceeded the records from 2013. Finally, by the end of August a heat wave affected the country for 3 days (26th to 29th), followed by rapidly decreasing temperatures.

Globally, precipitations were 10% under normal conditions in the country, leading to a decrease of the hydraulic production compared to summer 2016.

These weather conditions, in addition to a high nuclear power production and low consumption with a minimum of 30,000 MW on 13 August, resulted that the balance of RTE was in export during all summer. We can also note that the solar production increased by 8% compared to last summer, and the wind generation increased by 35%.

Specific events and unexpected situations that occurred during the past summer

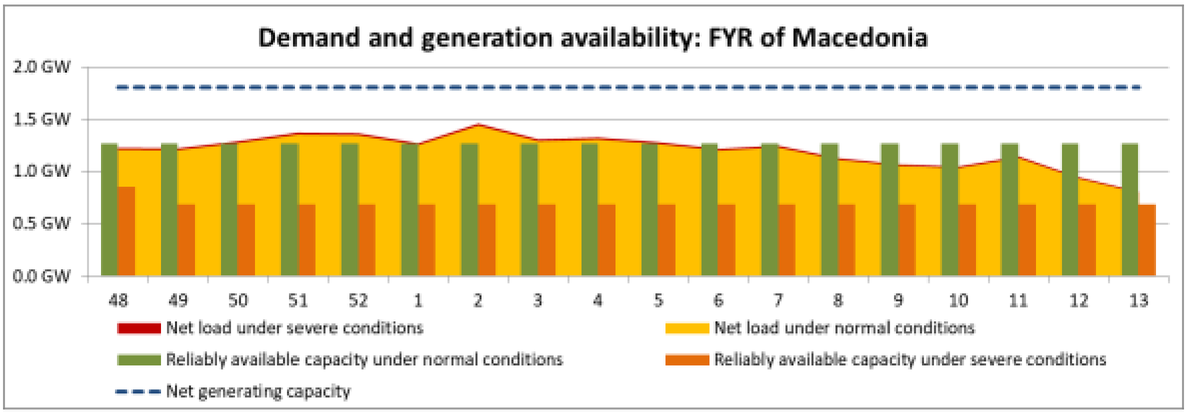
On 29 June, RTE sent messages on EAS (ENTSO-E Awareness System) for « loss of tools and facilities » due to an incident on the IT infrastructure.

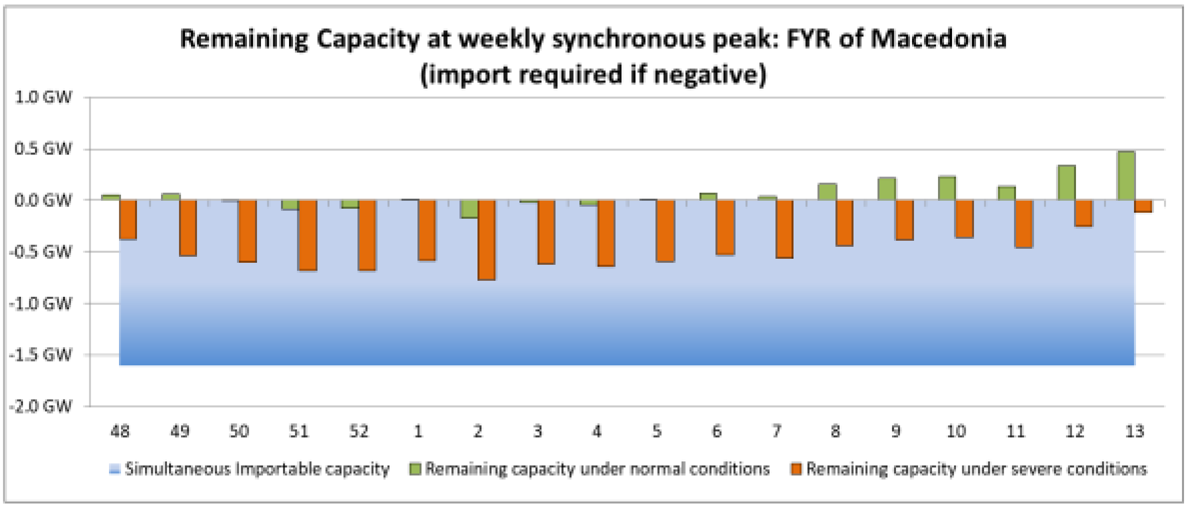
Several overloading events occurred on AC lines in the south of France due to the high flows between France and Spain. The remedial actions were mostly counter-trading with Spain and topological manoeuvres when possible.

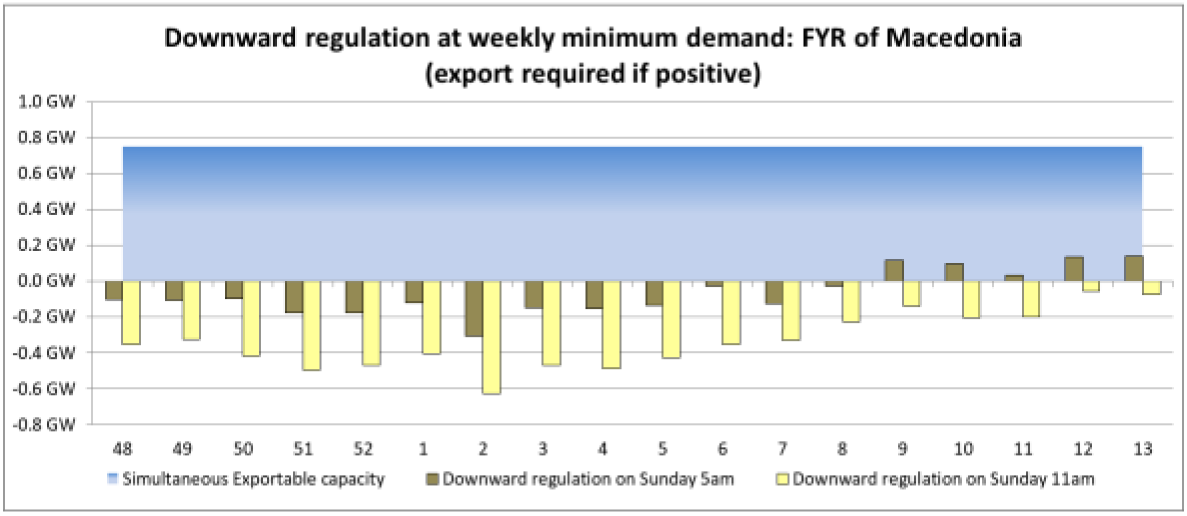
We can also note that several balancing mechanism's warning alerts have been published through the summer, in day ahead, due to low downward margin (i.e. too much production in the case of load contingency). This was mostly due to the low manoeuvrability of production unit.

FYR of Macedonia: Winter Outlook 2017/2018

In the coming winter, no adequacy issue is expected. Our current transmission capacity is sufficient to meet the needs for energy imports and exports. The maintenance schedule of the generation units is set to minimum. No problems in the transmission network are expected because all the maintenance work has been finished during the summer period.







FYR of Macedonia: Summer Review 2017

During past summer period, no unexpected events with significant (local and regional) character occurred in Macedonian Power System. All intended maintenance and overhauls works were completed in accordance with the plans. Interconnections were available during the whole period; we did not face any difficulty with regards to NTC quantity, cross-border allocation or relationship with market participants.

Germany: Winter Outlook 2017/2018

The balance between generation and demand is generally expected to be maintained during the winter period in case of normal conditions. For severe conditions, according to the more pessimistic approach of this year's methodology, adequacy could depend on imports and/or use of strategic reserves and out-of-the-market demand side response (DSR).

A longer cold spell in combination with dry weather conditions and low water in rivers in southern Germany, as in winter 2016/2017, could limit the availability of remedial actions.

Due to changes in the quantitative data collection, the input of the new element 'strategic reserves' is described below.

The strategic reserves contain:

Lignite units in stand-by ('Sicherheitsbereitschaft'): were set to achieve the climate protection targets. Lignite fired power plant blocks with a total capacity of 2.7 GW will go step-by-step to stand-by mode for backup purposes. Currently, power plant blocks with a capacity of 914 MW are in this backup mode. The lead time in which the power plants are completely available is 240 hours.

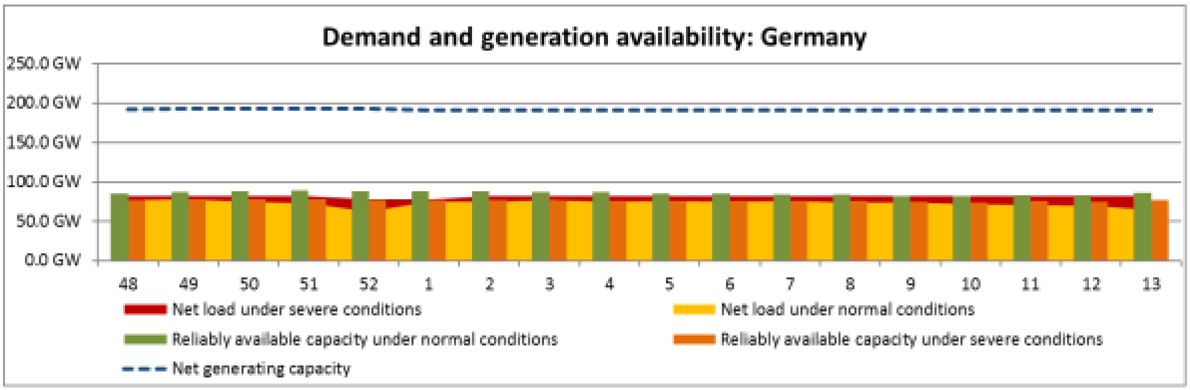
Grid reserve: is used to resolve congestions and contains 5.7 GW of different types of power plants located in Germany. In addition, German TSOs contract further with power plants for grid reserve in neighbouring countries that are not considered in the German data for Winter Outlook 2017/2018.

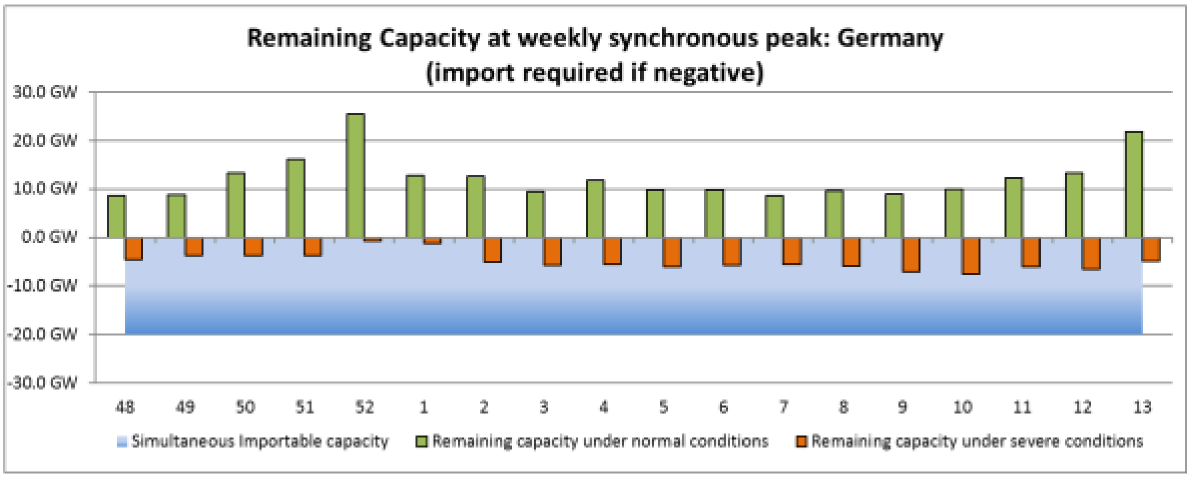
Out of the market Demand Side Response: With the Ordinance on Interruptible Load Agreements (AbLaV), the regulatory framework for the contractual obligation of interruptible loads has been adapted to the developments of the German energy market. The requirements on interruptible loads have been modified so that loads from 5 MW with predictable load characteristics can be pre-qualified as interruptible loads. They can be obliged to take measures to maintain grid and system security. For the purpose of AbLaV, interruptible loads are defined as consumption units that can reliably reduce their demand for a fixed capacity upon request by the German TSO. Currently, about 1 GW of interruptible loads is available.

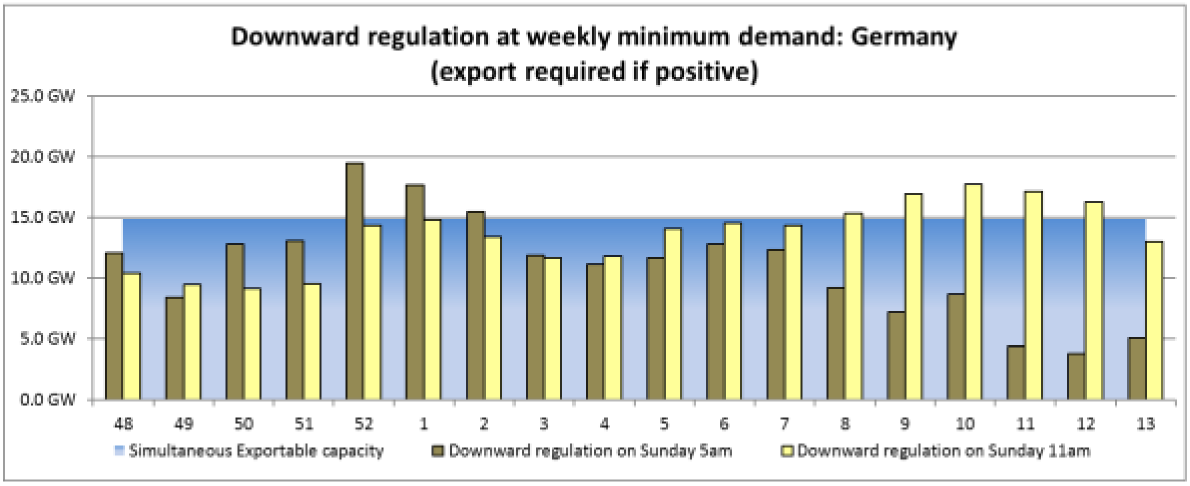
Concerning the Pumped storage plants (PSP) it has come to a minor change in the installed capacity. The PSPs of the 'Kraftwerksgruppe Obere Ill-Lünersee', which are installed in Austria, but are assigned to the German control block, are now considered by the German TSOs and included in German dataset. The affected amount of power is approximately 1.7 GW.

Most critical periods for maintaining adequacy margins and counter-measures

The period around Christmas could be critical due to an oversupply of the German control area. Although that was not the case in the previous year, dedicated measures are available, if necessary. There are extended possibilities to reduce wind power feed-in in such situations. In situations of high RES feed-in in the north and high load in the south of Germany, the need for remedial actions to maintain (n-1) security on internal lines and on interconnectors is expected.







Most critical periods for downward regulation and counter-measures

The interconnectors are expected to play an important role for the export of excess generation during demand minimum periods. According to the quantitative analysis of the downward regulation capabilities for daytime and night-time minimum demand conditions and high RES feed-in situations with excess generation could occur. In cases of high excess generation, specific laws and regulations allow the German TSOs to reduce the RES feed-in to mitigate any negative effects on the network. Therefore, no critical situations are expected.

Germany: Summer Review 2017

General comments on past summer conditions

In the last summer, there were no significant events concerning the system adequacy. According to the German weather forecast service (‘Deutscher Wetterdienst’, DWD), July was rather warm and wet with quite few sunshine compared to recent years. The average mean temperature in July was 18.1°C, which is 0.1°C more than the average of the years 1981–2010. The highest temperature was 35.6°C, the lowest temperature was 3.5°C. Generally, temperatures in the south tended to be higher than in the north.

Specific events and unexpected situations that occurred during the past summer

The installed capacity of PV plants has moderately increased from 38.4 GW in the summer 2016 to a value of 40.1 GW in July 2017.

There were needs for remedial actions to ensure voltage stability last summer on weekends and because of longer non-availabilities of two nuclear power plants in southern Germany.

Great Britain: Winter Outlook 2017/2018

Great Britain expects available generation and interconnection capacity to be sufficient to meet the demand throughout winter 2017/2018.

Generation capacity, connected at transmission level, is 70.6 GW. This is higher than last year (65.0 GW). Winter 2017/2018 is the first delivery year for the Capacity Market. It aims to ensure the security of the electricity supply by providing a payment for reliable sources of capacity, alongside electricity revenues, to ensure the delivery of energy when needed. In addition to the capacity secured through the Capacity Market, there are some plants without Capacity Market contracts that have indicated they will be operational this winter. As a result, looking at winter 2017/2018, Great Britain's operational surplus is forecasted to be significantly higher than in recent years.

The demand under NORMAL conditions uses 30 years average demand, and the demand under SEVERE conditions uses a 1 in 20 figure. Customer demand management (CDM) is expected during SEVERE conditions.

The forced outage rate under NORMAL conditions is the average of last 3 years. Under SEVERE conditions the forced outage rate is the highest value of the last 3 years.

Most critical periods for maintaining adequacy margins and counter-measures

Under normal conditions, the highest demand is 49.7 GW in week 50 (13 Dec 2017). Corresponding RC is 5.9 GW, which is the lowest forecasted margin for winter 2017/2018. However, we believe Great Britain will still be able to export via the interconnectors.

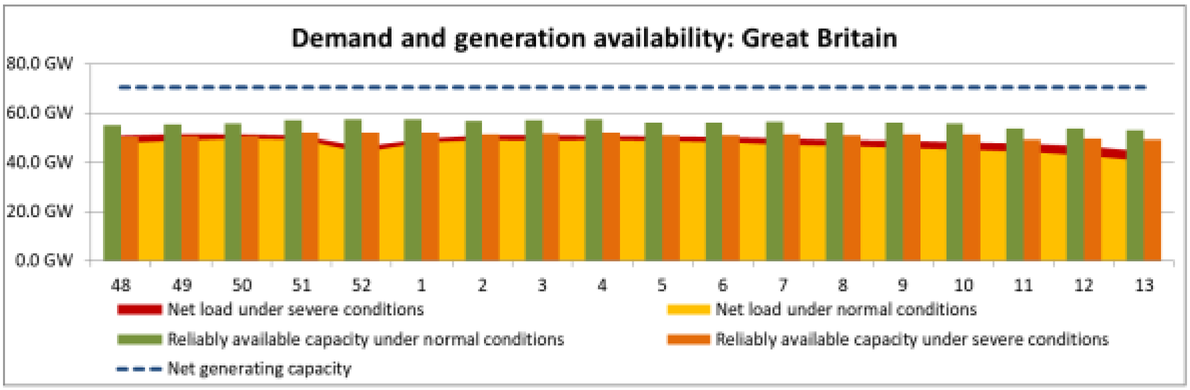
Under severe conditions, the highest demand is forecast as 53.0 GW in week 49 (6 December 2017) and week 50 (13 December 2017). Highest negative margin (-0.9 GW) is expected in week 49. As seen in recent years, this demand can be managed by some imports through the interconnectors (import capacity of around 4 GW), plus the market would be expected to respond to the tighter margin. Weeks 48 and 50 have lower margins, but are manageable.

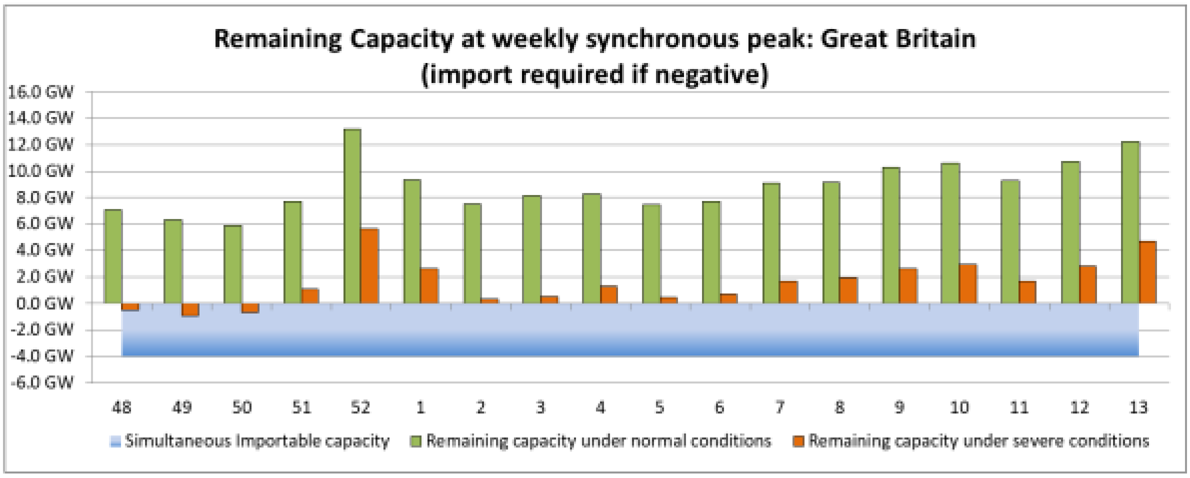
There are no planned outages on the interconnectors throughout the winter.

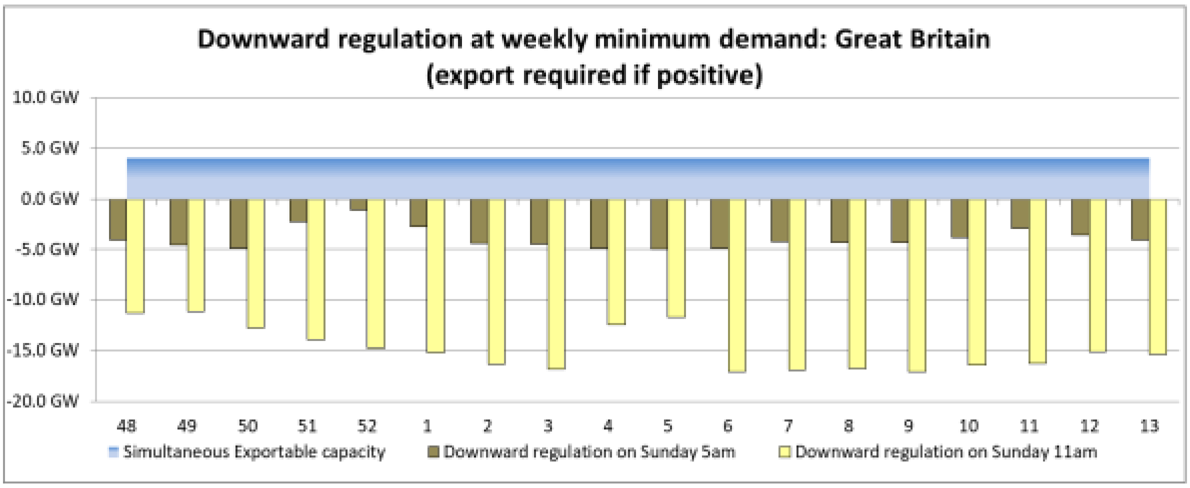
Most critical periods for downward regulation and counter-measures

For the overnight minimum period week 52 (27 December 2017), Great Britain has the lowest downward regulation capabilities (1.1 GW) due to the low load around Christmas holiday.

The daytime minimum period in week 49 has the lowest downward regulation capabilities (11.2 GW).







Great Britain: Summer Review 2017

General comments on 2017 summer conditions

Summer 2017 in Great Britain was wetter and warmer than normal. Margins during the summer were manageable. No EMNs (Electricity Margin Notice) or CMNs (Capacity Market Notice) were issued to the market, and Great Britain had issued one localised NRAPM (Negative Reserve Active Power Margin) for downward margin issue. There were no generation closure or new conventional generation commissioning during the summer.

Specific events and unexpected situations that occurred during the last summer

There was one localised downward margin issue that was due to a local constraint within Scotland on 6 June.

There were several planned outages on the French interconnector: Bipole 2 (19–30 June), Bipole 1&2 (22–25 August) and Bipole 1 (11–29 September); there were also planned outages on Britned interconnector: Bipole (15–18 May), Pole1 (18–19 September) and Pole2 (18–21 September).

The lowest system demand was 17.1 GW on 11 June 2017 at 06:00 local time (BST).

The lowest afternoon demand day was on 9 April 2017. The daytime low demand was even lower than the overnight demand for the first time ever. This was due to the growth of embedded solar. Highest PV output was 8.7 GW on 26 May 2017.

Great Britain had 24 hours without coal generation on 21 April 2017.

Greece: Winter Outlook 2017/2018

For the balancing of the Greek system, the following factors are essential in the upcoming winter period (2017/2018):

1. The compliance with the levels of pollution (NOx), which requires the outage of some units for a long time.

2. The sufficient natural gas import (liquid and gas), which is crucial for securing the supply of the Greek system.

3. The low hydraulic storage of hydropower stations, which can lead to the increased use of natural gas to produce electricity in Greece.

4. The role of exchange programmes via interconnections, which in case they are importing, may cause problems to the security of balancing.

The evolution of these factors will determine the level of adequacy and security of the Greek interconnected system.

Most critical periods for maintaining adequacy margins and counter-measures

The most critical period during winter is the second half of December and January. Heavy snowfall events and decreased temperatures can lead to increased system demand. Moderate imports are needed to meet operating criteria under normal conditions.

The role of interconnectors is currently important for generation adequacy, especially in the cases of the gas supply problems (like last year).

Most critical periods for downward regulation and counter-measures

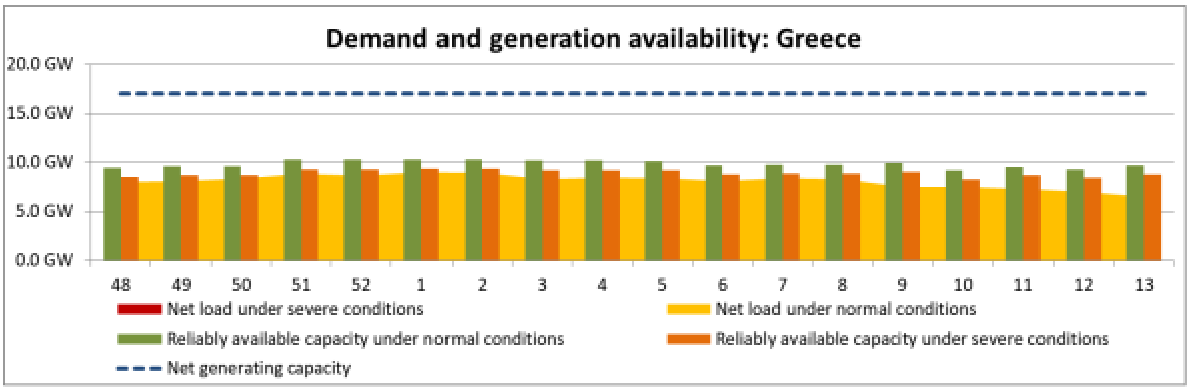
The most critical periods for downward regulating capacity are usually from 00:00 to 06:00, mainly on the weekend days.

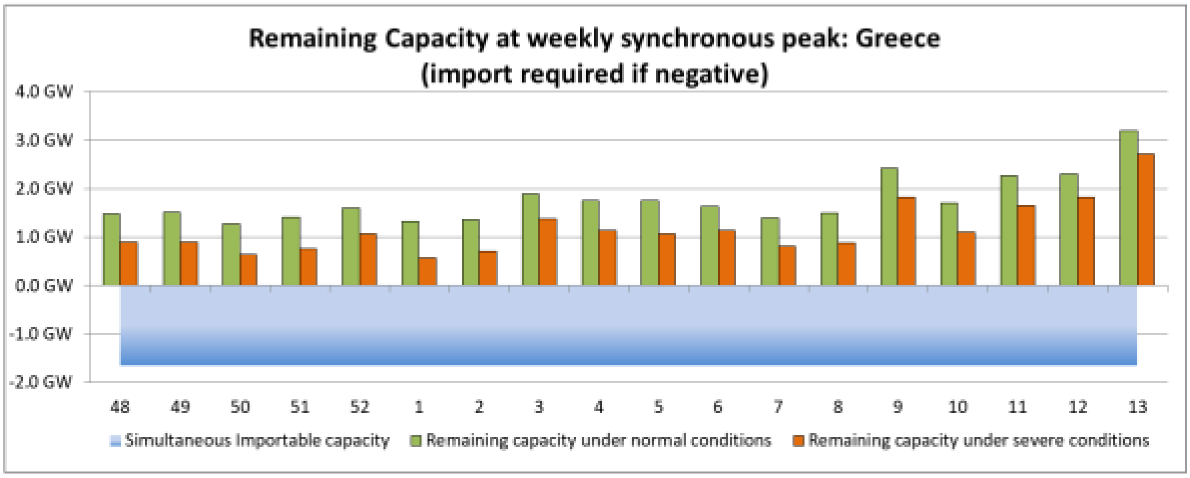
The counter-measures adopted are:

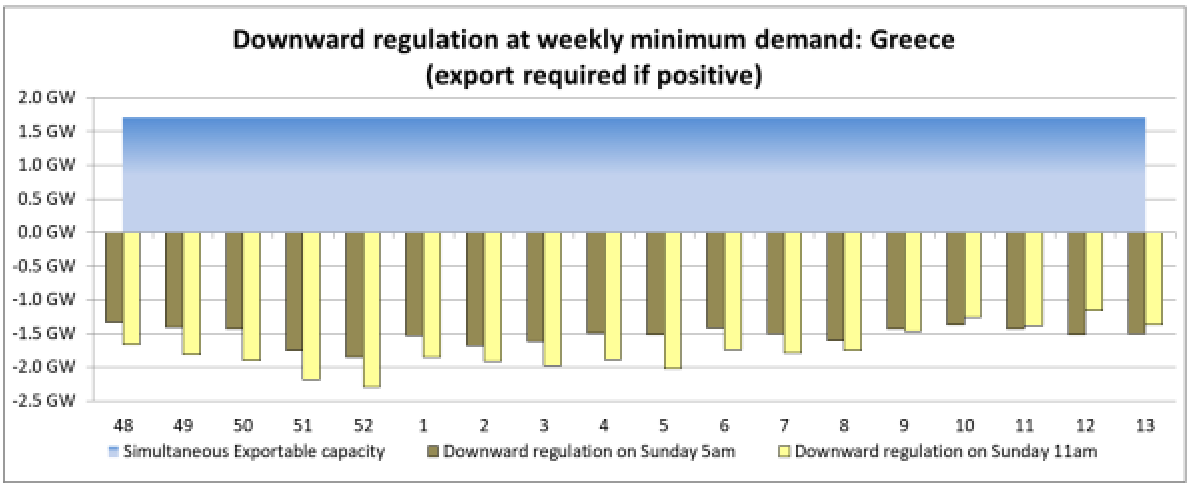
- Request for sufficient secondary downward reserve; and

- Use of Pump Units.

The interconnectors are not used for reserve exchange.







Greece: Summer Review 2017

General comments on past summer conditions

Last summer there were normal climatic conditions and the temperature ranged to normal level for the season.

There were no high outflows of the reservoirs during the summer.

Specific events and unexpected situations that occurred during the past summer

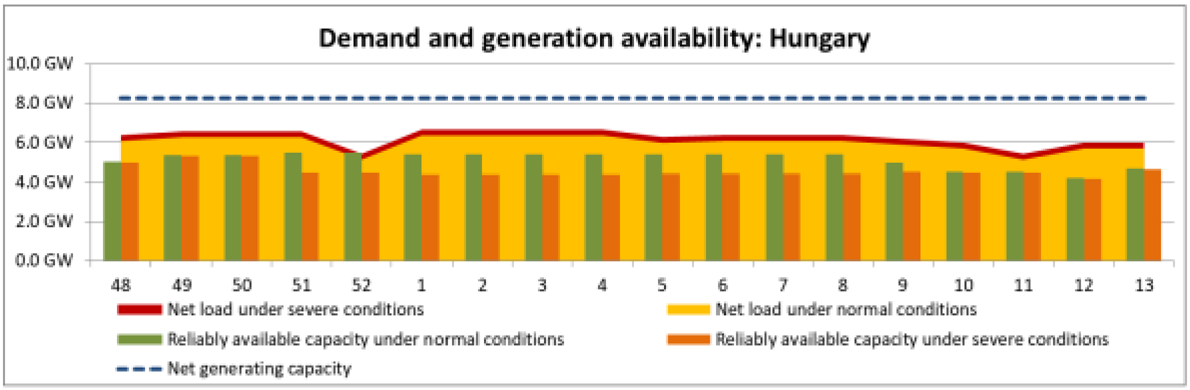
During the summer, some forest fires occurred and affected the transmission capacity.

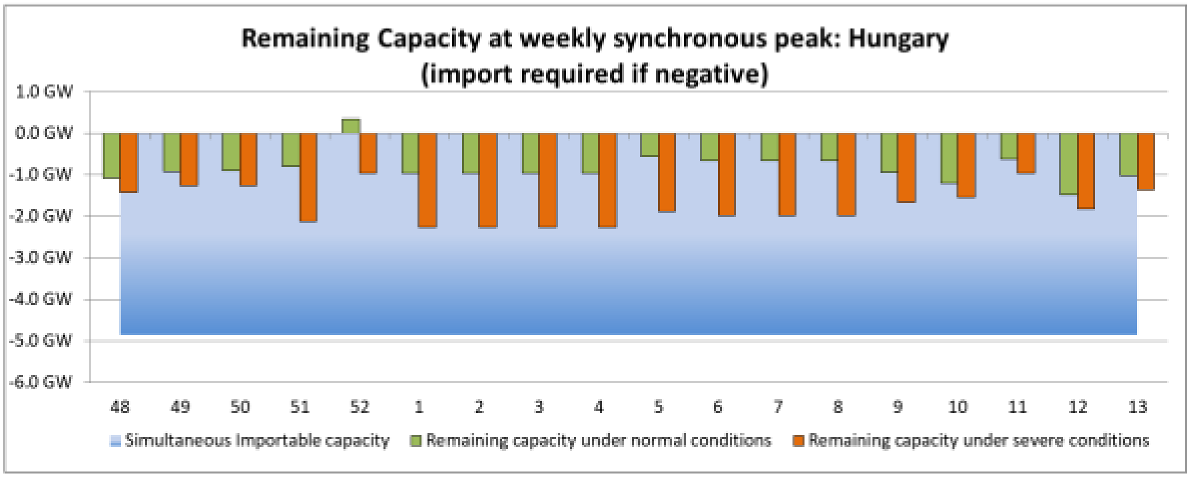
In addition, due to many malfunctions and damages to power units, several units were unavailable, causing extra challenging conditions to the Greek power grid.

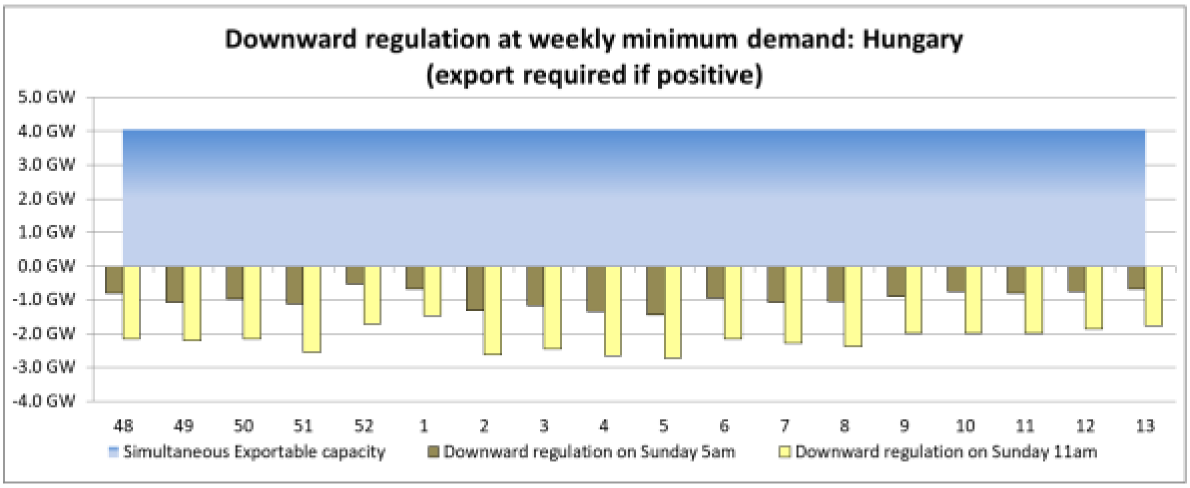
Hungary: Winter Outlook 2017/2018

In spite of the growing uncertainty on both generation and demand sides, as a result of market development on the one hand, and the promotion of variable generation on the other hand, the Hungarian power system is expected to be on the safe side during the next winter period. However, the TSO must manage carefully several risks:

- According to the experience of last winter, there is a possibility that the generating units may have difficulties due to extreme cold temperatures. Mainly, the frozen solid fuel could cause problem in coal-fired systems. Under extreme conditions this could even cause 1,000 MW of capacity outage.
- Hungary usually imports between 2 and 3 GW of electricity at daily peak demand. The major part of this import is necessary to guarantee system adequacy under normal and severe conditions as well. Cross-border exchange is a matter of economy for market players. Their decision-making can be influenced by contractual conditions, e.g. on reserves.
- Overall cross-border capacity is satisfactory. However, allocation of cross-border capacity rights on the respective border sections may be an issue.
- The increasing level of photovoltaic generation in the Hungarian system cause higher uncertainty in the operational planning period and real-time system operation as well.
- The Hungarian electricity system significantly depends on the import of gas. In case the gas supply wanes or terminates, then the operation of gas-fired power plants could become unpredictable, which in extreme conditions could cause a 3,000 MW capacity outage in contribution with the decrease of electricity import from Ukraine. The unavailability of the needed capacity in this rate for a relatively long period of time cannot be compensated by domestic sources or by additional import. In the case there is no continuous gas supply, it is possible to run out of alternative fuels within two weeks. Moreover, it is necessary to take into consideration further decrease of import as a consequence of available capacity limitation in the gas-fired power plants of the adjacent electricity systems.
- The reference adequacy margin at weekly peak is 0.5 GW, the capacity of the largest generation unit in the power system.







Most critical periods for maintaining adequacy margins and counter-measures

The level of maintenance during the winter period is approximately zero, owing to planned maintenance outside of the high load period of the year. The highest level of maintained capacity is about 1,200 MW on 17–22 March.

Most critical periods for downward regulation and counter-measures

In the Hungarian electric power system, the required adequacy margin can be guaranteed only by a considerable amount of import. Several years are necessary to overcome this historical feature, which is a result of missing competitive, highly flexible generation units. The most critical periods for downward regulation would be during the celebration days in December. Incentives for proper scheduling by market players are provided through balancing energy pricing, as well as by market maker contracts between the TSO and the service providers for the necessary regulation capacity.

Hungary: Summer Review 2017

General comments on 2017 summer conditions

Summer 2017 temperature did not significantly differ from the last few years, so there was no major change to the level system load. There was, however, an increase of energy demand in the Hungarian power system. Outages of generators were rather low. The grid was reliable and controllable.

Specific events and unexpected situations that occurred during the last summer

During August, the actual demand was higher than the expected demand because the average temperature was higher than normally in this month. The peak load in summer 2017 (6,357 MW) did not reach the peak load of summer 2016 (6,366 MW). There were no significant generation outages, which remained between 100 and 800 MW. Extreme weather, i.e. a local tornado, caused damage to six 400 kV towers of an interconnection line with Croatia. However, the lack of the line (for approximately a month) did not influence the security of supply significantly.

Iceland: Winter Outlook 2017/2018

Most critical periods for maintaining adequacy margins and counter-measures

No adequacy issue is expected in Iceland for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.

Iceland: Summer Review 2017

General comments on past summer conditions

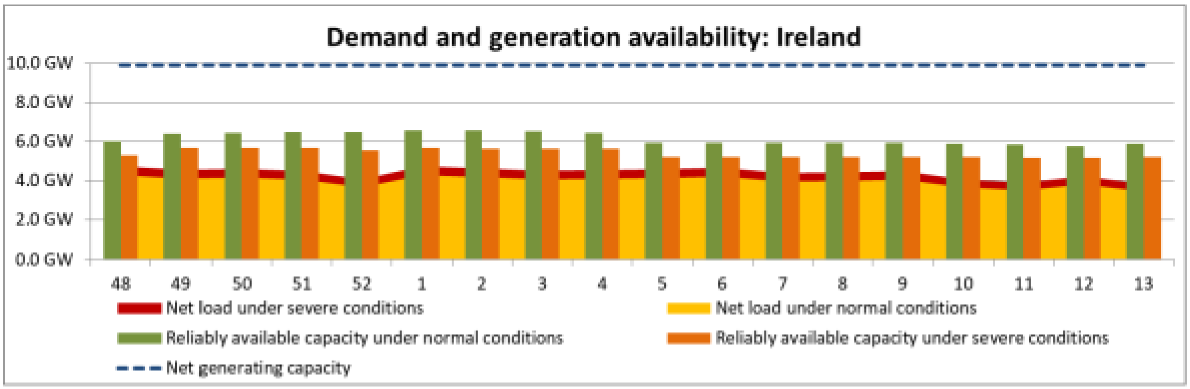
No adequacy issue was identified in Iceland during the last season.

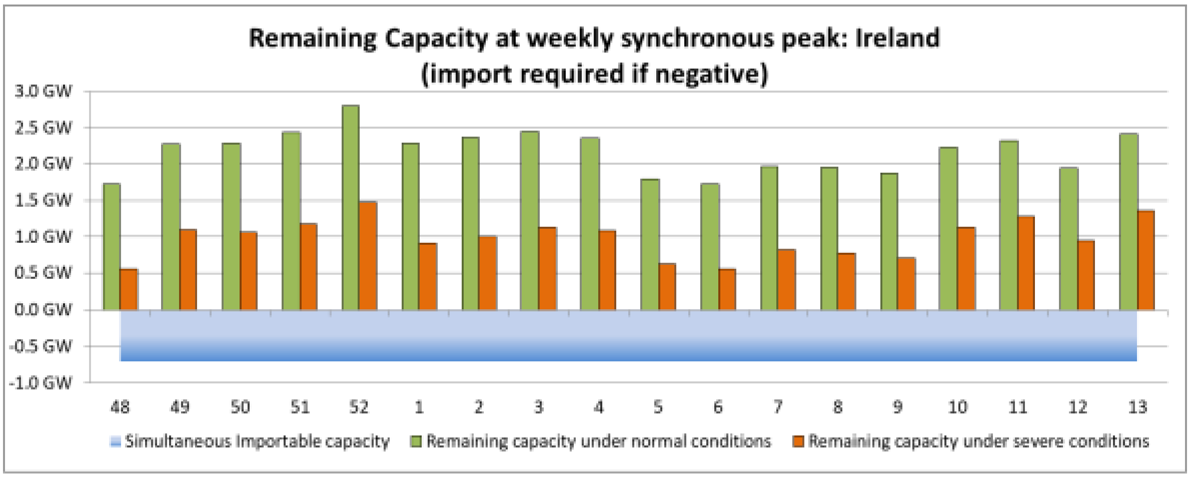
Specific events and unexpected situations that occurred during the past summer

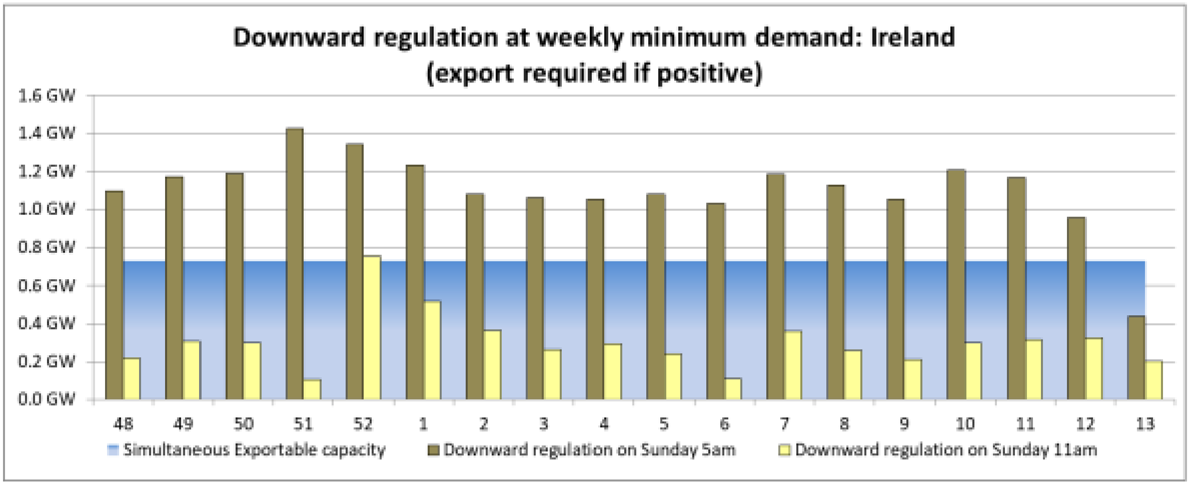
None.

Ireland: Winter Outlook 2017/2018

Adequate generating capacity is expected for the coming winter period.







Ireland: Summer Review 2017

General comments on past summer conditions

Adequate and secure generation was available for the entire summer period.

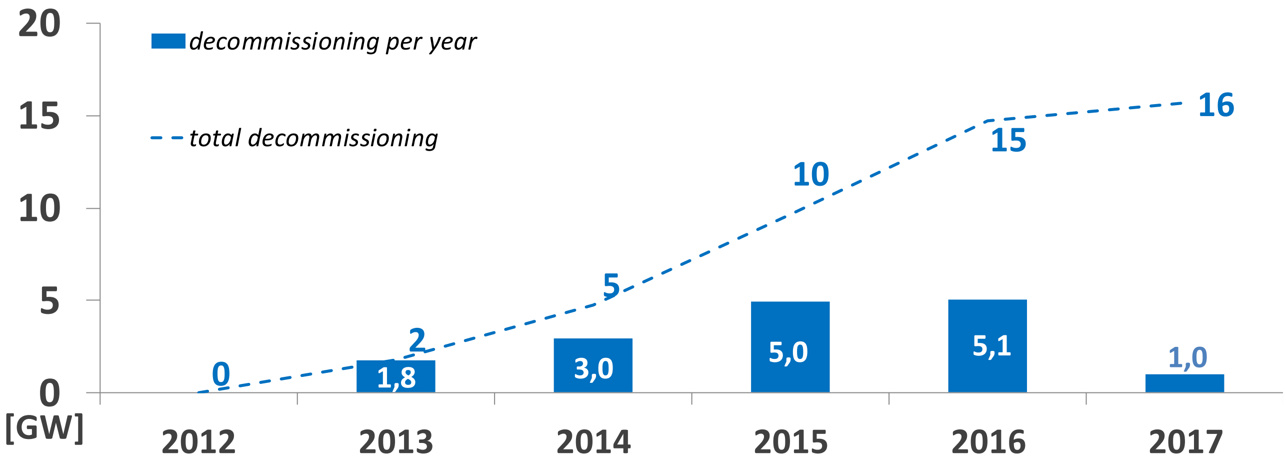
Specific events and unexpected situations that occurred during the past summer

There were an unusually high number of forced outages of generators in the Dublin region, but the security of supply was maintained throughout the summer period.

Italy: Winter Outlook 2017/2018

Generation capacity in Italy

In recent years, the Italian power system has faced a significant reduction of the conventional (thermoelectric) power fleet. The growth of variable (e.g. wind and PV) generation, together with a drop in demand, is putting commercial pressure onto traditional generators and is leading to the decommissioning of the oldest power plants. Between 2012 and 2017, the following phenomena affected the power system operation and adequacy in Italy: about 16 GW installed generation was phased out. The total amount of installed conventional power plants fell from 77 GW to 61 GW and an additional 3.4 GW conventional power capacity is not available due to environmental/legal constraints and mothballing. This trend can be observed in the figure below. This phenomenon has been seriously affecting the power system adequacy in Italy in recent years; some important warning signals in terms of adequacy on the national level scarcity already registered during summer 2015 and winter 2016/2017.



Nevertheless, for the first time since 2011, there is no reduction in the available generation capacity compared to the previous year (Winter Outlook 2016/2017). In fact, even if the decommissioning trend did not stop yet, some important thermoelectric plants came back online from previous mothballing condition (around 1.8 GW). Grid reinforcements, developed by the Italian TSO during the last years, also helped to smooth out some effects caused by the power plants' decommission (especially in the main islands).

Available capacity considered in this report does not contemplate the possible unavailability of a big coal power plant in the Southern part of Italy do to authorization constraints. In case this risk will materialize, the available capacity will decrease about 2.5 GW, increasing the probability of incurring in scarcity situations.

Main outcomes of the adequacy assessment

Under normal conditions, the excess of capacity in the Southern Italian Bidding Zones cannot be fully transferred to the Northern Italian Bidding Zones (where the available generation capacity is expected to be lower than the load demand) due to internal grid constraints. Nevertheless, available import from neighbouring countries can cover the needs of the Northern area. Hence, for the next winter, no problem regarding system adequacy is expected in the Italian system under normal conditions.

Under severe conditions:

- In week 2 and 3, the excess of capacity in the Southern Italian Bidding Zones cannot be fully transferred to the Northern Italian Bidding Zones (where the available generation capacity is expected to be very lower than the load demand) due to internal grid constraints. At the same time, available import from neighbouring countries is unable to cover the needs of this Northern area due to a wide-spread scarcity situation in Europe. Hence, for winter 2017/2018, relevant risks for the Italian power system's adequacy are expected in the case of severe conditions.
- In some of the weeks between weeks 4 and 10, a lack of generation capacity in the Italian power system as a whole is detected (internal grid constraints are not relevant in these scenarios). Yet, available import from neighbouring countries seems to be sufficient to cover the needs of the Northern area.

High renewables production (wind and solar) during low load periods, taking into account the level of other inflexible generation, could lead to a reduced downward regulating capacity especially in the Southern Bidding Zones (e.g. South, Sicily and Sardinia).

Concerning the external risk for the security of supply, it should be noted that the Italian generation fleet heavily depends on natural gas.

Most critical periods for maintaining adequacy margins and counter-measures

Under normal conditions, no problem regarding system adequacy is expected, and the least comfortable period is expected during January and February.

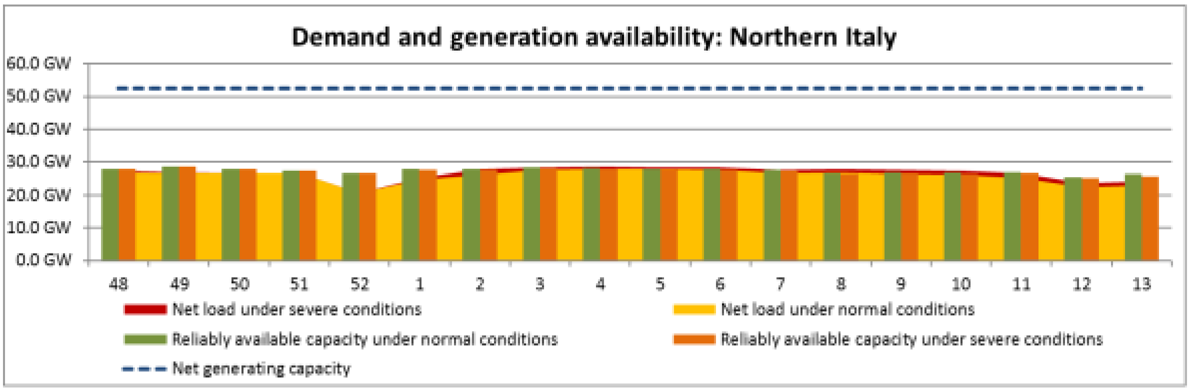
Under severe conditions, the situation for the winter 2017/2018 could lead to the need of imports for several weeks from December until end of February.

An appropriated planning (and coordination) of planned grid and generation outages has been performed, but in case of need, postponement or even cancellation of maintenance could be needed.

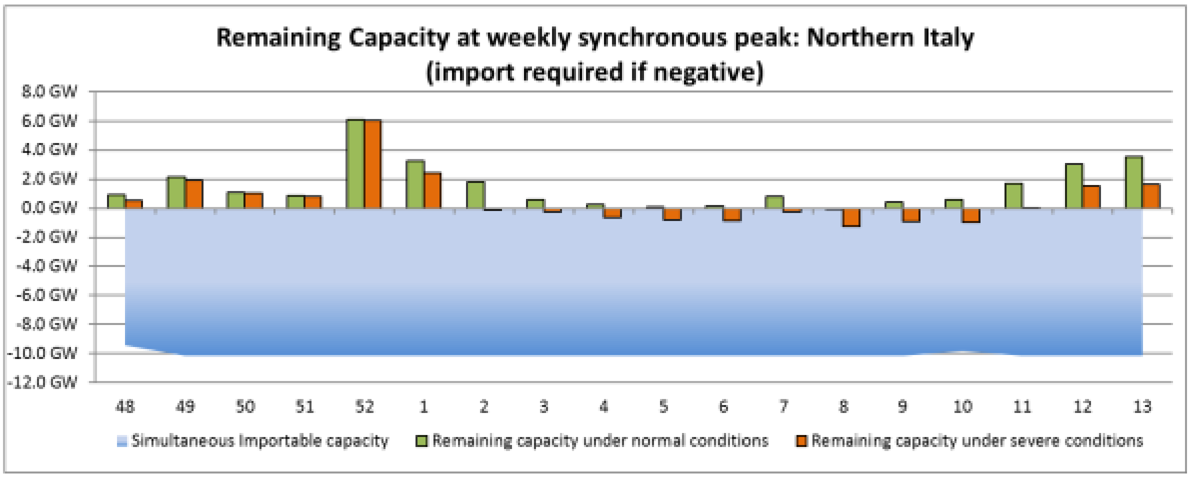
Improved regional coordination processes (including regional weekly adequacy assessment– SMTA project) will support the definition of proper and efficient counter-measures in case the risk of incurring in critical situations will be detected in the short-term.

Most critical periods for downward regulation and counter-measures

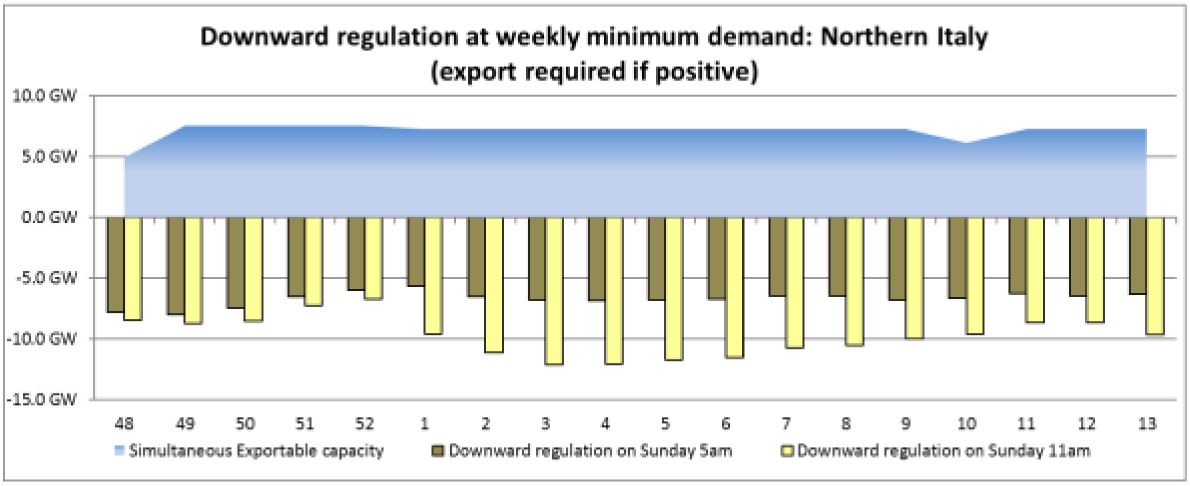
The worst weeks for downward regulation are expected to be the weeks of Christmas. To cope with this risk, the Italian TSO (Terna) prepared preliminary action and emergency plans and, in case of need, will adopt the appropriate counter-measures. To guarantee system security, Terna could adopt enhanced coordination with neighbouring TSOs and special remedial actions, such as the curtailment of inflexible generation. Further special actions, such as NTC reductions, could be planned in cooperation with neighbouring TSOs.



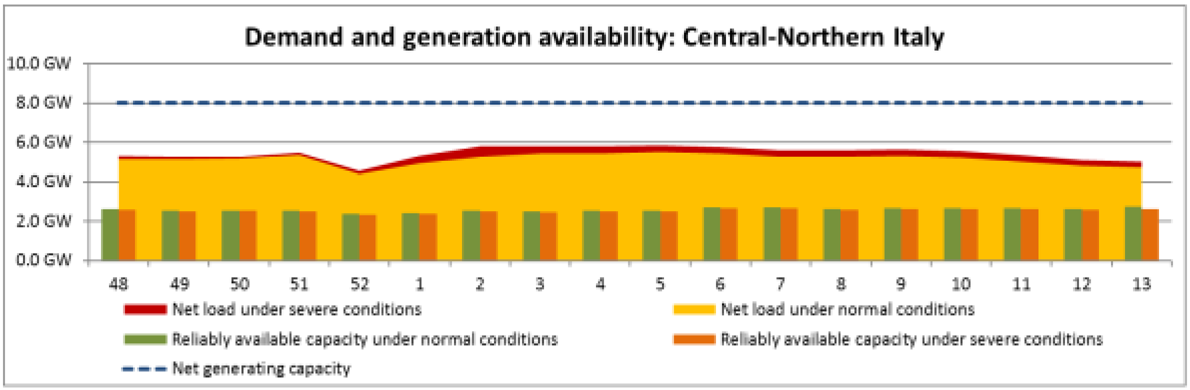
Demand and generation availability: Northern Italy
60.0 GW
50.0 GW
40.0 GW
30.0 GW
20.0 GW
10.0 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

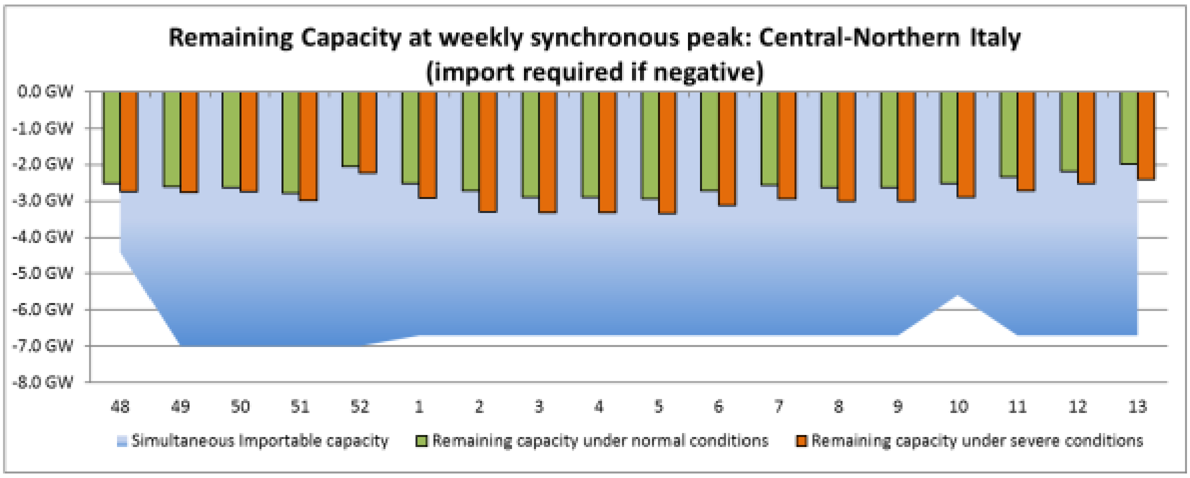


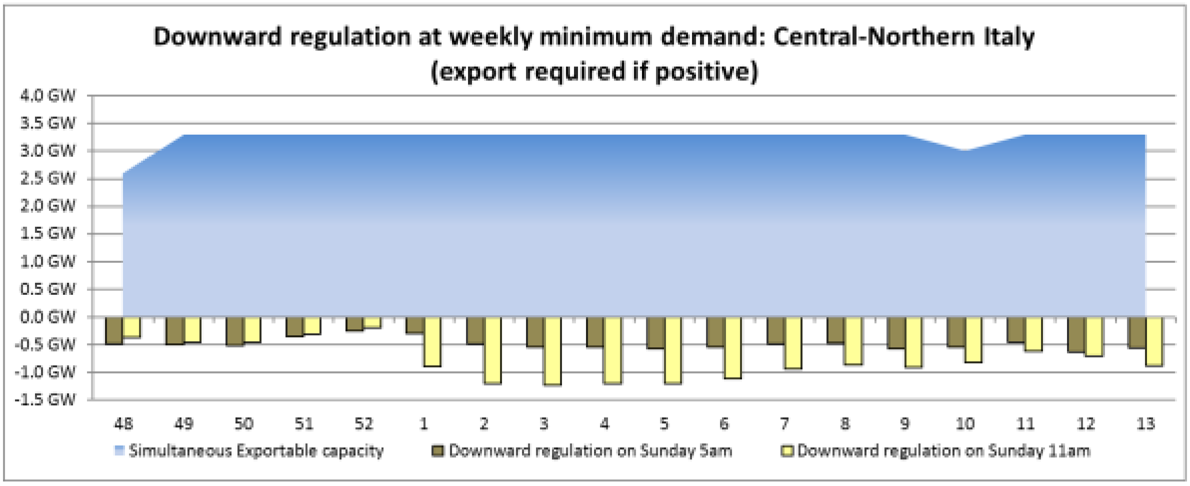
Remaining Capacity at weekly synchronous peak: Northern Italy
(import required if negative)
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
-2.0 GW
-4.0 GW
-6.0 GW
-8.0 GW
-10.0 GW
-12.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

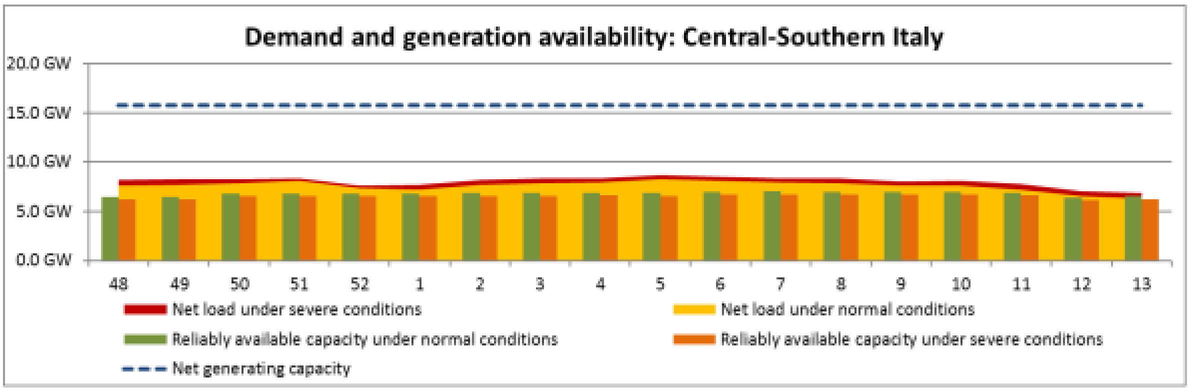


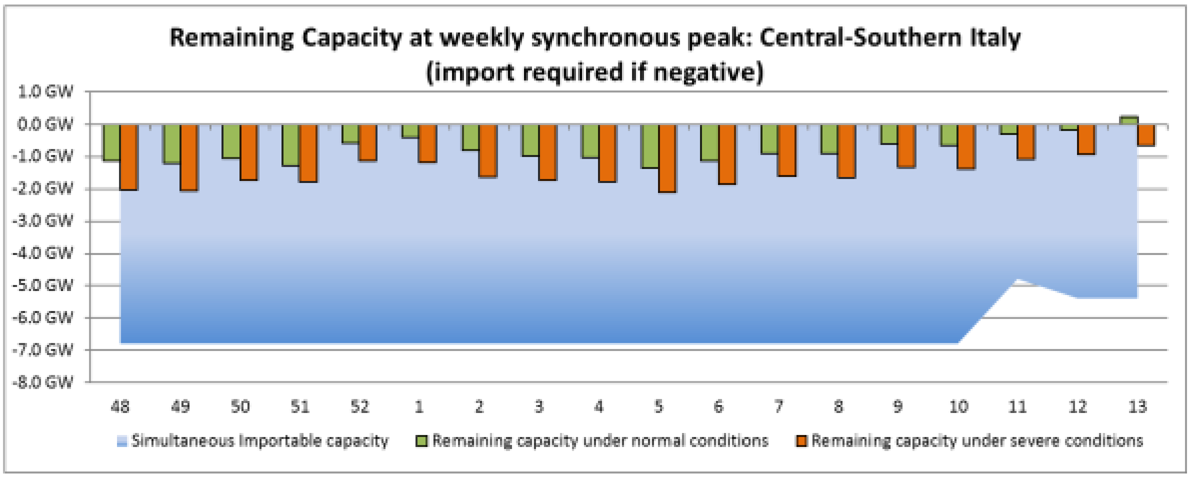
Downward regulation at weekly minimum demand: Northern Italy
(export required if positive)
10.0 GW
5.0 GW
0.0 GW
-5.0 GW
-10.0 GW
-15.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

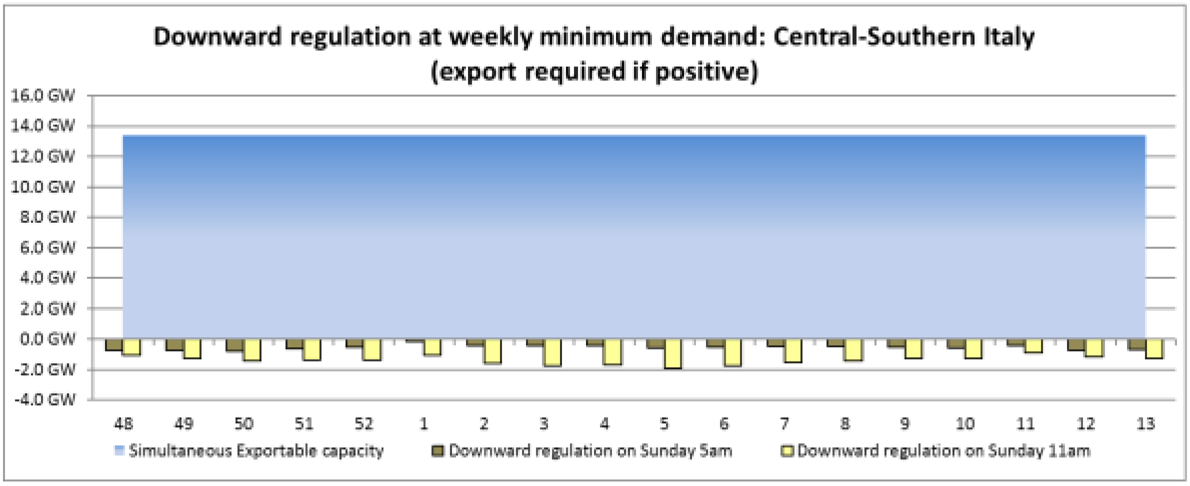

Demand and generation availability: Central-Northern Italy
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

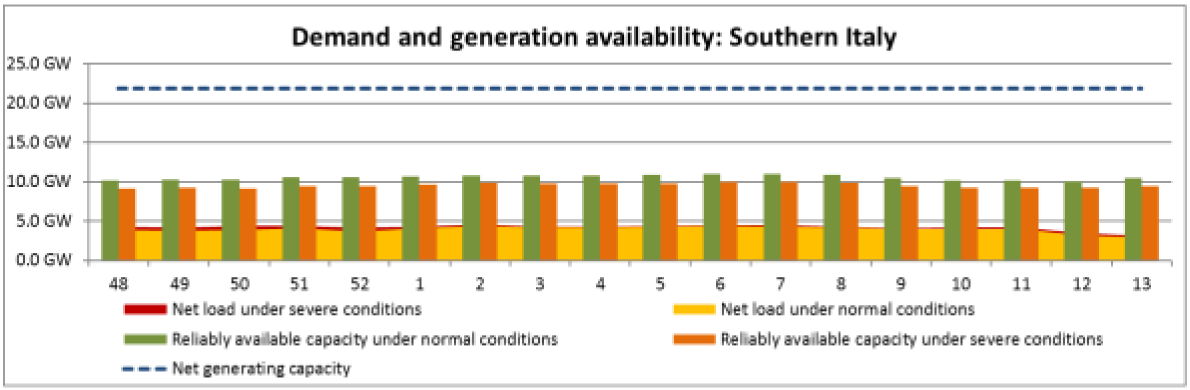

Remaining Capacity at weekly synchronous peak: Central-Northern Italy
(import required if negative)
0.0 GW
-1.0 GW
-2.0 GW
-3.0 GW
-4.0 GW
-5.0 GW
-6.0 GW
-7.0 GW
-8.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions


Downward regulation at weekly minimum demand: Central-Northern Italy
(export required if positive)
4.0 GW
3.5 GW
3.0 GW
2.5 GW
2.0 GW
1.5 GW
1.0 GW
0.5 GW
0.0 GW
-0.5 GW
-1.0 GW
-1.5 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

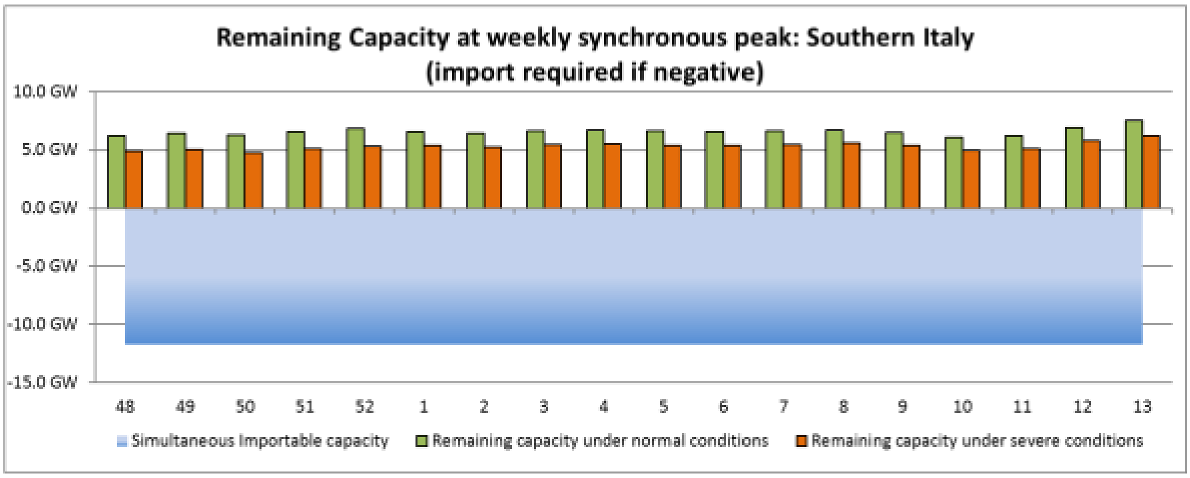

Demand and generation availability: Central-Southern Italy
20.0 GW
15.0 GW
10.0 GW
5.0 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity


Remaining Capacity at weekly synchronous peak: Central-Southern Italy
(import required if negative)
1.0 GW
0.0 GW
-1.0 GW
-2.0 GW
-3.0 GW
-4.0 GW
-5.0 GW
-6.0 GW
-7.0 GW
-8.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

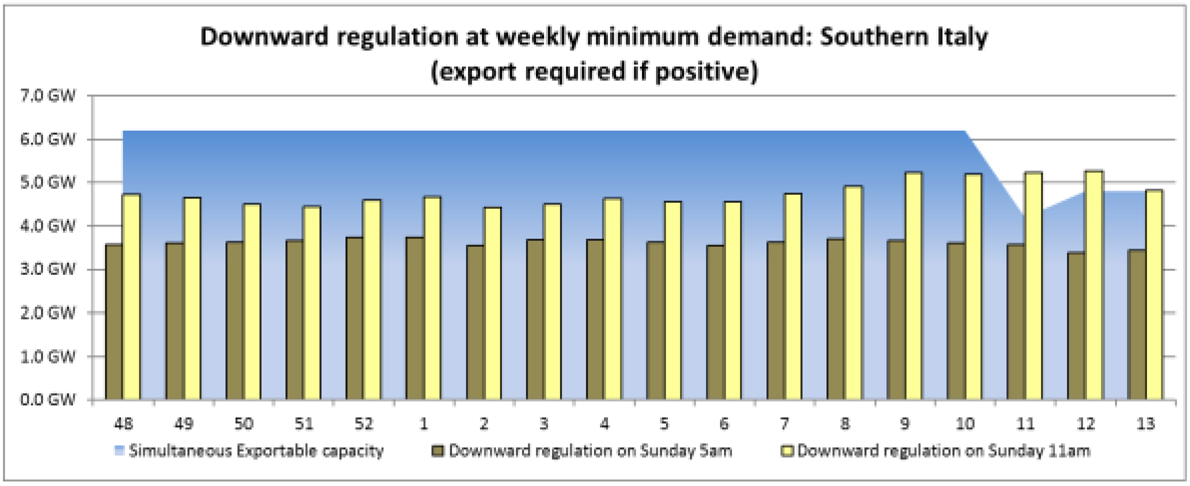

Downward regulation at weekly minimum demand: Central-Southern Italy
(export required if positive)
16.0 GW
14.0 GW
12.0 GW
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
-2.0 GW
-4.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am



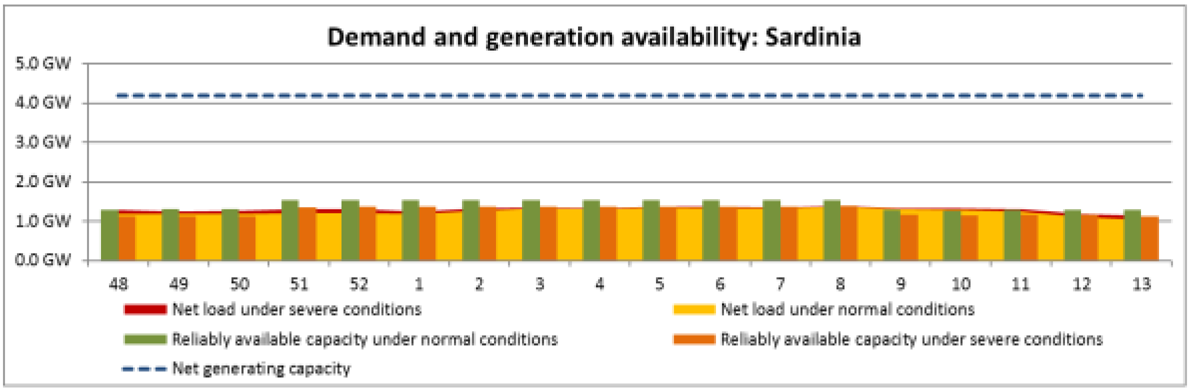
Demand and generation availability: Southern Italy
25.0 GW
20.0 GW
15.0 GW
10.0 GW
5.0 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

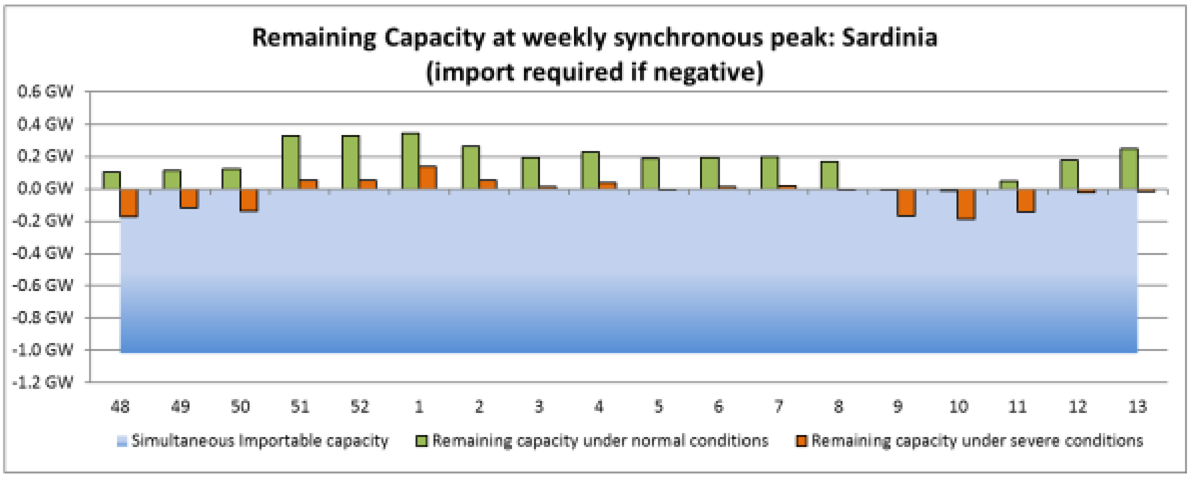


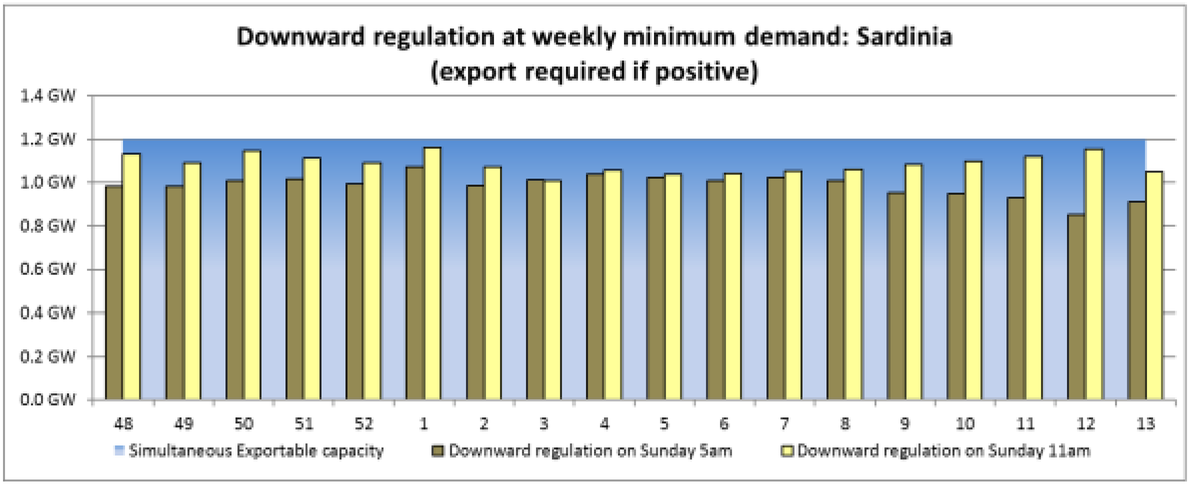
Remaining Capacity at weekly synchronous peak: Southern Italy
(import required if negative)
10.0 GW
5.0 GW
0.0 GW
-5.0 GW
-10.0 GW
-15.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

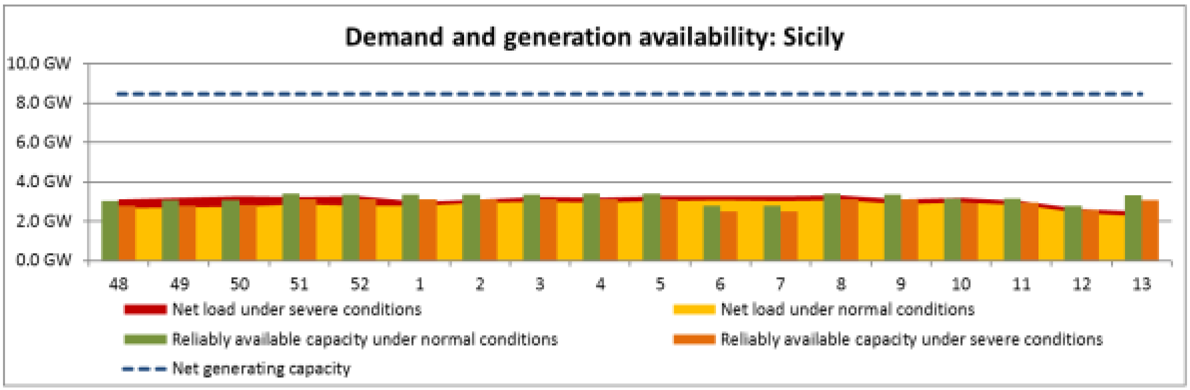


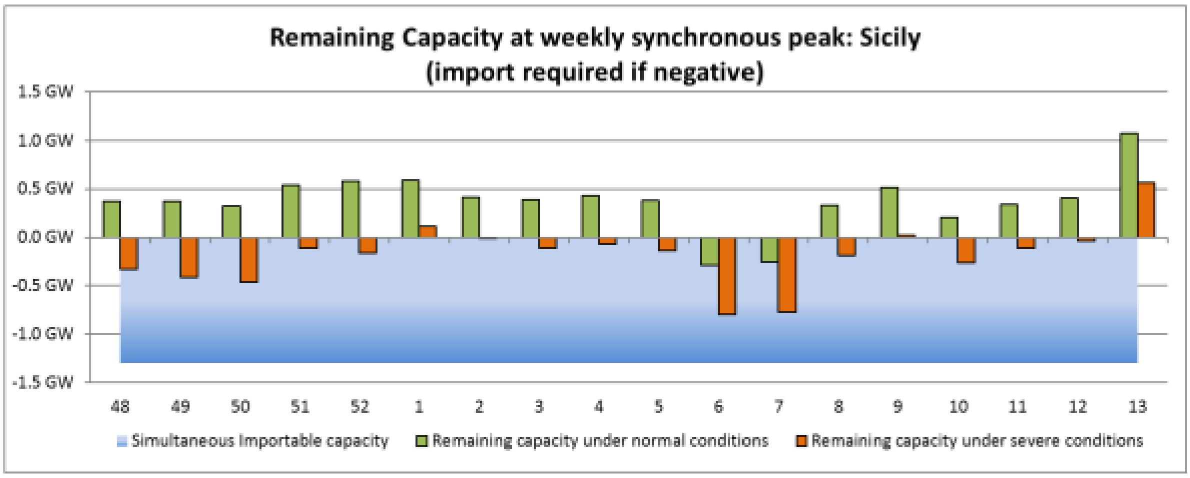
Downward regulation at weekly minimum demand: Southern Italy
(export required if positive)
7.0 GW
6.0 GW
5.0 GW
4.0 GW
3.0 GW
2.0 GW
1.0 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

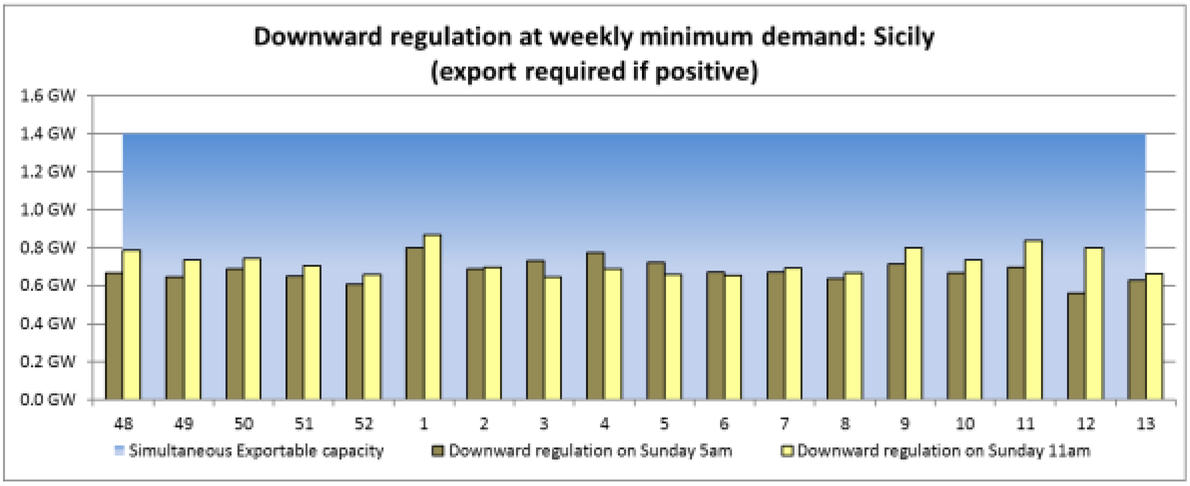

Demand and generation availability: Sardinia
5.0 GW
4.0 GW
3.0 GW
2.0 GW
1.0 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity


Remaining Capacity at weekly synchronous peak: Sardinia
(import required if negative)
0.6 GW
0.4 GW
0.2 GW
0.0 GW
-0.2 GW
-0.4 GW
-0.6 GW
-0.8 GW
-1.0 GW
-1.2 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions


Downward regulation at weekly minimum demand: Sardinia
(export required if positive)
1.4 GW
1.2 GW
1.0 GW
0.8 GW
0.6 GW
0.4 GW
0.2 GW
0.0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am







Italy: Summer Review 2017

General comments on past summer conditions

Summer 2017 recorded a significant increase (about 4.1%) in electricity demand compared to the same period in 2016. This is mainly due to temperatures that were on average higher than the previous year, especially in the first 20 days of June (2.7°C higher) and in the first 10 days of August (3.8°C higher).

In August, the maximum temperatures were higher than in 2016, mainly in the first part of the month, with an average increase of at least 5°C. Consequently, a high peak demand in the month was recorded (about 55 GWh reached on 3 August), mainly due to the effect of air conditioners.

However, the margins have been positive and sufficient to ensure the necessary system security standards thanks to the counter-measures applied for the period—coordination of the unavailability of network elements and generation plants and return in operation of some mothballed plants—and contribution to import energy margins (on average 5 GW).

Specific events and unexpected situations that occurred during the past summer

During the summer there were many fires, and there were high atmospheric temperatures.

However, these events were handled without causing problems to the electrical system security.

Latvia: Winter Outlook 2017/2018

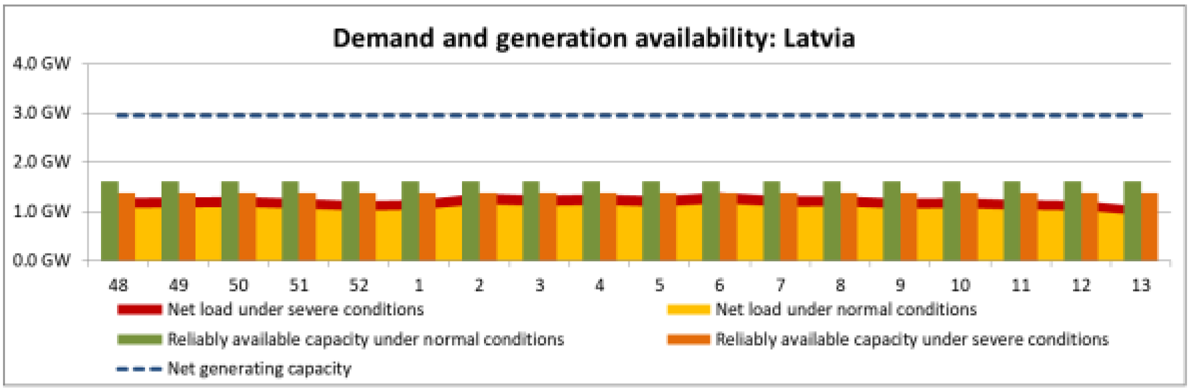
The load forecast is based on previous winter post-factum load. For normal conditions, it is expected that load could increase up to 1.7%, but for severe conditions the load could be much higher due to the fact that this can happen once in 20 years and the historical peak load from the last 10 years is applied. The actual load very much depends on weather conditions in the area of Latvia, and the actual air temperature on a particular day and hour. The TSO is not expecting load reduction in normal and severe conditions; therefore, load should be covered during whole winter period. The system service reserve is 100 MW in normal and severe conditions during whole year.

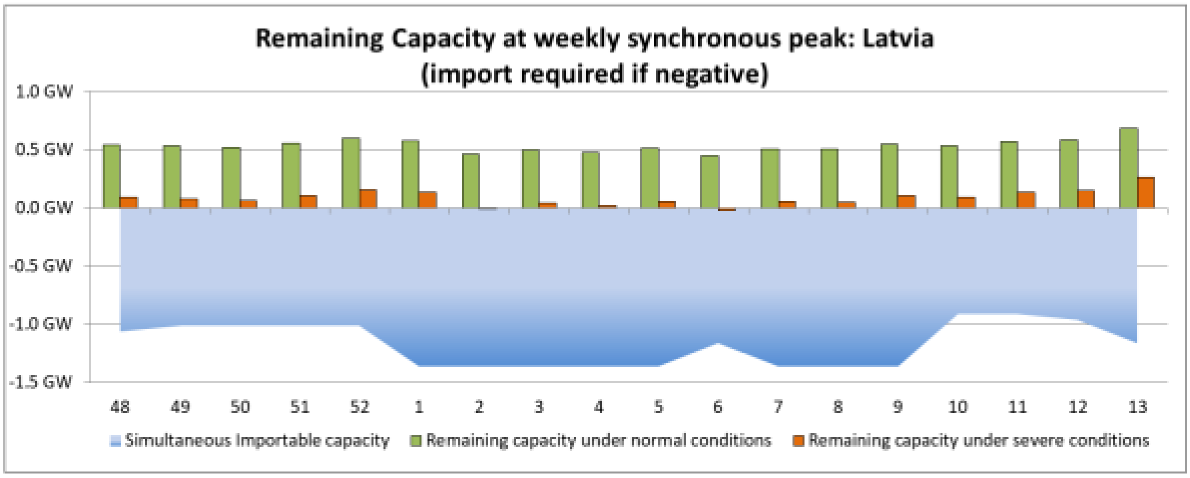
The total installed capacity for the Latvian power system is around 2.88 GW during the whole winter period. The fossil power plants are around 1.03 GW, the hydro power plants (HPPs; run of river) are around 1.6 GW and the rest of capacity is from other RES (wind, bio fuels and solar) –0.22 GW. Other non-RES generation refers to small Combined Heat and Power plants (CHPs) distributed within the area of Latvia. During almost the whole winter there is no scheduled maintenance and overhauls on gas power plants; therefore, the full capacity from generation of fossil fuel will be available. During whole winter period, a couple of units from HPPs on Daugava River are in maintenance. It is assumed that during the winter period the available capacity of HPPs for normal conditions is around 500 MW (average historical production amount during winter period), but in severe conditions the amount is reduced to 400 MW due to possible lower water inflow level. The full capacity of HPPs on Daugava River will be available from April to June, when there is usually a flood season and the water must be utilized as much as possible.

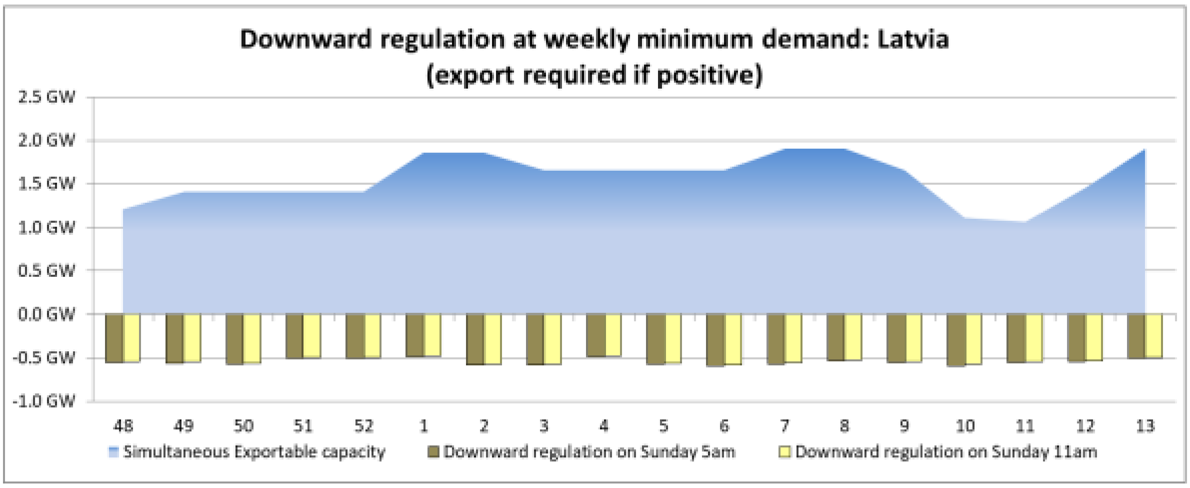
Most critical periods for maintaining adequacy margins and counter-measures

The most critical periods for the Latvian power system could be the weeks 2 and 6 in severe load conditions. The peak load in normal conditions can be covered during the whole observed winter period without any problems, but in the severe load conditions Latvian TSO will rely on electricity import from neighbouring countries. The assumption of additional increase of load by 18% in the severe conditions compared the normal condition is very conservative with a quite low probability.

In general, for the whole winter period Latvian TSO does not see trouble to cover a peak load in normal and severe load conditions. It does not expect a reduction of gas import or any other shortage in power plants in the area of Latvia.







Most critical periods for downward regulation and counter-measures

The amount of inflexible generation in Latvia is not so significant; therefore, we do not see a problem with the operation of inflexible generation in night-time and daytime minimum load hours. The inflexible generation is around 200 MW.

Latvia: Summer Review 2017

General comments on past summer conditions

The average air temperature in Latvia was lower than normal air temperature during the summer period. This was the coldest summer by air temperature since 2000.

The water inflow in Daugava River this summer was higher than expected and production of hydro was higher. The significant production of hydro reduced the electricity import from neighbouring countries.

The CHPs worked according to energy market principles.

Significant faults in the interconnectors were not observed.

The real import and export capacities from Estonia were higher than planned before. The prognosis was more conservative than real transmission network situation. Very similar capacity deviation was observed on cross-border Latvia–Lithuania where import capacities were very close to planned import capacities and sometime higher, but the export capacities were most of the time higher than planned. These deviations of plan did not cause any trouble for security of supply in area of Latvia and the updated capacities were used for power exchange within Baltic States.

Lithuania: Winter Outlook 2017/2018

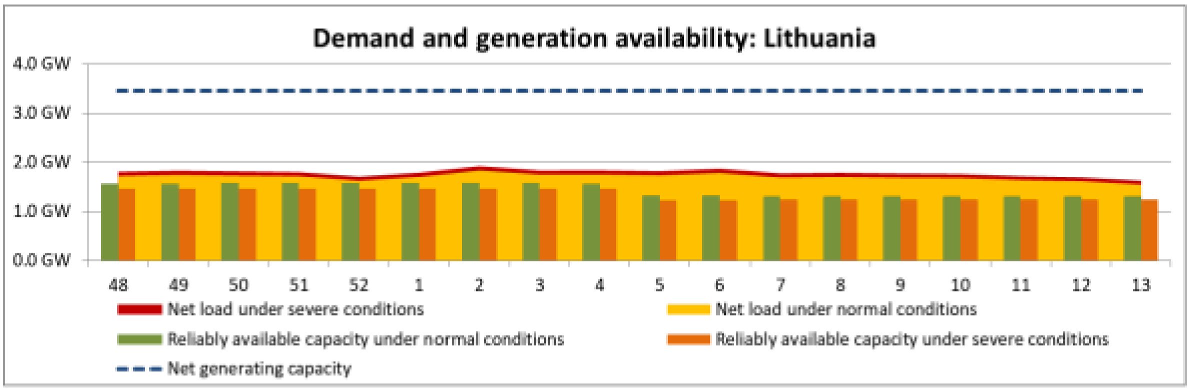
The load estimation for normal conditions was based on statistical data of previous three years. However, consumption is highly dependent on actual weather conditions in particular period. Comparing with a previous winter, total load is expected to be around 2.75% higher, with a maximum (under normal conditions) of 1,970 MWh in the beginning of January.

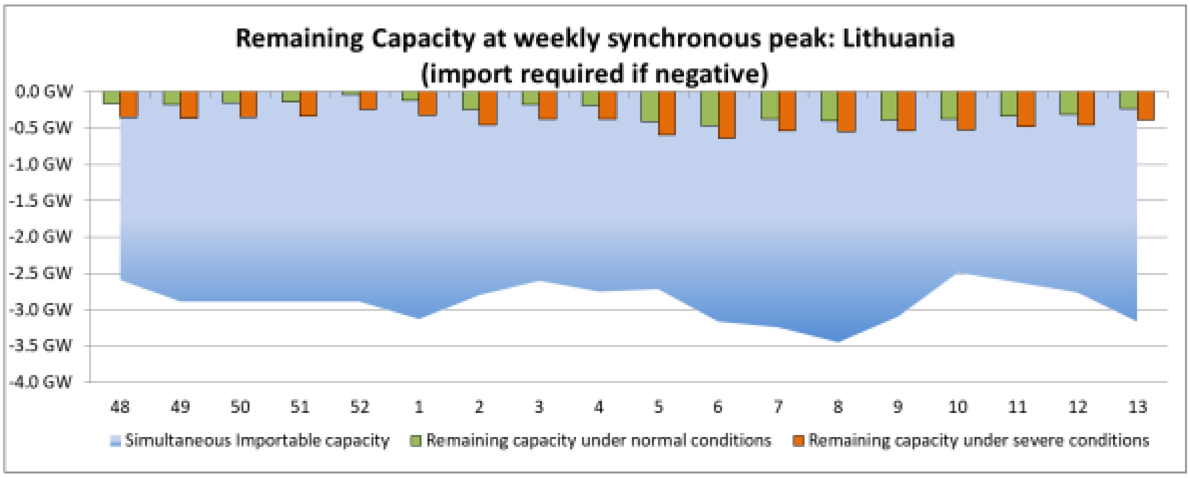
No significant changes are expected for net generating capacity since the last winter season. Total volume of frequency restoration reserves and replacement reserves for winter season will not change significantly and will be equal to 883 MW in average for whole season that is 26% of national net generating capacity (national NGC). Furthermore, for the upcoming winter season, the maintenance schedule will not be intensive. According to the maintenance schedule, the largest (7% of national NGC) generation inaccessibility due to maintenance will be on weeks 5 and 6 in 2018 when generating units of Kaunas Hydroelectric Power Plant and Kruonis Pumped Storage Plant will not be available. Moreover, large amount of capacity will not be usable due to mothballed Vilnius Combined Heat and Power Plant (CHP) and Kaunas CHP that combine 422 MW (12% of national NGC).

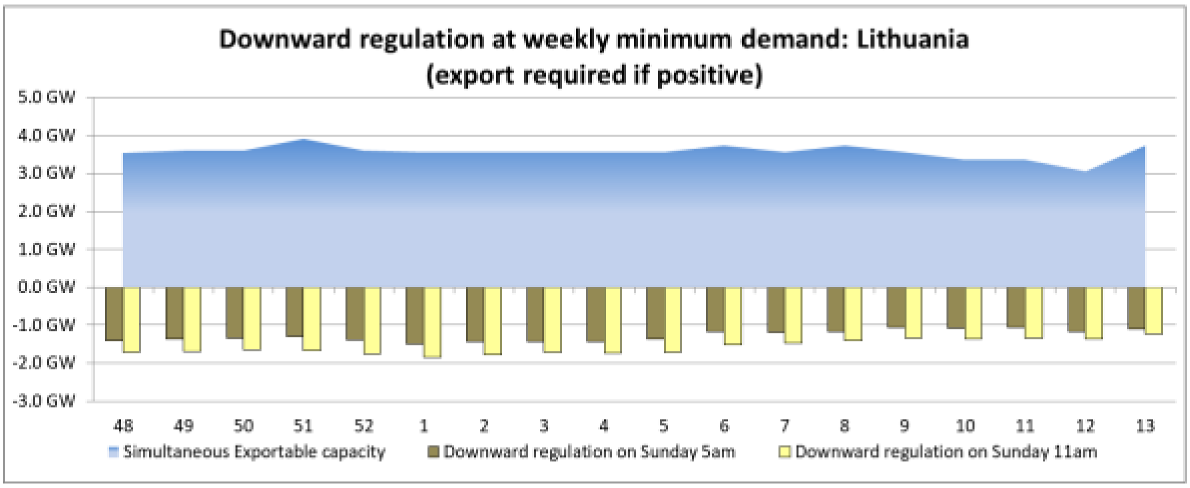
All import volume from third countries (Russia, Belarus) based on power flow calculations are allocated on the Lithuania–Belarus interconnection and highly depends on the Estonia–Latvia interconnection capacity. Higher restrictions of the import capacity from third countries are foreseen from week 10, due to maintenance activities on the Estonia–Latvia interconnection lines.

Due to the limited generation capabilities in the Kaliningrad region during peak load hours in January and February, reasonable decreasing capacities in the interconnection Lithuania–Russia is expected.

The balance of the Lithuanian power system during the upcoming winter season is forecasted to be negative. However, cross-border interconnection capacity is expected to be sufficient to maintain system adequacy.







Lithuania: Summer Review 2017

General comments on past summer conditions

Total national consumption in summer 2017 was 2.2% higher than in the previous summer. Moreover, in the several days of this summer, the precipitation amount level was critical and also resulted in consumption increase. The maximum load (1,576 MW) was reached in the middle of August, while the minimum load (835 MW) was in the middle of July.

The average summer balance portfolio consisted of 28% local generation and 72% imports from neighbouring countries. The largest sources of imported electricity were Russia (37%), Sweden (34%) and Latvia (30%).

In summer 2017, local generation was 3% lower than in the previous summer. There are two main reasons for the generation decrease. First, growth in allocated capacity of the Lithuania–Sweden HVDC interconnector led to a larger amount of imported electrical energy. Second, 44% (133 GWh) lower fossil fuels generation that can be explained by the higher price of generation using this type of fuel. On the other hand, mainly due to wind onshore net generation capacity increase (risen from 435 MW to 517 MW), wind generation was 25% higher (from 223 GWh to 280 GWh). Another significant difference was observed in hydro generation that, due to a higher precipitation level, increased by almost 17% from 222 GWh to 259 GWh.

Import capacity from third countries to Lithuania was restricted during most of the summer period because of reduced capacity of the Estonia–Latvia interconnection. The main reasons for the restrictions were higher ambient temperature and maintenance activities on the interconnection lines.

Another interconnection limiting capacity from third countries was Belarus–Lithuania. Higher capacity limitations lasted until week 30, due to the reconstruction of the Belarussian grid and maintenance activities on the interconnection lines.

Moreover, in the beginning of the summer period during weeks 16-17 and 19-21, the import volume from the Kaliningrad region to the Lithuanian power system significantly decreased because of maintenance activities in the Kaliningrad Thermal Power Plant.

Furthermore, during weeks 27 and 30, the import and export capacity of the Lithuanian power system was reduced by unplanned outages of the NordBalt HVDC interconnection.

Specific events and unexpected situations that occurred during the past summer

No unexpected situations occurred during the last summer period.

Luxembourg: Winter Outlook 2017/2018[33]

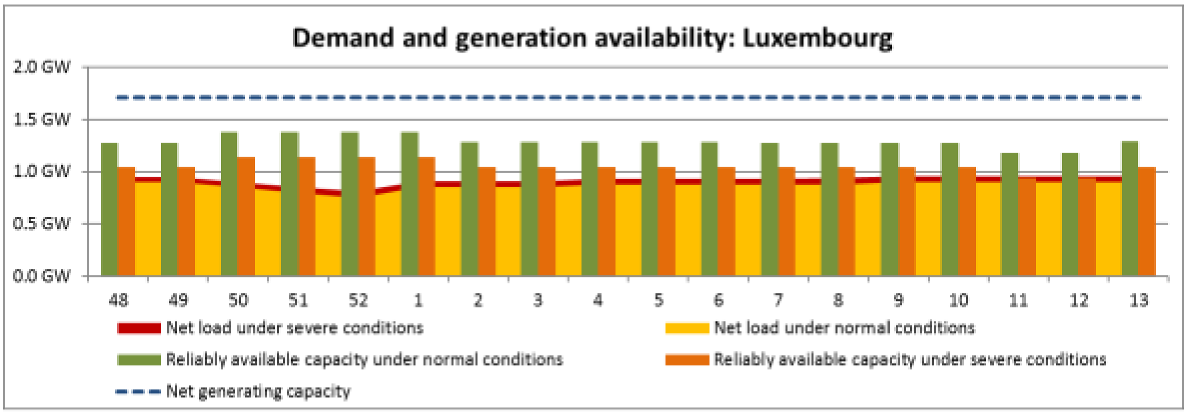
Most critical periods for maintaining adequacy margins and counter-measures

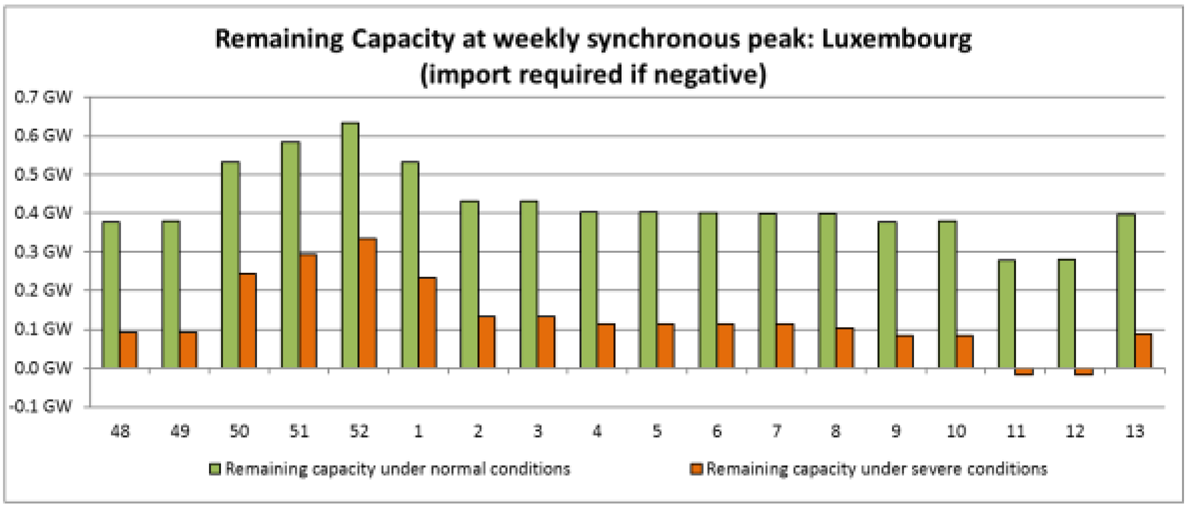
No adequacy issue is expected in Luxembourg for the coming winter season

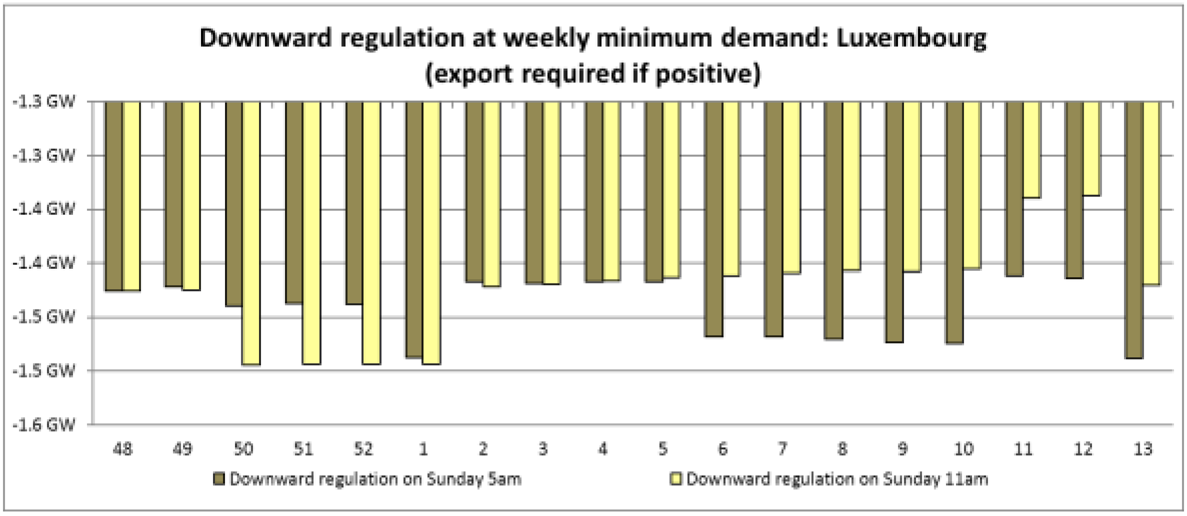
Most critical periods for downward regulation and counter-measures

None.

[33] NTC in graphs is not represented because an infinite interconnection is considered with at least one country.







Luxembourg: Summer Review 2017

General comments on past summer conditions

No adequacy issue was identified in Luxembourg during the last summer season.

Specific events and unexpected situations that occurred during the past summer

None.

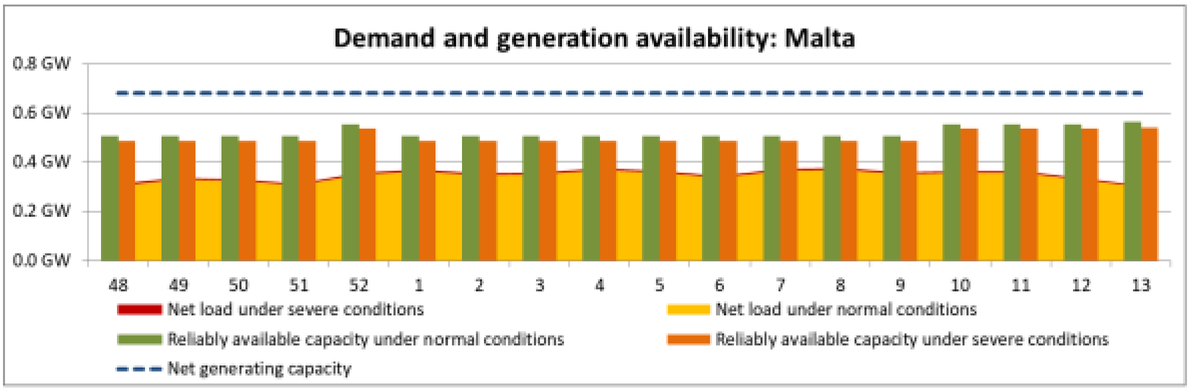
Malta: Winter Outlook 2017/2018

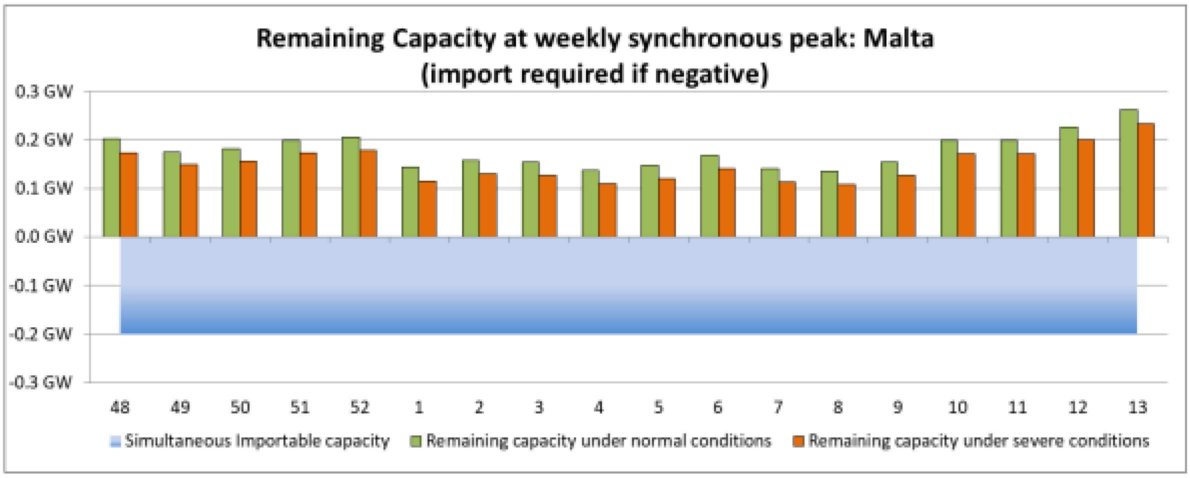
Most critical periods for maintaining adequacy margins and counter-measures

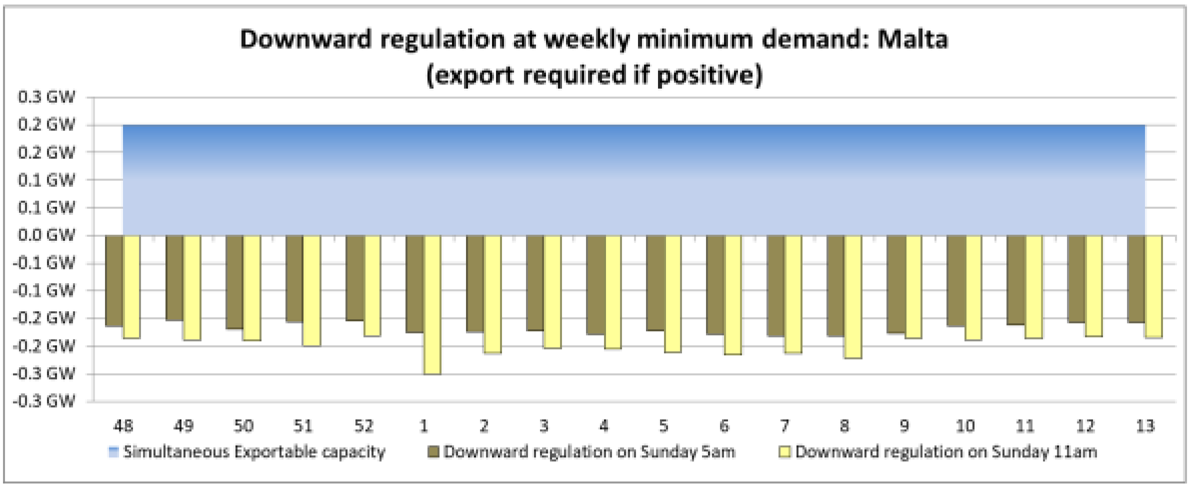
No adequacy issue is expected in Malta for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.







Malta: Summer Review 2017

General comments on past summer conditions

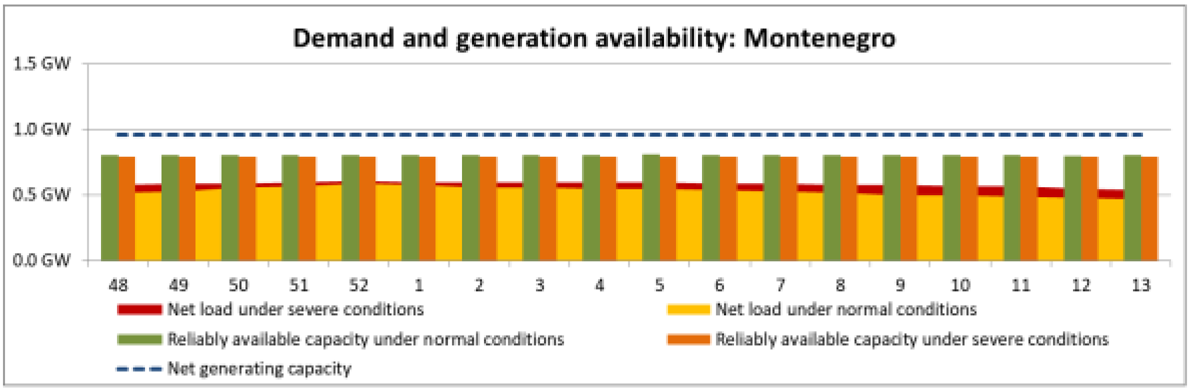
No adequacy issue was identified in Malta during the last summer season.

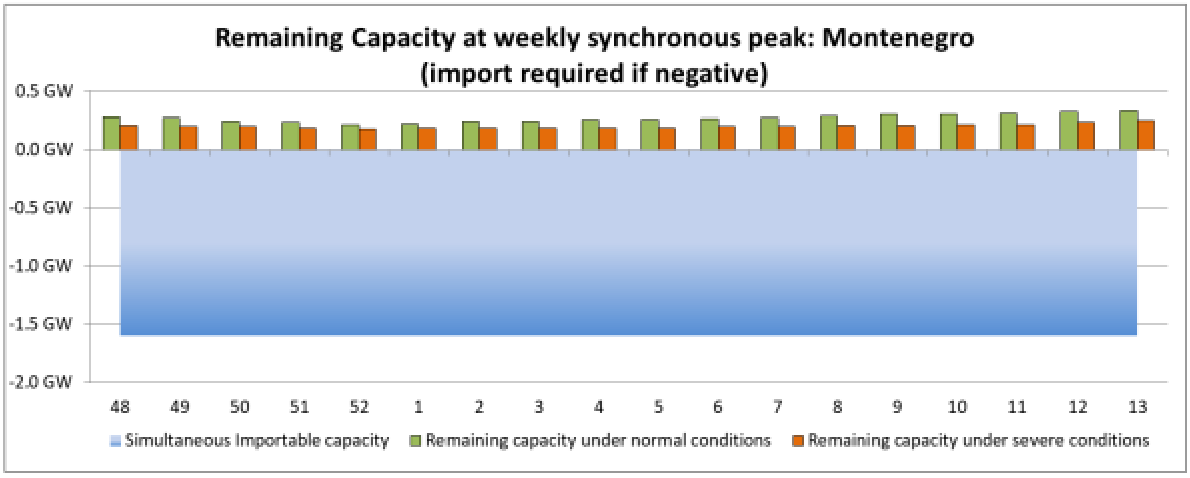
Specific events and unexpected situations that occurred during the past summer

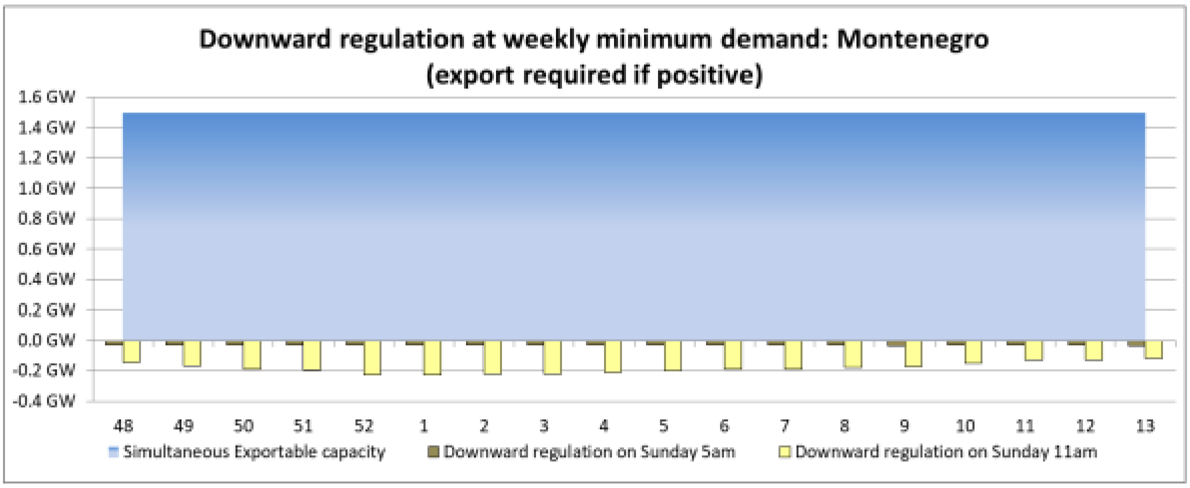
None.

Montenegro: Winter Outlook 2017/2018

The operation of the Montenegrin power system is expected to be secure and reliable during winter 2017/2018. Generation-load balance problems, under normal conditions, are not expected.







Montenegro: Summer Review 2017

General comments on past summer conditions

Summer 2017 was characterized by the extremely high air temperature with long duration, which caused increased consumption, occasionally a strong northern wind and low precipitation. A tropical wave occurred between 31 July and 10 August. During these 11 days, the air temperature reached daily and exceeded 40°C, reaching 42.5°C (9 August 2017). This is a record number of consecutive days with temperature of 40°C and above. So far, there were 8 consecutive days with a temperature of 40°C and higher in July 2007.

The import was necessary to cover the demand and to prevent further decrease of reservoir levels during July and August.

Specific events and unexpected situations that occurred during the past summer

There were no critical outages/events in the Montenegrin transmission network during the summer. Most of the planned works were completed in accordance to the maintenance schedule for 2017. The availability of interconnectors has been more than adequate, and we had no problem with the implementation of the cross-border transactions.

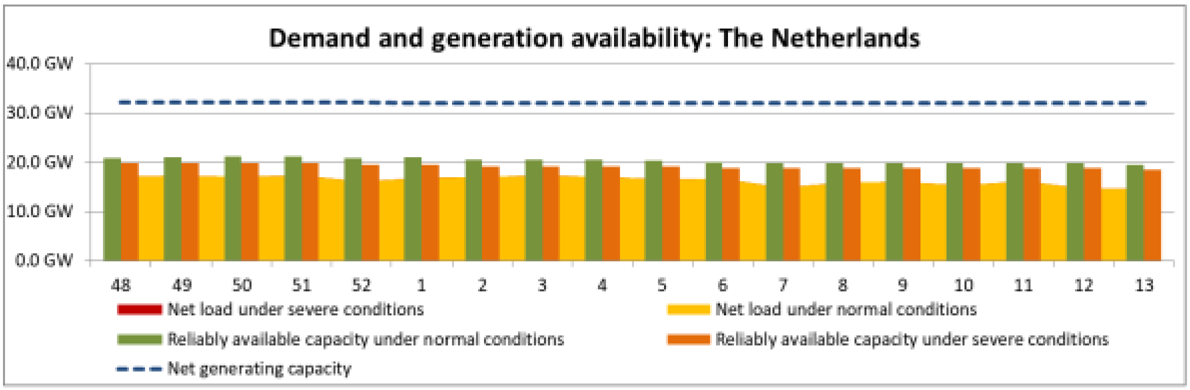
Netherlands: Winter Outlook 2017/2018

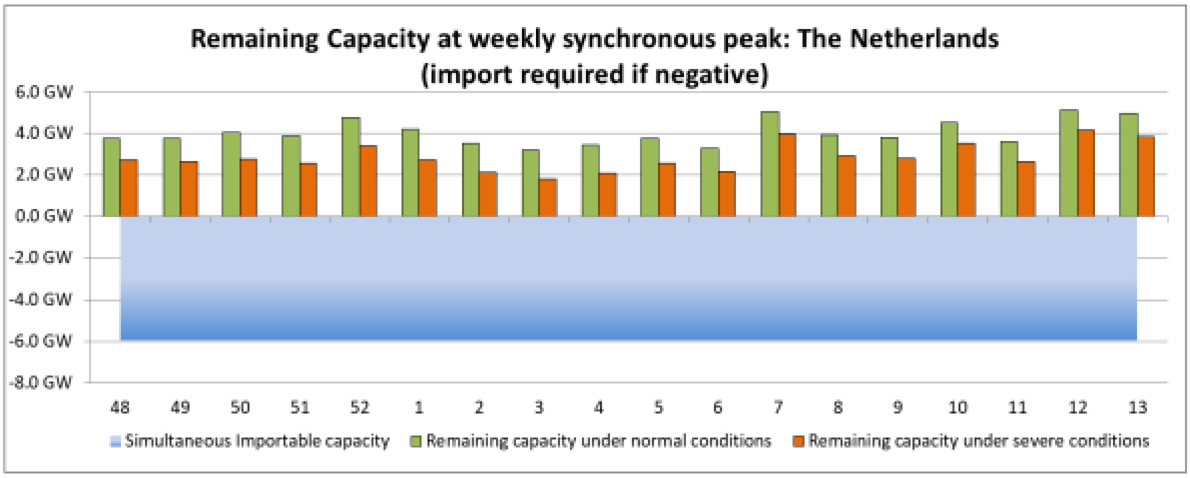
Most critical periods for maintaining adequacy margins and counter-measures

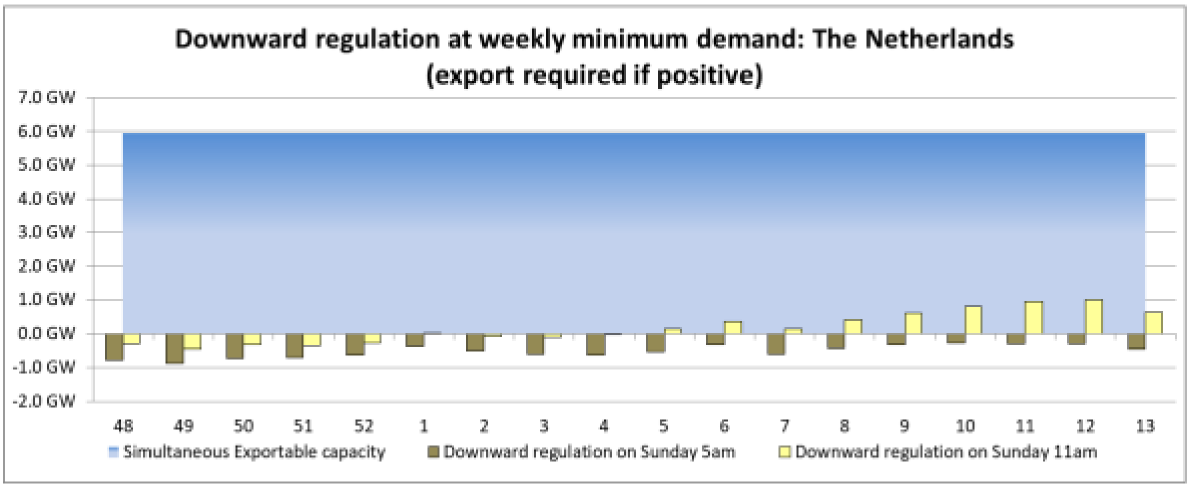
No adequacy issue is expected in the Netherlands for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.







Netherlands: Summer Review 2017

General comments on past summer conditions

No adequacy issue was identified in the Netherlands during the last season.

Specific events and unexpected situations that occurred during the past summer

None.

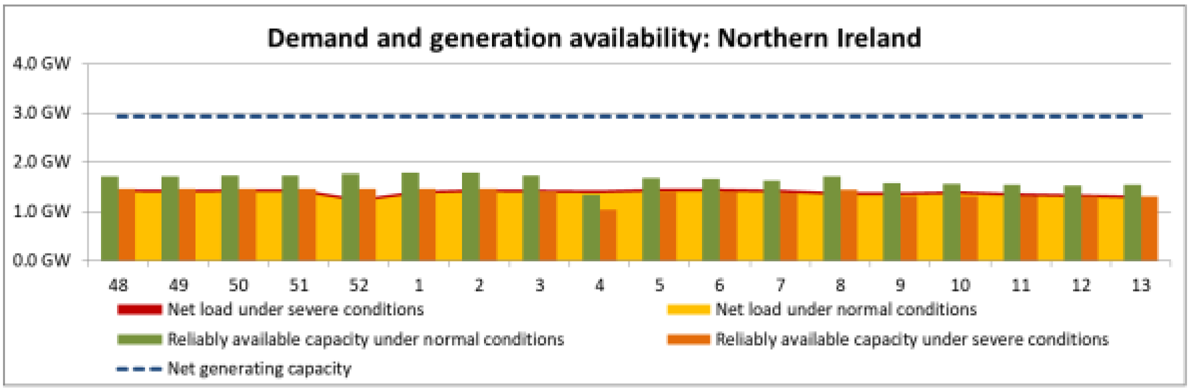
Northern Ireland: Winter Outlook 2017/2018

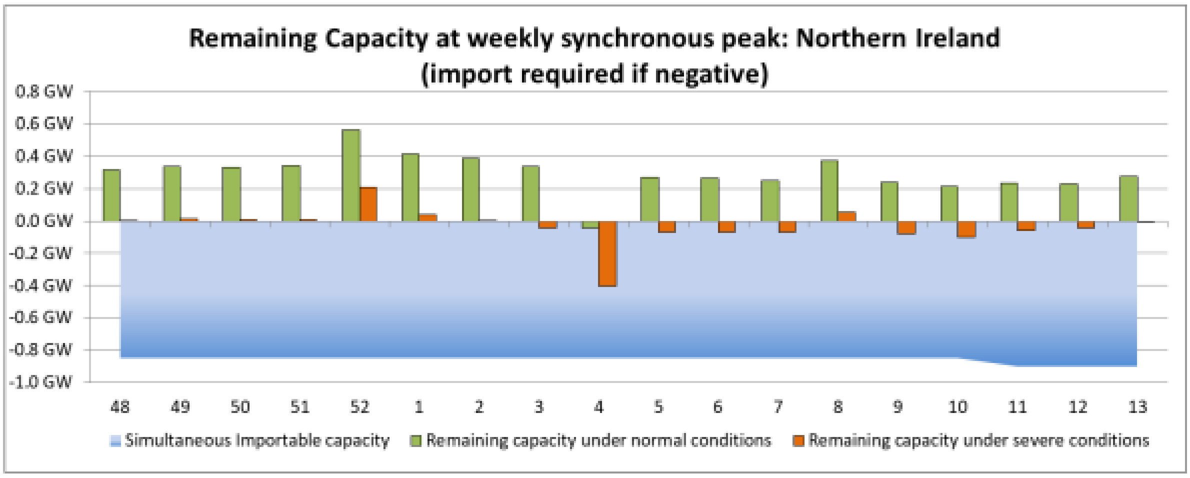
Most critical periods for maintaining adequacy margins and counter-measures

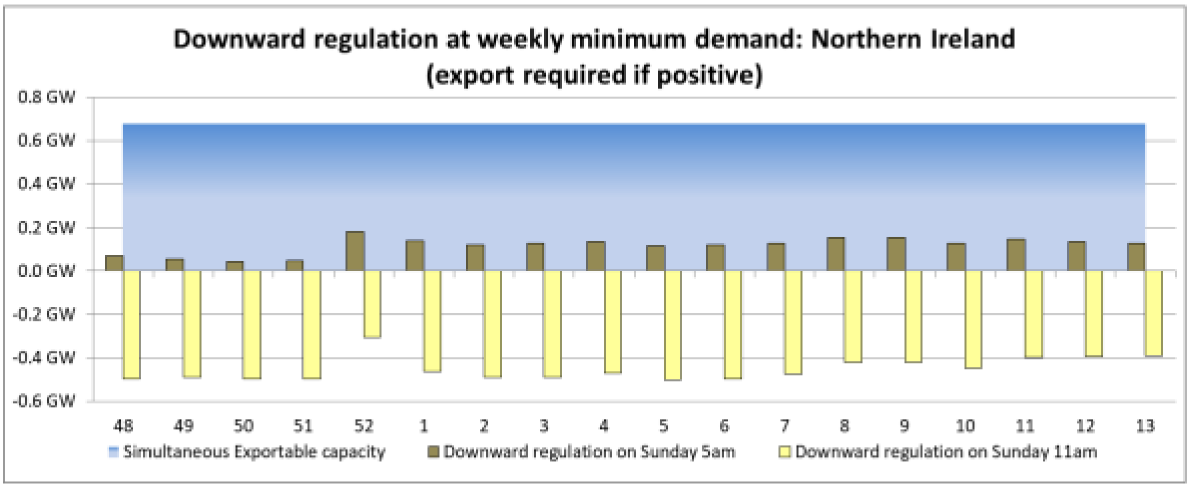
No adequacy issue is expected in Northern Ireland for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.







Northern Ireland: Summer Review 2017

General comments on past summer conditions

No adequacy issue was identified in Northern Ireland during the last summer season.

Specific events and unexpected situations that occurred during the past summer

None.

Norway: Winter Outlook 2017/2018

Statnett does not expect any critical situations for maintaining adequacy or downward regulating during winter 2017/2018. We expect the demand will be higher than the inflexible generation in all hours. Norway is normally self-supplied with electricity with a capacity surplus. This is also the situation for severe conditions.

The current hydrological situation with a normal reservoir level, normal power prices and export of power from Norway is expected to continue during the autumn and winter if we have a normal or high inflow of water to the reservoirs.

Most critical periods for maintaining adequacy margins and counter-measures

A sudden and long-lasting change to a cold and dry weather, combined with several severe generating outages in Norway or Sweden (nuclear), can potentially change the current normal reservoir level to a shortage situation within a short time span. Some price areas within Norway may also experience a shortage due to internal congestions. Such a shortage is not likely to happen before the middle or end of May next year (next Summer Outlook). Even with dry weather during the autumn, the producers have much time to adjust production and increase import during the winter to avoid such a situation.

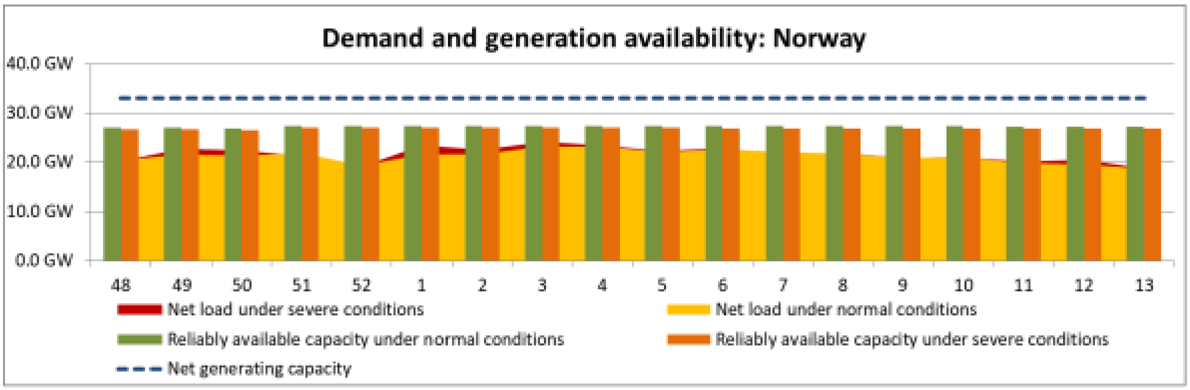
The exchange capacity between Norway and Sweden in the Winter Outlook are maximum capacities that we can expect. These exchange capacities can be reduced in periods with cold weather and high load in the Oslo area.

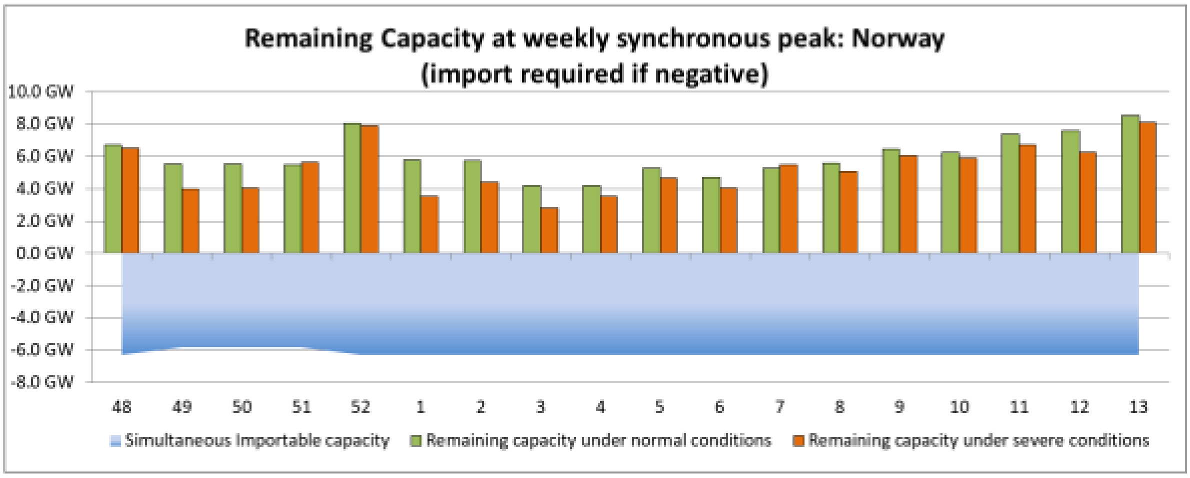
Unavailable generating and transmission capacities are based on Nord Pool Urgent Market Messages of 1 September 2017. There may be more disconnections of production and transfer capacities after market participants have submitted their needs for disconnections for the winter season by 1 October and approval by Statnett a little later.

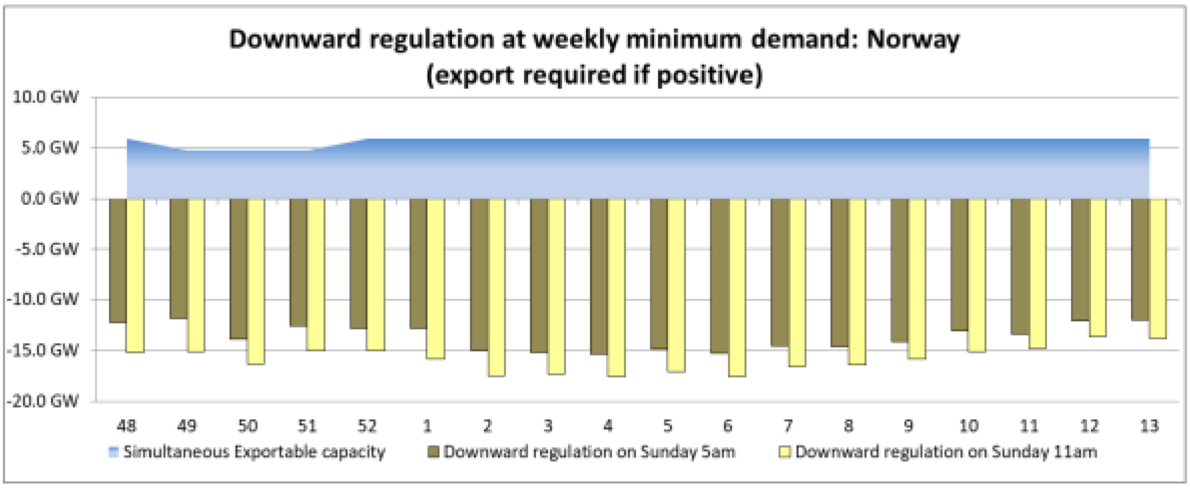
We have common Nordic reserves that can be difficult to allocate to single countries, and there may be allocation of reserves on a short-term notification later this winter in case of severe conditions. In addition, the automatic frequency restoration reserve (aFRR) for 2018 is not decided yet. Hence, the reserves estimate in the winter outlook are a bit rough.

Most critical periods for downward regulation and counter-measures

No critical periods for downward regulating capacity are identified and will probably not be a problem in the winter because most hydropower generators run at peak time, and we expect export on foreign exchanges, which can be disconnected, most of the time.







Norway: Summer Review 2017

General comments on past summer conditions

As expected in the Summer Outlook, delivered in February 2017, the adequacy in Norway has been satisfactory during the summer. The hydro reservoirs changed from levels lower than normal by the end of last winter to normal levels between weeks 20 and 25. A high level of maintenance and disconnections during the summer has not caused any serious problems.

Poland: Winter Outlook 2017/2018

General comment

Power balance results are comparable with previous Winter Outlook ones. On the one hand, about a 1.2 GW of coal-fired power generation capacity is forecasted for decommissioning since 1 January 2018, as the result of emissions standards and lifespan. On the other hand, a power output is foreseen from new units commissioned in September 2017. The foreseen level is included in power balance results; however, due to test phase this level may not be fully available.

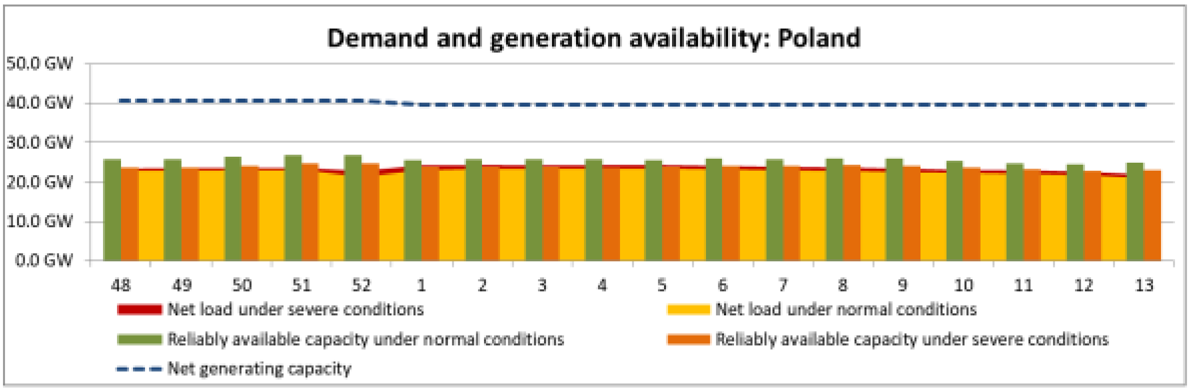
Negative power balance in some reference points can be covered using import capacity. In addition, PSE (Polish TSO), has contracted 362 MW of Demand Side Response (DSR), which may be activated in case of inadequacy.

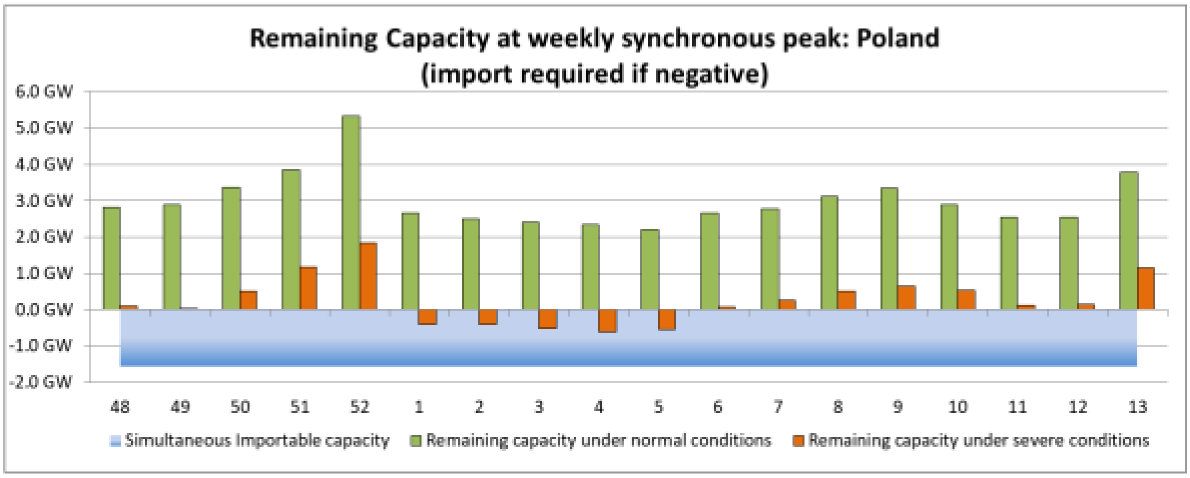
At the beginning of July 2017, the repaired Phase Shifter Transformer (PST) (one out of four installed PSTs) was recommissioned after a 9-month absence (failure on 22 September 2016). Except from existing PSTs in Mikułowa substation (and planned PSTs in Vierraden, referred to second interconnection between Germany and Poland), in July 2017 the last two PSTs of four planned, were commissioned in Hradec substation (Czech Republic). Additional PSTs in the region are foreseen for installation in the second half of 2017 in Röhrsdorf substation (Germany). As they are/will be in operation in the close neighbourhood and possibly influencing each other, it is very important to coordinate tap settings of these PSTs. Ongoing work in trilateral working group should allow working out the rules referred to tap setting coordination:

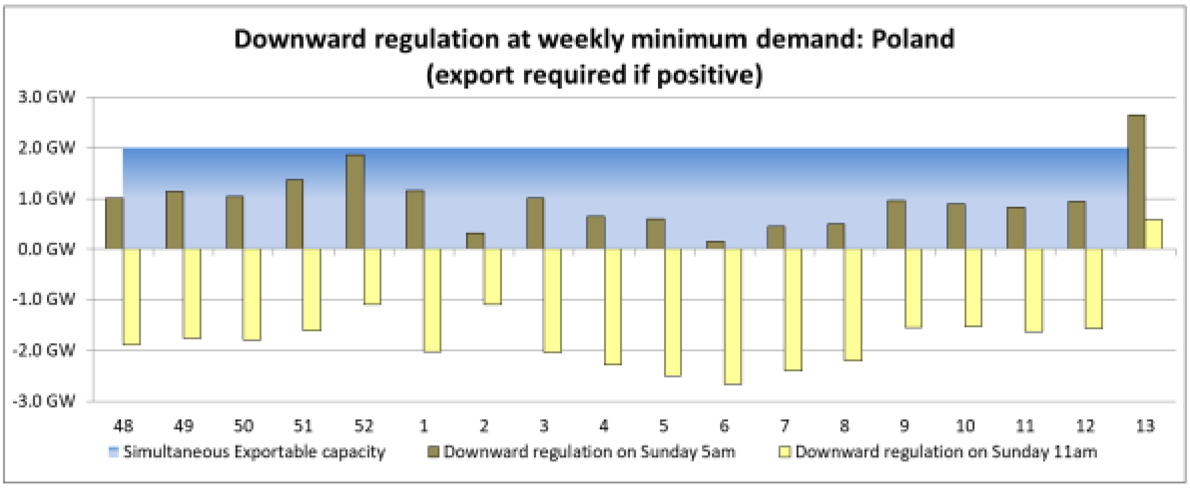
Existing (solid line) and planned / under construction (dotted line) PSTs in the region

Most critical periods for downward regulation and counter-measures

PSE does not prepare a forecast for downward regulation capabilities in a yearly and monthly horizon, so the provided data is an estimation only. A detailed specification is done within the operational (daily) planning, when the precise forecast of load and wind generation is known. In case of possible problems with balance, the system PSE has operational procedures to keep it at a safe level, including wind farms switching off as a last counter-measure. PSE can confirm there are some stress days during the year (especially during Christmas, Easter and holidays in May), when low demand and simultaneously high wind conditions could cause balance issues in the Polish power system. The national downward analysis at 5:00 local time, where RES infeed representing the 95th percentile) shows the possible need for export in all reference points. Sunday 1 April 2018 is the 2018 Easter Sunday and—as mentioned above—export needs may exceed the level of exportable capacity. PSE does not expect problems with balance at 11:00 local time on Sundays. Solar generation (which is circa 0.22 GW) is still negligible in the Polish power system.







Poland: Summer Review 2017

General comments on past summer conditions

There were no power balance issues noticed last summer, as weather conditions were favourable. The summer was not dry and heat waves were short-lived. Nevertheless, a new historical summer peak load was registered on 1 August 2017 at 13:15. It amounted to circa 21.7 GW.

Operational conditions were favourable as well; no N-1 criteria problem occurred.

Specific events and unexpected situations that occurred during the past summer

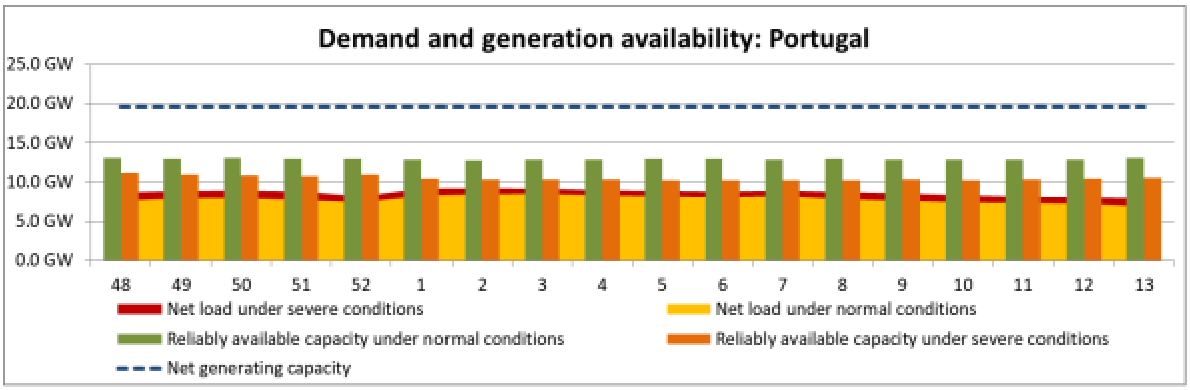
At the beginning of July, the repaired PST (one of four installed) was recommissioned after a 9-month absence (failure on 22 September 2016).

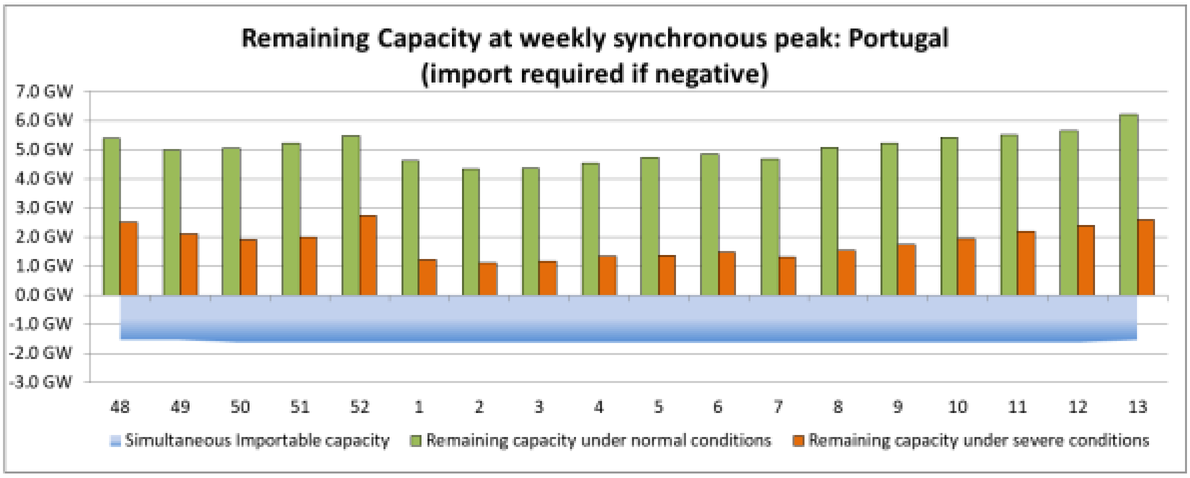
A strong hurricane hit the north-west part of Poland on 11–12 August 2017. Wind speed reached the highest level in 38 years, clocking up to 150 km/h. A few transmission lines were damaged, but without influence on customers. The significant troubles related to the distribution network only.

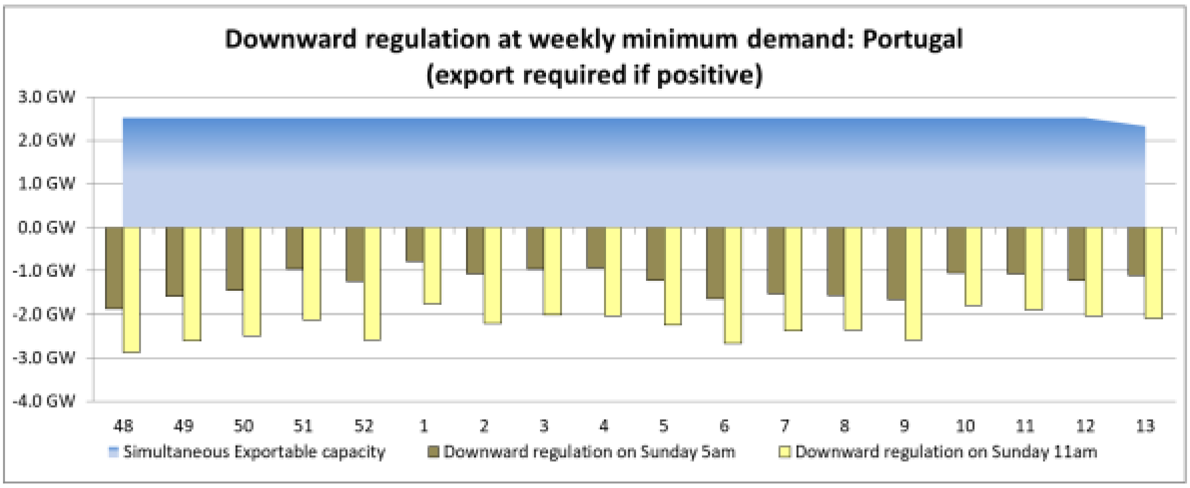
In September 2017, two new units were synchronized with the network. First, one is a hard coal unit with net generating capacity (NGC) amounted to circa 1,000 MW (1,075 MW of gross value). This is the biggest unit in the Polish power system. Second, one is a gas combined heat power plant (CHP) with the NGC, which amounted to circa 600 MW (630 MW of gross value). Currently, there is a trial operation period of these units.

Portugal: Winter Outlook 2017/2018

No adequacy risks for the Portuguese power system in the next winter season were identified in our assessment, despite the actual hydro storage level being close from the 10-year minimum for this time of the year.







Concerning system downward regulation capability, from our perspective, the eventual issues with inflexible generation are expected to be managed internally without resorting to export capacity.

Portugal: Summer Review 2017

General comments on past summer conditions

This summer, despite the very dry condition, the temperatures were in general mild, so the energy demand was essentially the same from last year and in line with the normal scenario presented on Summer Outlook report.

The hydro generation was clearly below expected, particularly in July when the production reached just 37% of the average. But even in August, when the values are very low, the energy produced was just 85% of the average values.

The wind power production index was in normal levels (1.04 in July and 0.99 in August).

With hydroelectric production in such low levels, renewable sources supplied only 31% of electricity consumption plus exports. For non–renewables, which accounted for the remaining 69%, natural gas units stood out, setting the record of the highest monthly production value ever consecutively in July and in August.

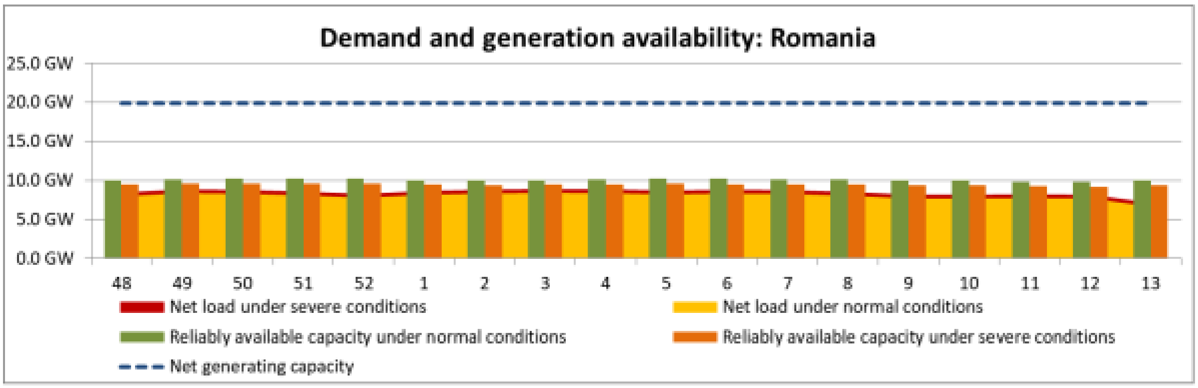
The high utilization of thermal power units is associated both with the reduced availability of renewable primary sources and with the trade balance with high exports to Spain (about 11% and 19% of national consumption in July and August, respectively).

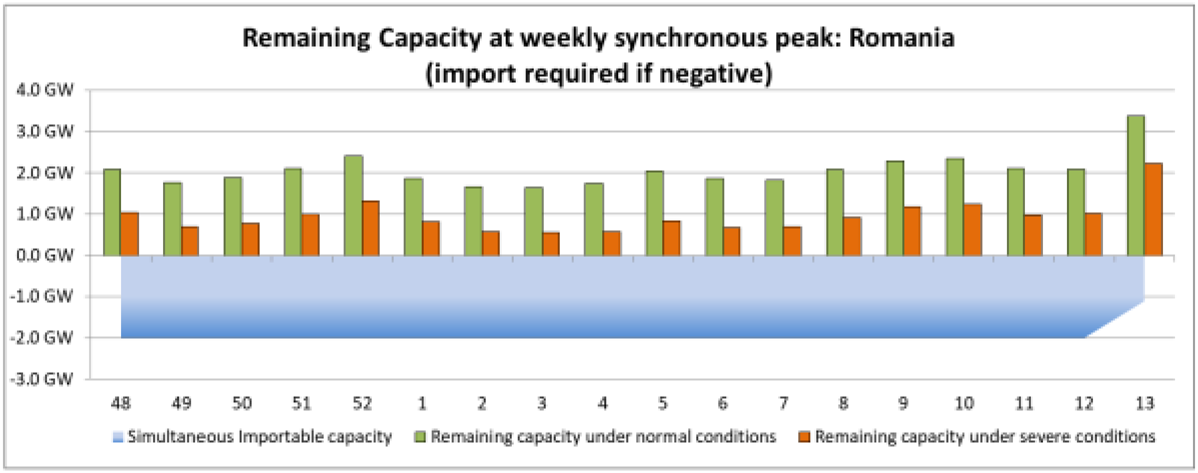
Specific events and unexpected situations that occurred during the past summer

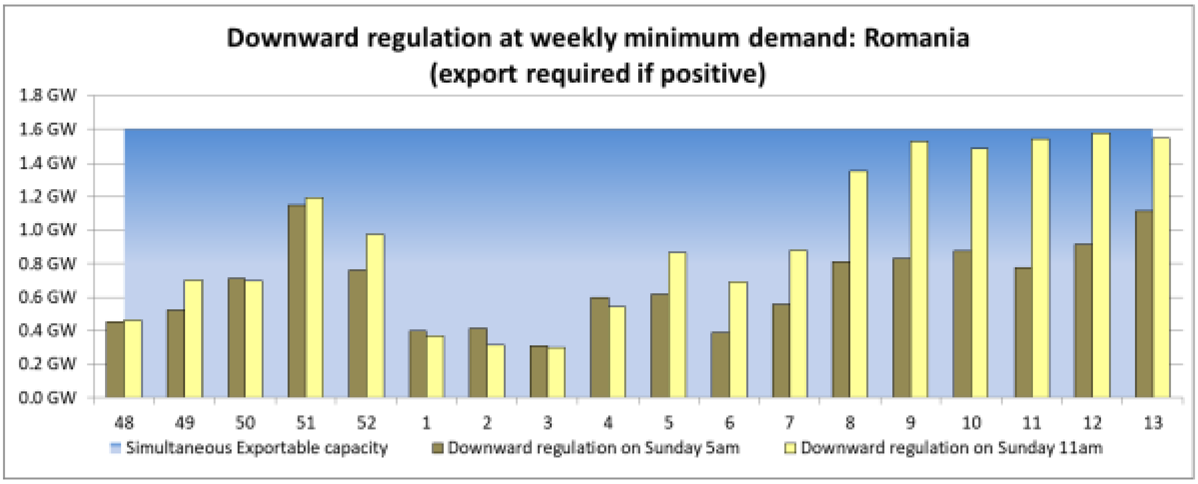
Last summer Portugal was, one more time, plagued by fires that obviously have posed difficult challenges to the system operation. However, this situation did not cause unsupplied energy.

Romania: Winter Outlook 2017/2018

The balance forecast for winter 2017/2018 does not indicate any problem that could affect the Romanian power system adequacy for normal condition. In the case of severe conditions due to bad weather with very low temperatures values and no wind, adequacy critical periods may occur.







Most critical periods for maintaining adequacy margins and countermeasures

In case of a gas crisis certain thermal power plants can be switched from gas fired operation to oil fired operation. In this way a possible gas crisis will not endanger the system adequacy during the coming winter.

For the critical periods due to bad weather conditions of temperatures values below –15ºC and no wind generation, the remaining capacity can have the lowest values between 550 – 700MW during the high peak time. The cross border transmission capacities will allow the possible need for imports if there will be sources in the region. In the case of lack of regional sources, Romania shall apply the provisions of the directive 2009/72/EC implemented in internal legislation in terms of safeguard measures.

Most critical periods for downward regulation and countermeasures

In case of positive downward regulation during the minimum demand on some Sunday reference time points, the cross-border transmission capacities for export will allow to export the excess of inflexible RES generation. However, if the export schedules are significantly lower than the NTC export value, then it is possible to apply market rules to reduce the RES generation, in order to keep the balance.

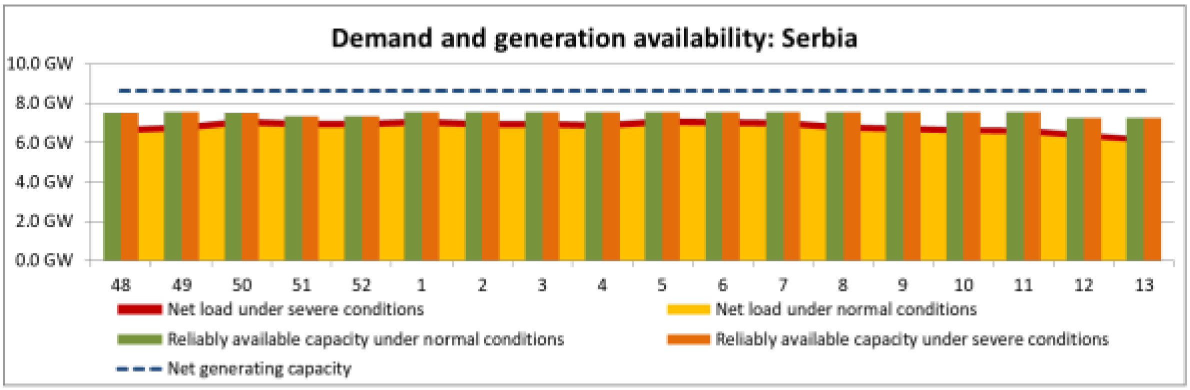
Romania: Summer Review 2017

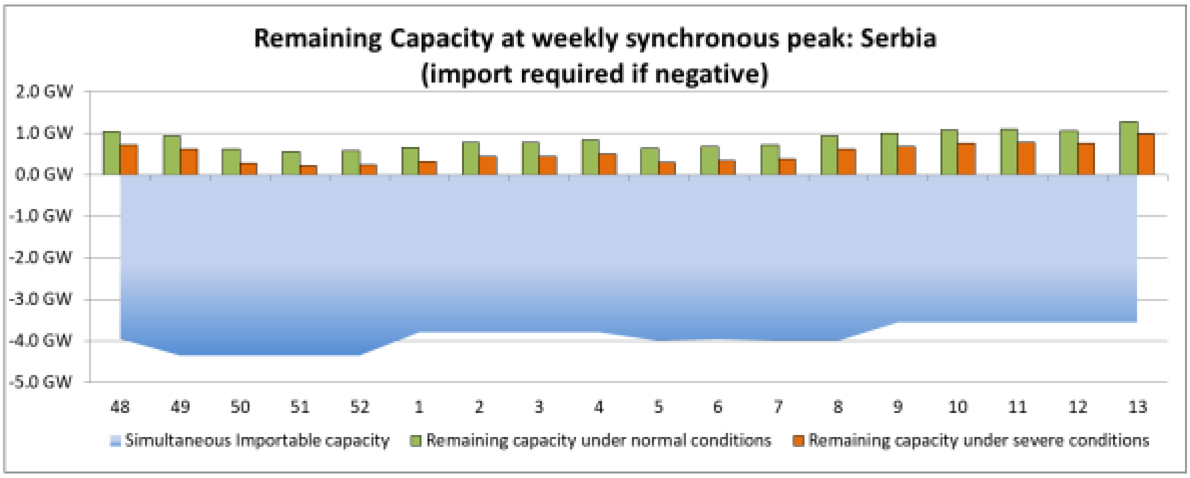
General comments on past summer conditions

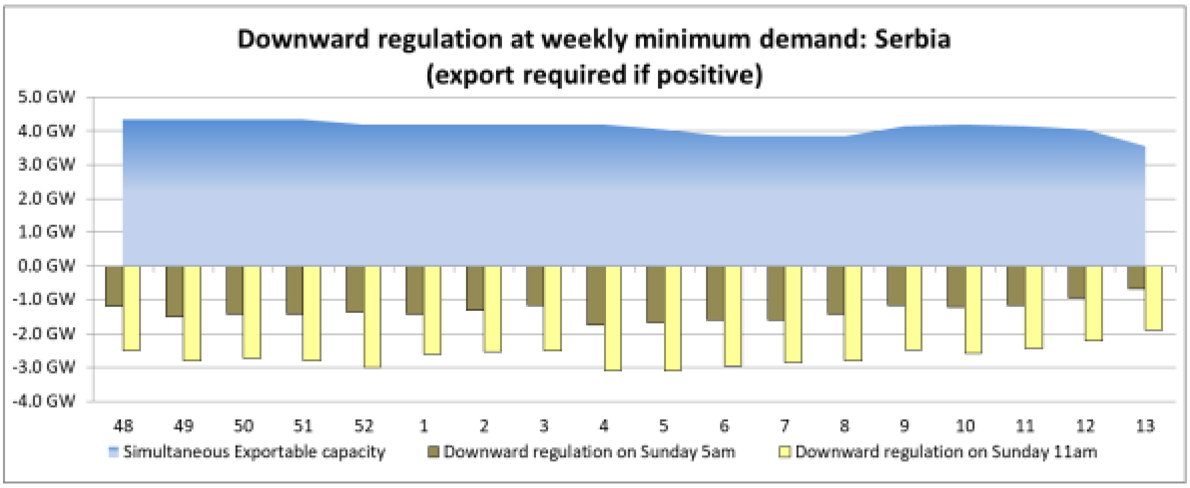
During summer 2017, no significant or unusual events appeared in the Romanian power system. The average peak temperature values were higher than normal ones during certain weeks in most parts of the country, but the power balance was manageable.

Serbia: Winter Outlook 2017/2018

For winter 2017/2018, we do not expect problems in covering demand. Moreover, a small amount of energy exporting is expected during February and March, under normal weather conditions.







The maintenance of power units and transmission network are to be completed before the significant increase of demand. The only major overhauls of the two hydro generators are planned during December, February and March, but the missing power of 200 MW does not significantly affect the adequacy.

In the case of shortage of gas, it is estimated that it may increase consumption up to 300 MW. Further increase over this margin in winter peak is not possible due to constraints in the distribution system (i.e. experience from the gas crisis in 2009).

Problems in covering demand can occur at extremely high peak loads under severe weather conditions in December and January, and then energy imports will be required. Taking into account that maintenance of interconnectors and significant internal lines are not performed during the winter seasons, there will be enough cross-border capacity to meet domestic and regional demand.

Serbia: Summer Review 2017

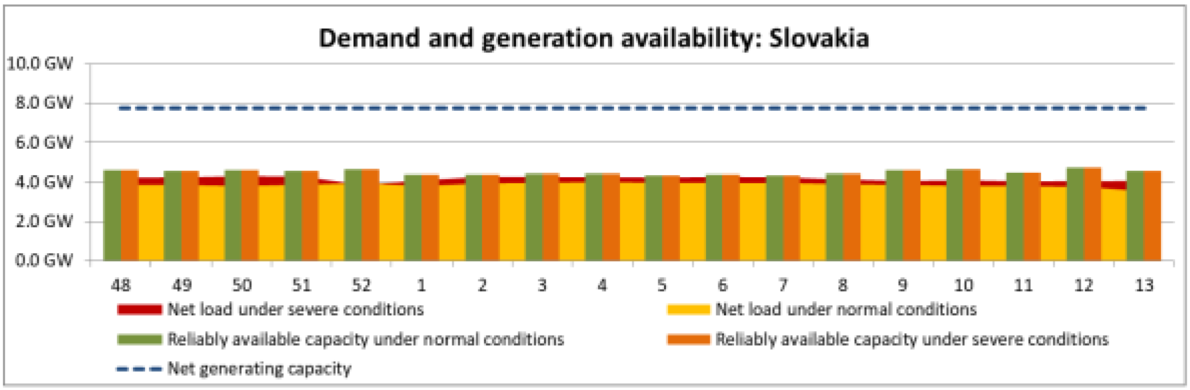
General comments on past summer conditions

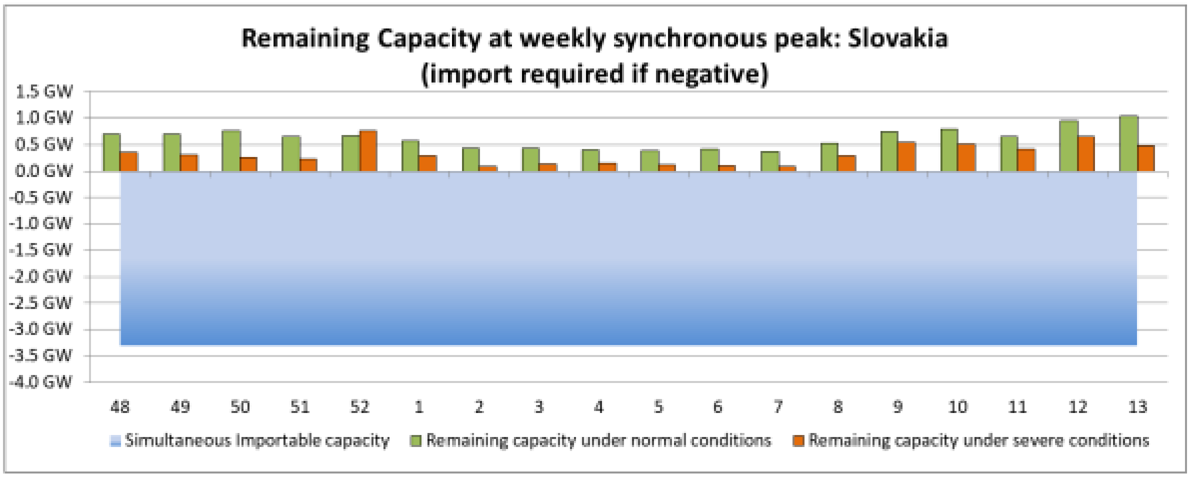
In general, summer 2017 passed without major problems. Temperatures were moderate and loads were as expected.

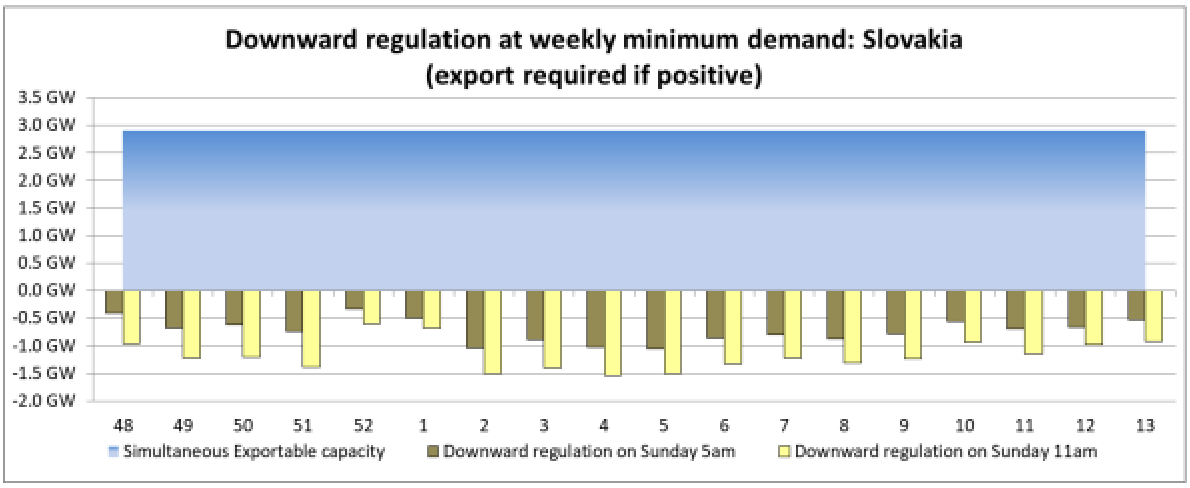
The higher levels of maintenance in June and first half of July did not disrupt the generation–load balance. In August and September in particular, there was a significant increase in energy exports.

Slovakia: Winter Outlook 2017/2018

No adequacy risk is identified in the winter outlook 2017/2018 of Slovakia. The expected generation capacity will be sufficient to meet foreseen peak demands this winter and to ensure the appropriate level of security of supply under normal conditions. During winter, the maintenance schedule is reduced to a minimum. Forecasted peaks are expected with the same level as last winter. Regarding severe conditions scenario, the remaining capacity (RC) is positive for the whole winter period except the weeks from mid-January to mid-February, when the RC is slightly negative. However, cross-border capacities for electricity import are sufficient.







Slovakia: Summer Review 2017

General comments on past summer conditions

The evaluated summer period 2017 is from June to September. In summer 2017 there were similar weather conditions compared to the previous summer. The average temperature during the summer months was 19.1°C (in summer 2016 it was 19.2°C). August 2017 was much warmer than in 2016 (+2.5°C). The average temperature in September 2017 was much lower than in 2016 (-2.6°C).

The following results of production and consumption are preliminary and can be changed later after the updating of data.

The production of electricity in Slovakia during summer 2017 was slightly lower (index 99%) than for summer 2016. In particular, the production of hydro power plants (HPPs) decreased significantly from June to August (index 79.2% of all summer). In contrast, nuclear power plants slightly increased in production (index 103%) because of higher production in June.

Electricity consumption was slightly higher than in the previous summer (index 101.6%). Consumption increased in June (101.5%), July (101.7%) and mainly in August (104.1%), but it decreased in September (99.2%). The summer peak load 3,854 MW was recorded on Friday (28 June 2017 at 13:00), whereas in the previous summer it was 3,753 MW (1 July 2016 at 13:00). The weekly peaks were higher in summer (mainly in August) with the exception of two weeks.

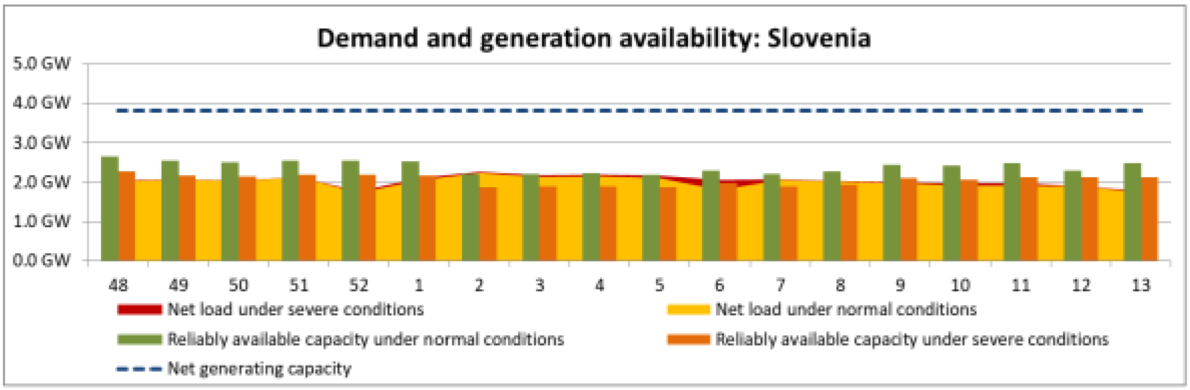
In summer 2017 the imported share of electricity consumption in Slovakia increased to 7.9% compared to 5.5% in summer 2016. The electricity was imported during all 2017 summer months. As a comparison, the import of electricity in summer 2016 was recorded only in June and September. Cross-border capacities were sufficient for these imports.

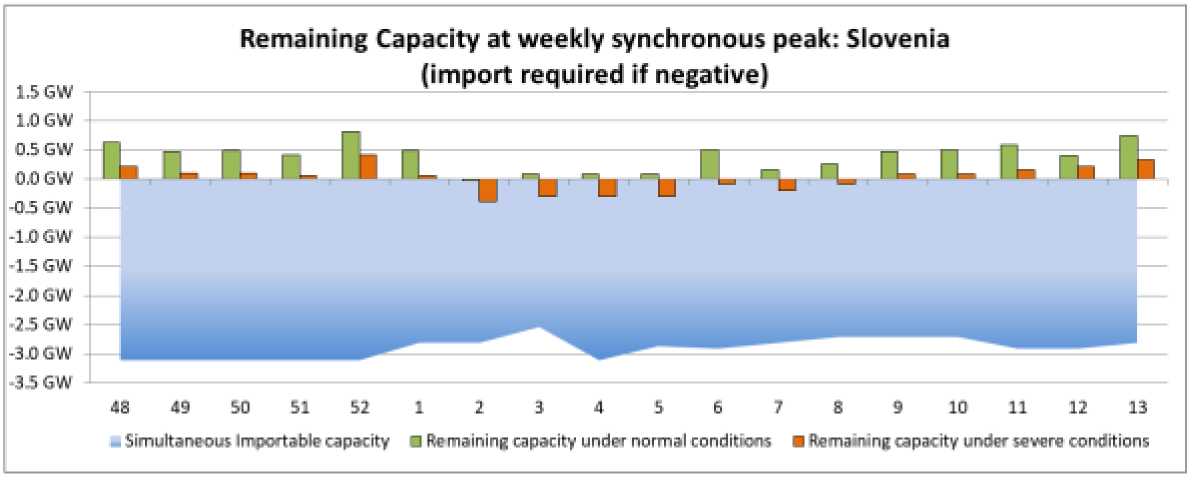
Specific events and unexpected situations that occurred during the past summer

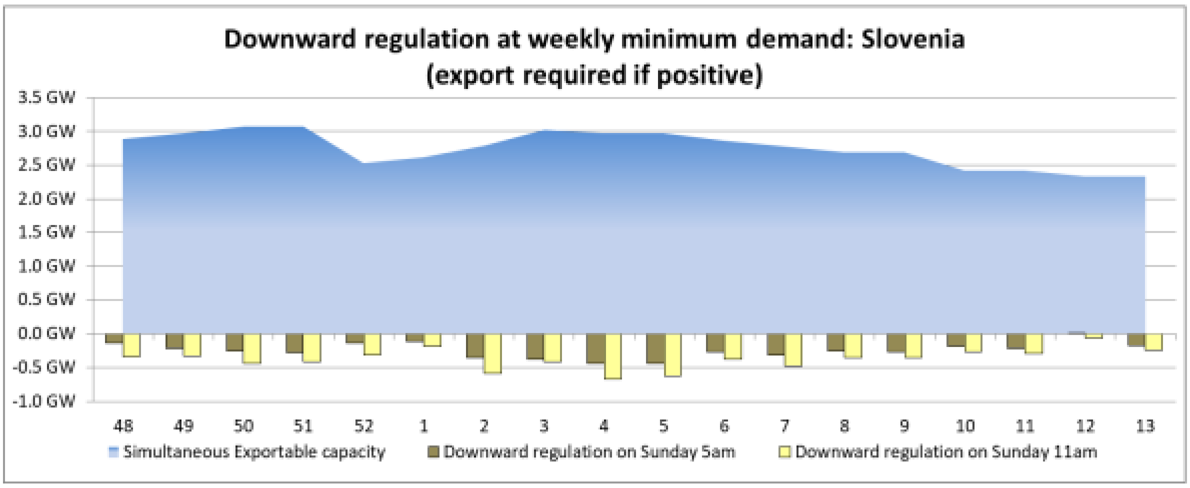
There were not any specific event or unexpected situation to be mentioned.

Slovenia: Winter Outlook 2017/2018

Results show Slovenia might under normal conditions face a negative remaining capacity (RC) during the second week of 2018. These negative capacities may occur due to a high number of hydro power plants (HPPs) under maintenance and a relatively high load at the same time. In the case of severe conditions, the RC is expected to be negative between the second and the eighth weeks; in such cases we expect to cover all energy needs using importing capacities.







Slovenia: Summer Review 2017

General comments on past summer conditions

On average, summer 2017 temperatures in Slovenia were higher than normal; the amount of precipitation was substantially lower too. This affected the hydro generation, which was 30% lower than expected.

Specific events and unexpected situations that occurred during the past summer

Apart from a lower hydro generation, there were no specific events or unexpected situations concerning adequacy last summer.

Spain: Winter Outlook 2017/2018

From the perspective of upward adequacy, no risk situation is detected in the Spanish peninsular power system for the upcoming winter. Good generation/demand adequacy can be expected regardless of imports from neighbouring countries. If average conditions are considered, remaining capacity (RC) at the reference point in time will be over 15.4 GW. In the case of severe conditions, the assessed RC is still over 8.8 GW.

In Spain, winter demand local peak usually occurs around 20–21 h.

Hydro reservoir levels are currently much lower than the historical average values: around 30% of their total capacity, which is 18% lower than the average historical values during September. However, even in the case of these drought conditions, simultaneous extreme peak demand, very low wind generation (less than 10% of wind installed capacity) and a high thermal forced outage rate, assessed RC is still over 7.5 GW.

Although there are no assessed adequacy risks, the factors that could reduce the RC during the next winter in the Spanish system would be the sensitivity of the load to temperature in extreme weather conditions, persisting drought conditions, and gas availability to combined cycle thermal plants during situations of low RES.

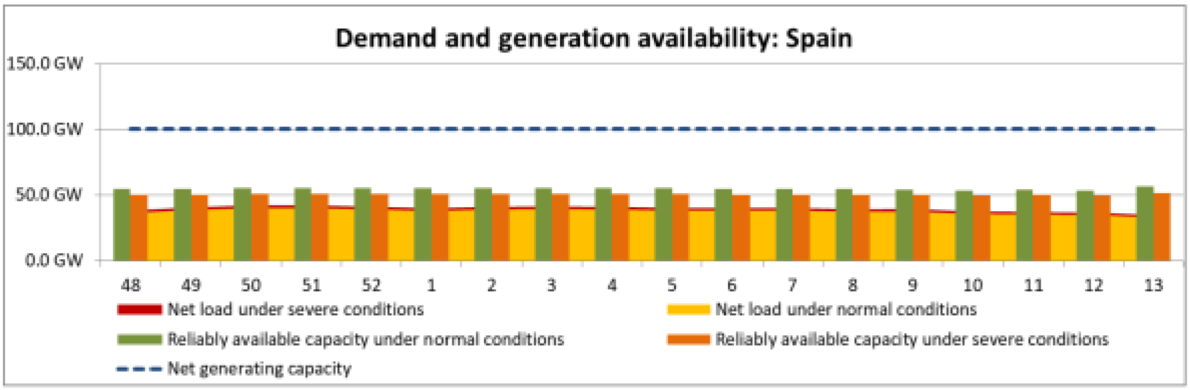
Assumptions

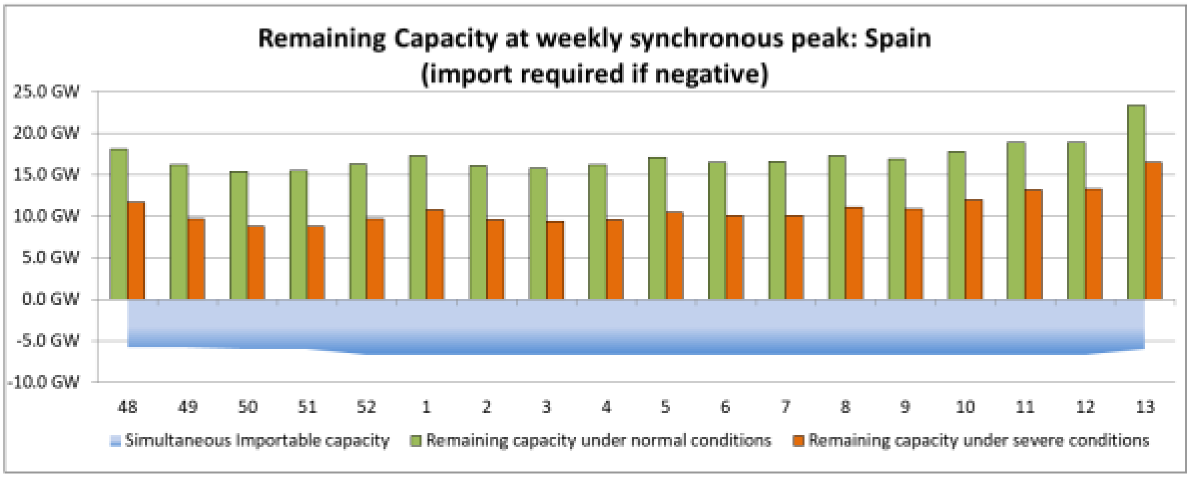
It is expected that the total demand in 2017 will slightly increase, continuing the trend of the last two years.

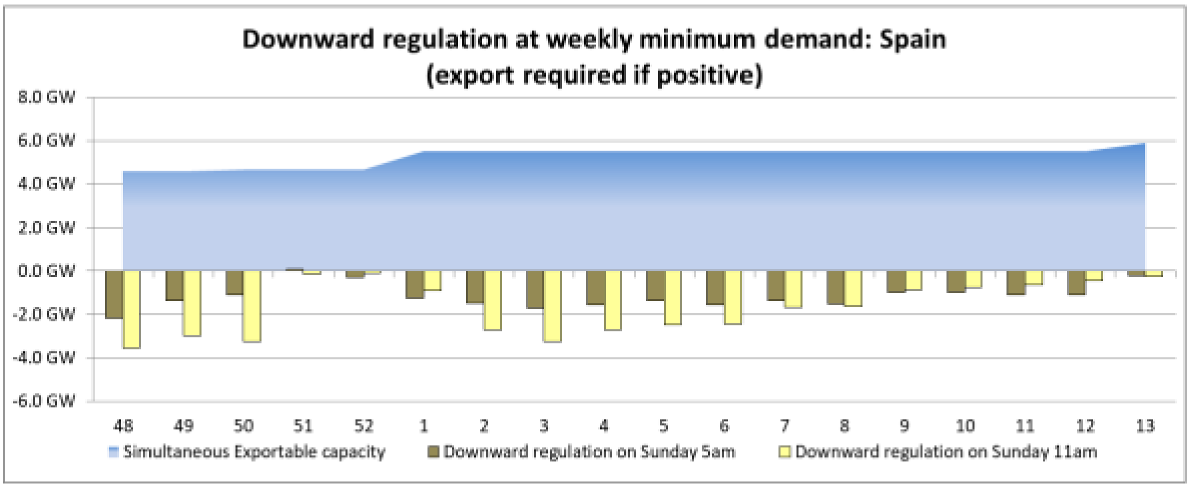
For peak values—mainly in severe conditions—the sensitivity of the load to the temperature is a key factor that is considered together with the historical demand values. The highest 2017 demand values for the moment took place in January, due to the cold spell that affected a large part of Europe.

Outage rates were calculated considering the historical behaviour of units and the average value for each technology. For technologies such as wind and solar power, a 0% outage rate is assumed, as the total available amount of power is calculated from statistical studies that include outages.

The Net Transfer Capacity (NTC) values are calculated taking into account forecast scenarios that are shared with neighbouring countries and with different time scopes. Weekly values are calculated considering planned outages and overhauls in the system.







Most critical periods for downward regulation and counter-measures

With the RES percentiles used for the calculation of downward regulation, there are periods with risk of RES spilling (mainly at 5:00, during the Christmas period and at the beginning of spring due to the low demand).

The Spanish TSO has a specific control centre for renewable sources (CECRE), which permanently monitors the RES production to keep balance. Besides, because RES producers participate in ancillary services, the need for RES curtailment has been sharply reduced.

The export capacity of interconnectors is a key factor to avoid the spilling of renewable energy, mainly wind power. Another point worth mentioning is the importance of energy storage—mainly pump storage plants- in order (PSPs)—to properly manage the excess of inflexible power.

Spain: Summer Review 2017

General comments on past summer conditions

The temperatures were higher than the average values during summer, especially during the month of June (3ºC higher in average). In July and August, average temperatures were 0.8ºC higher than average. Nevertheless, the demand peak values were lower than last summer (peak demand of 39.5 GW was reached on 13 July 2017).

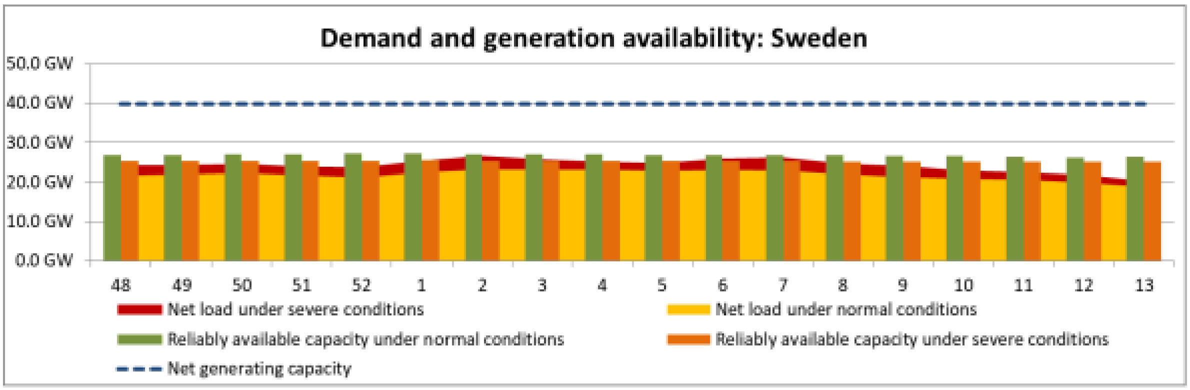
Water inflows were lower than average during summer 2017.

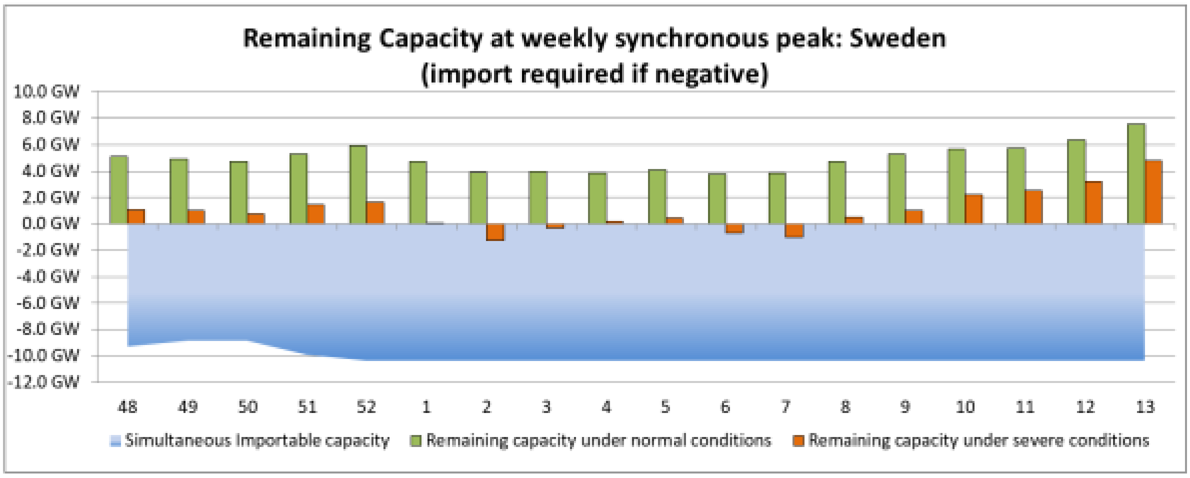
There were no adequacy problems.

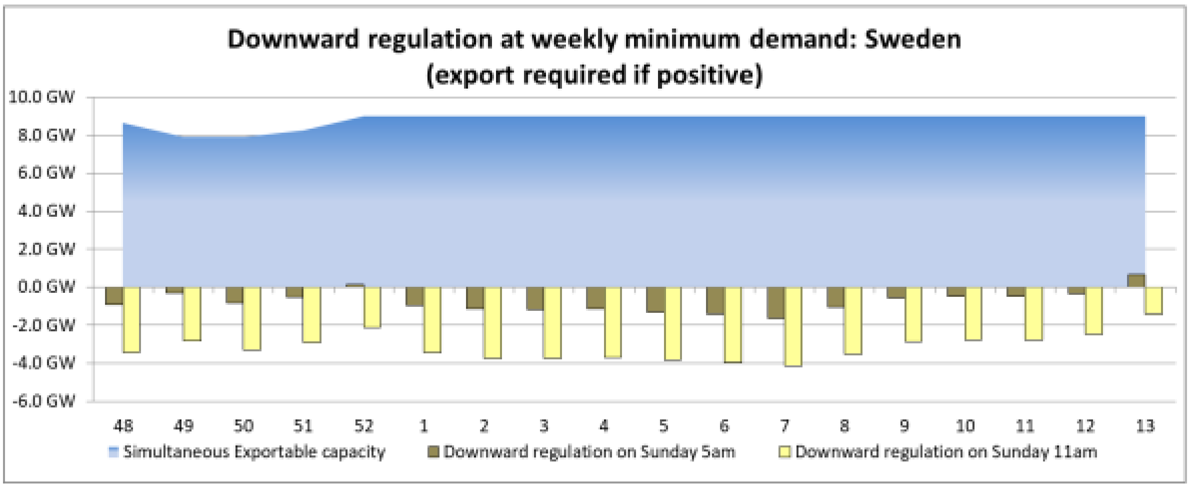
Sweden: Winter Outlook 2017/2018

Adequacy margins have decreased since last winter, partly due to the decommissioning of the nuclear power plant Oskarshamn 1 (473 MW).

Because internal congestions are not accounted for in the analysis, there is a risk that adequacy margins are overestimated.







Most critical periods for maintaining adequacy margins and counter-measures

The most critical periods for maintaining adequacy in Sweden are at times with cold weather because electricity consumption strongly depends on outdoor temperatures. In severe conditions, the domestic power balance is expected to be negative for some weeks in January and February. In that case, interconnectors are expected to play a role in maintaining adequacy.

To secure power adequacy at peak load, Svenska Kraftnät contracts a peak load reserve. For winter 2017/2018, the peak load reserve is in total 747 MW, of which 562 MW is production capacity and 185 MW is load reduction.

Most critical periods for downward regulation and counter-measures

No critical periods for downward regulation are foreseen in Sweden during the winter.

Sweden: Summer Review 2017

General comments on past summer conditions

The weather conditions for the past summer were in general normal.

Specific events and unexpected situations that occurred during the past summer

As noted in the Summer Outlook Report 2017, there was an increased need for import to the south of Sweden in August and September, as a result of half of the installed nuclear power capacity being on maintenance. Extended maintenance for some nuclear power plants further worsened the situation, and in combination with limitations on interconnections, this led to a rather strained situation and high prices in Sweden, Denmark and Finland for some hours. Another consequence was, however, that the challenging situation foreseen in the Summer Outlook Report 2017, with need for extra downward regulation capacity due to a high level of nuclear production, did not get as challenging as expected. The planned outages were prolonged.

The low nuclear power production caused unusually low levels of inertia.

Switzerland: Winter Outlook 2017/2018

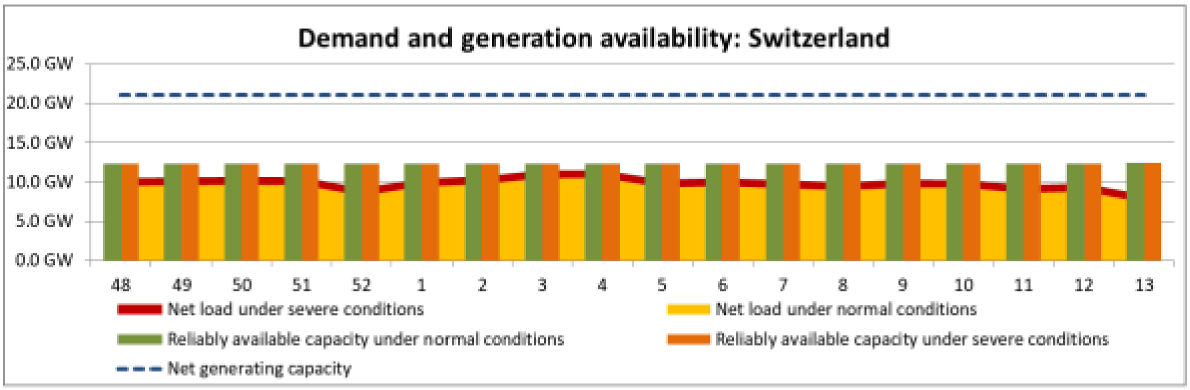
Using the current adequacy methodology, no special problems are detected.

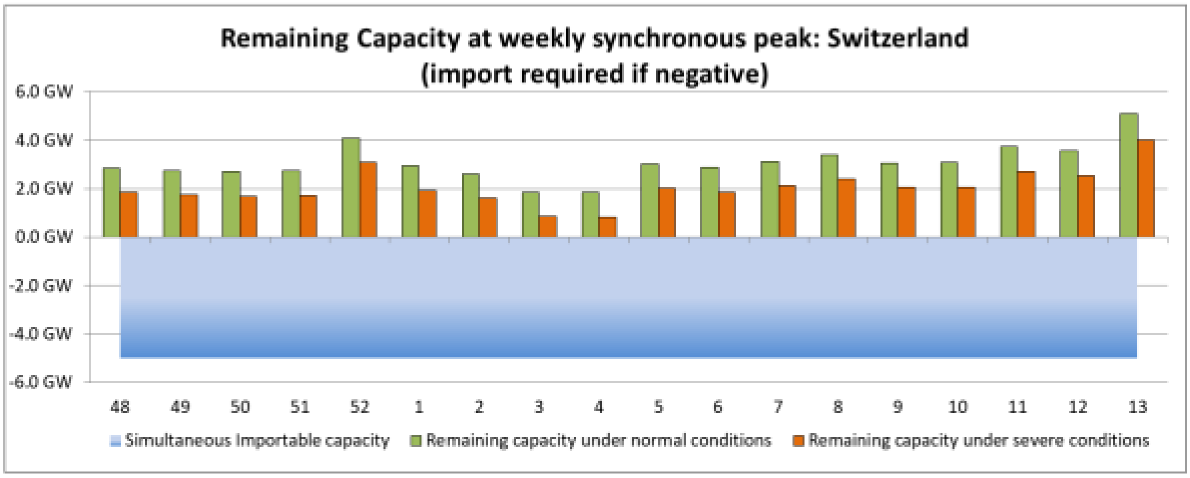
Deterministic capacity-based assessments [MW] cannot reveal potential problems faced by hydro-dominant countries like Switzerland. In particular, for Switzerland it is very important to also consider energy constraints [MWh]. The typical winter deficit in Switzerland, which was observed in the results of the PLEF regional adequacy study (published in March 2015), cannot be properly reflected or inferred by the numbers provided according to the deterministic capacity-based assessments.

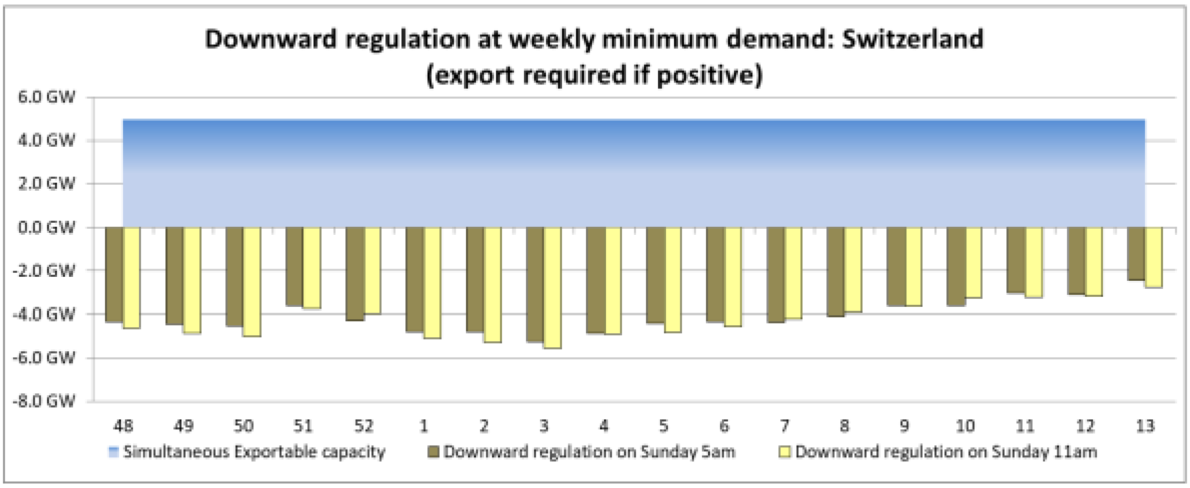
This methodology does not aim to provide insights on possible overloads and voltage problems that might occur.

In other terms, even if the used methodology concludes that no problems are expected in Switzerland, specific problems might still arise (cf. winter 2015/2016 and cold spell in January 2017).

Switzerland TSO (Swissgrid) is currently trying to adapt the current methodology to take the aforementioned energy constraints into account.







Switzerland: Summer Review 2017

General comments on past summer conditions

Switzerland experienced its third hottest summer since the measurements began in 1864. The precipitations exceeded the seasonal norms in the south of the Alps and in the Valais. In the other parts of Switzerland, they comprised between 70% and 100% of the seasonal norms.

In most parts of Switzerland, the sunshine was slightly above the seasonal norms.

Specific events and unexpected situations that occurred during the past summer

Sometimes, during the evening, high hydro generation led to high Swiss overall exports.

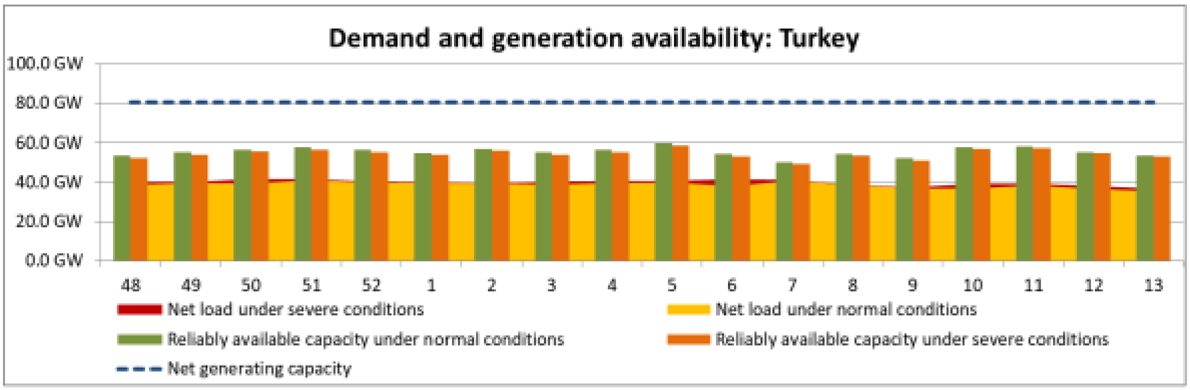
Turkey: Winter Outlook 2017/2018

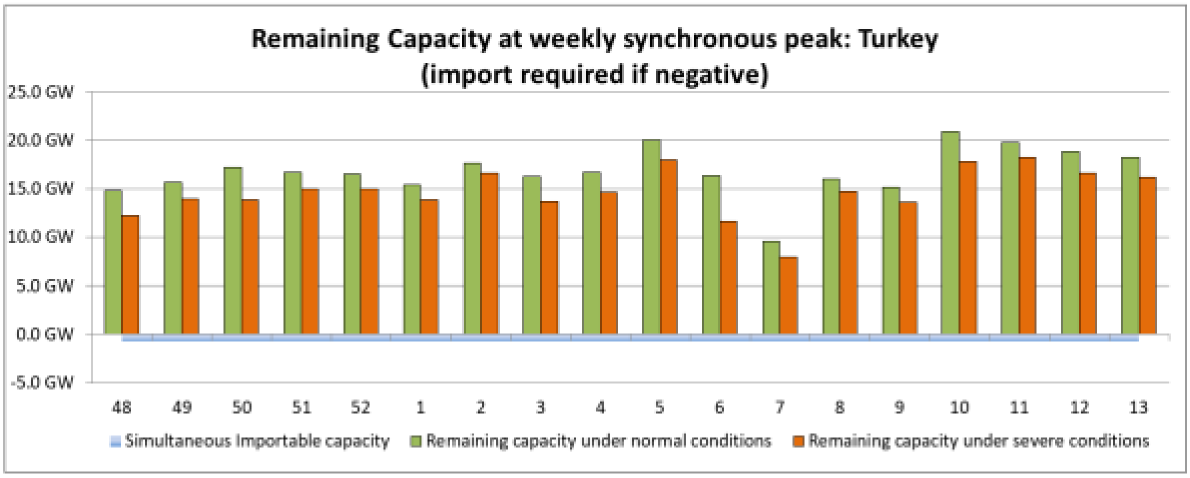
Most critical periods for maintaining adequacy margins and counter-measures

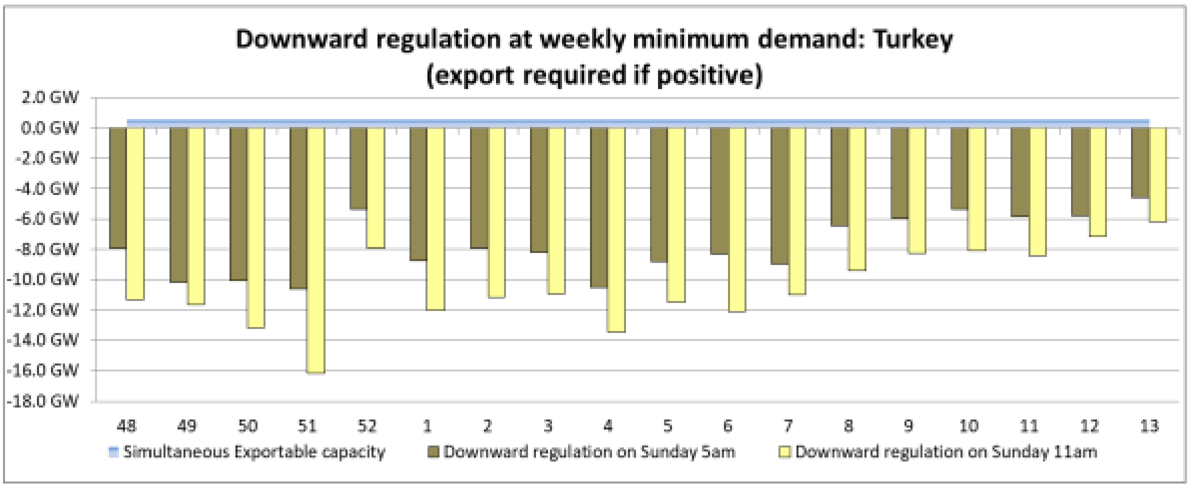
No adequacy issue is expected in Turkey for the coming winter season.

Most critical periods for downward regulation and counter-measures

None.







Turkey: Summer Review 2017

General comments on past summer conditions

No adequacy issue was identified in Turkey during the last summer season.

Specific events and unexpected situations that occurred during the past summer

None.

Appendix 2: Continuously Improving Methodology Based on TSO Expertise

The integration of large numbers of renewable energy sources (RES) and the completion of the internal electricity market as well as new storage technologies, demand-side response, (DSR) and evolving policies require revisited adequacy assessment methodologies.

ENTSO-E, supported by committed stakeholders, is continuously improving its existing adequacy assessment methodology with a special emphasis on harmonised inputs, system flexibility and interconnection assessments. The target agreed by the stakeholders and published by ENTSO-E is the *Target Methodology for Adequacy Assessment.*[34]

To improve data quality and pan-European consistency, ENTSO-E invested in a pan-European Climate Database (PECD 2.0) that covers 34 years of historical data (1982–2015). The PECD is used in the seasonal outlook as follows:

- All wind and PV load factors for each reference point in time are computed based on the PECD and used as input for individual country graphs and pan-European calculations; and
- The load sensitivity to temperature in each country is calculated based on the PECD.

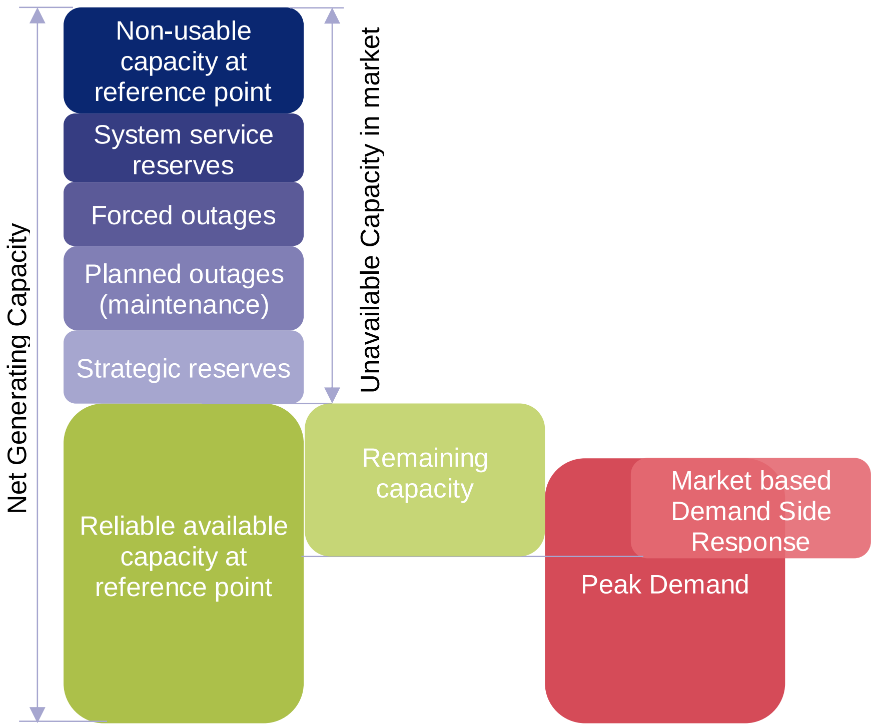
1. Upward Adequacy and Downward Regulation Definitions

The **upward adequacy analysis** consists of identifying the ability of generation to meet the demand by calculating the 'remaining capacity' (RC) under either normal conditions or severe conditions.

- '**Normal conditions'** correspond to average weather conditions resulting in a normal peak demand, normal wind production and hydro output, and an average outage level of classical generation power plants;
- '**Severe conditions**' correspond to severe weather conditions resulting in a higher peak demand, low wind production and hydro output, and a high outage level of classical generation power plants. This scenario corresponds to conditions that would happen less than 1 in 20 years.

[34] https://www.entsoe.eu/news-events/announcements/announcements-archive/Pages/News/ENTSO-E-Assessment-of-the-Adequacy-Methodology-Consultation-is-Released-.aspx

The analysis is the same under normal or severe conditions, and it is schematically depicted in the figure below:[35]



Upward adequacy methodology.

The upward adequacy analysis highlights periods when countries have RC or when countries are lacking RC and are counting on importing.

One synchronous point in time is collected for all countries to allow for a meaningful pan-European upward adequacy analysis when determining the feasibility of cross-border flows. The most representative synchronous point in time for the upward adequacy analysis is Wednesday 19:00 CET during wintertime and 19:00 CEST during summertime. At this time, the highest European residual load[36] is identified from historical data.

It is important to emphasise that the scenarios evaluated in the assessment represent conditions that are significant and realistic for the European system as a whole. Therefore, they may differ from the scenarios evaluated in each individual country-perspective analysis, which correspond to significant and realistic conditions for each country. For example, the

[35] See Glossary for definitions in Appendix 5:.

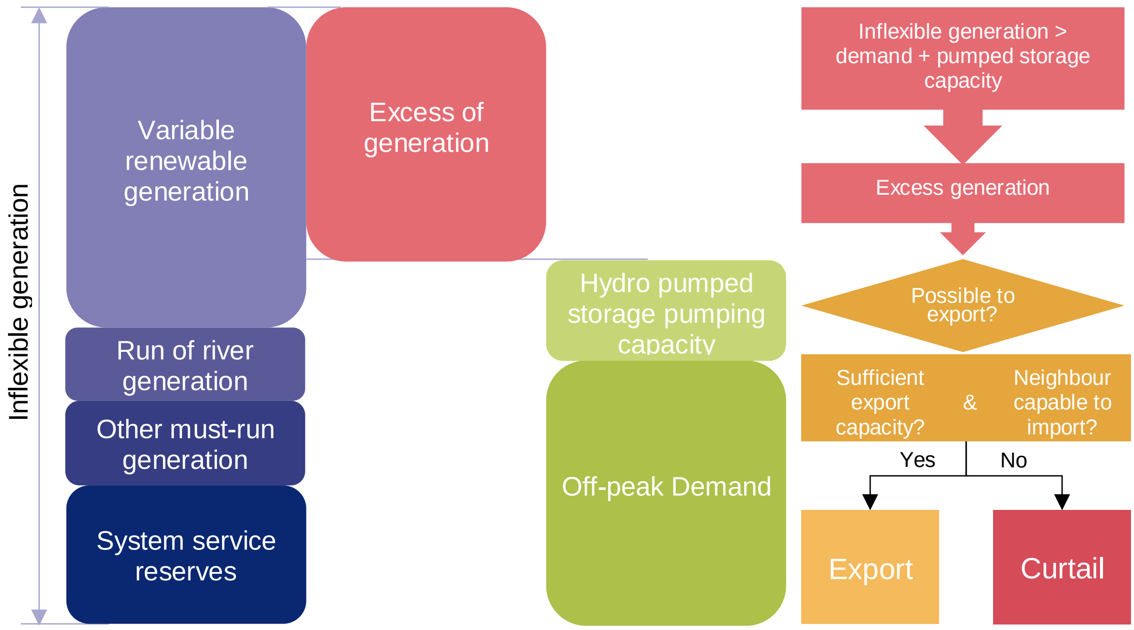
[36] Residual load = Total load – Renewable generation. The time of highest residual load is shifted from 12:00 in the past to 19:00.

severe conditions of the entire European system do not correspond to the 'simple envelope' of each individual severe condition.

For the upward simulations, the demand reduction measures (market based) are considered, as reported by the TSOs, whereas available strategic reserves and out of market demand reduction measures are disregarded.

The **downward regulation analysis** consists of identifying the excess inflexible generation during low demand periods (e.g. run-of-river hydro generation, solar and wind power, possibly also CHP units or generators to maintain dynamic voltage support). In the case of high renewable infeed during low demand, generation could exceed demand at the country level, even while pumping for hydro storage. In that case, the excess generation needs to be exported to a neighbouring country and even curtailed after all available export capacity has been used.

The analysis is schematically depicted in the figure below:



Downward adequacy methodology.

The downward analysis highlights periods when countries cannot export all their excess generation and may require that excess generation be curtailed due to limited cross-border export capacity.

Two synchronous points in time are collected for all countries to allow for a meaningful pan-European downward regulation analysis when determining the feasibility of cross-border flows. The most representative synchronous points in time for the downward regulation analysis are Sunday 05:00 and 11:00 (CET during wintertime and CEST during daylight saving time period). At 05:00, the lowest European total load is identified in a database of historical data. At 11:00 CEST, the total load is higher, but for some countries, the combination with high solar irradiation is more constraining.

This downward analysis becomes increasingly essential as many TSOs experience growing system operation constraints due to an increase in variable generation on the system (wind and solar) and the lack of flexible generation.

2. Upward Adequacy and Downward Regulation Methodology

2.1 Pan-European analysis

The methodology is described below for a pan-European upward adequacy analysis. However, the downward regulation analysis uses the same approach. The goal of the analysis is to detect whether problems could arise on a pan-European scale due to a lack of available capacity (upward adequacy) and to provide an indication of whether countries requiring imports will be able to obtain these across neighbouring regions under normal and severe conditions as well as from which countries the required energy might originate.

The pan-European analysis consists of several steps. The **first element** that is checked is whether, in individual countries or modelled regions, there is enough power capacity to cover the demand. Here, all RC is added, and when the result is greater than zero, there should be adequate capacity theoretically available in Europe to cover all the needs of the countries. There should not be any problems with this approach, neither for normal nor severe conditions. As this method does not consider the limited exchange capacity between countries, it is too optimistic to draw final conclusions based on it. In the **second step,** the pan-European analysis is based on a constrained linear optimisation problem. The problem is modelled as a linear optimisation with the following constraints:

- Bilateral exchanges between countries should be lower than or equal to the given NTC values; and
- Total simultaneous imports and exports should be lower than or equal to the given limits.

The pan-European adequacy tool calculates which groups of countries would have a generation deficit for a certain week due to saturated cross-border exchanges.

For neighbouring systems of the geographic perimeter of the study that are not modelled in detail, like Morocco, Russia, Belarus and Ukraine (except Burshtyn Island, which operates synchronously with continental Europe), the following values were assumed for the pan-European analysis:

- The balance (RC) of these systems was set at 0 MW; and
- A best estimate of the minimum NTC comes from neighbouring systems belonging to ENTSO-E.

This approach will result in the potential to 'wheel' energy through these non-modelled bordering countries, without changing the total generation level of the whole studied pan-European area.

Regarding the linear optimisation problem, a simplified merit-order simulation approach has been implemented to show which countries may be prone to import in a market perspective, even if they do not need to import for adequacy reasons. An iterative approach is used by gradually adding the available generating capacity of different generation types. The simplified merit order that is used is the following:

1. Solar,
2. Onshore wind,
3. Offshore wind,
4. Other renewable sources (including run of river),
5. Nuclear,
6. Coal,
7. Gas,
8. Other non-renewable sources,
9. Hydro-pumped storage, and
10. Market-based demand side management
11. Strategic reserves (only used in sensitivity simulation presented in Section 3.4)

It is important to note that the merit-order approach is a simplified approach that does not aim to predict the real market behaviour. Furthermore, the simplified hydro-power modelling using deterministic capacity-based assessments and merged modelling of reservoir and run-of-river hydro might not capture all specificities of countries with a large share of hydro production (Norway, France, Switzerland, etc.).

2.2 Probabilistic analysis for regions or countries at risk

In case the analysis shows that a country or region (combination of adjacent countries) could experience adequacy issues for a specific time point, this country or region is investigated in more detail.

The goal of this detailed analysis is to detect what the main drivers are of a certain adequacy issue (e.g. temperature in country X, wind or PV infeed in country Y, etc.) and to be able to give an indication of the probability of occurrence of a situation.

For every reference time point, the collection of hundreds of records[37] is used to run numerous simulations. The following high-level methodology is applied to build each one of those simulations:

- As a starting point, the qualitative data provided by the TSOs for severe conditions are used;
- Next, the severe-condition load is replaced by the normal-condition average load as given by the TSOs. For the related reference temperature, the average temperature over all records is used;
- The capacity factors for onshore wind, offshore wind, and solar generation are replaced by those of the concerned record; and
- The normal-condition load is scaled using load-temperature sensitivity relations. The difference between reference temperature and the temperature of the concerned record is translated into 'increase/decrease' of load, using the methodology described in Appendix 3:

After performing these manipulations on the base data, the simulation is run (including the simulation of cross-border exchanges with other countries), and the results are calculated. In this manner, for every simulation, whether the considered region suffers adequacy issues or not is determined.

3. Data Processing

3.1 Renewable Infeed Data

For the upward adequacy analysis, the renewable infeed is handled through an estimate of non-usable capacity in normal and severe conditions by country. For wind (onshore and offshore) and PV generation, the non-usable capacities by default were calculated using the PECD. This PECD contains, per country and per hour, load factors for solar, onshore wind, and offshore wind in a 34-year period (1982–2015). It also includes geographically averaged hourly temperatures.

To create a consistent scenario throughout Europe, the following approach was adopted for a given time:

- All 'records' are retained that lie within the interval of 3 hours before the reference time and three hours after the reference time, on a date (day/month) from 14 days before the reference date and 14 days after the reference date. This yields a collection of

[37] For one point in time, record of six days before, six days after, one hour before and one hour after.

6,902 records (34 years x 29 days x 7 hours) per reference time point. However, considering importance of reference hour for solar irradiation, only reference hour is considered, which limits record number to 986 (34 years x 29 days x 1 hour)

- Country representative load factors (solar, onshore and offshore wind) are extracted as, the 50th percentile (median) and 5th percentile (1-in-20 situations) values of the record collections for the adequacy analysis under normal and severe conditions respectively.

Thus, consistent pan-European renewable infeed scenarios are created. For example, the 5th percentile scenario represents a simultaneous severe scenario for the different countries and for the different primary energy sources. It should be noted that this approach guarantees a very constraining scenario, as it considers a perfect correlation between the different capacity factors (i.e. renewable infeed in all countries is simultaneously assumed to be equal to the 5th percentile). This scenario can then be used to detect regional adequacy issues that can consequently be investigated in more detail and with a more realistic (and therefore less severe) renewable infeed scenario if necessary.

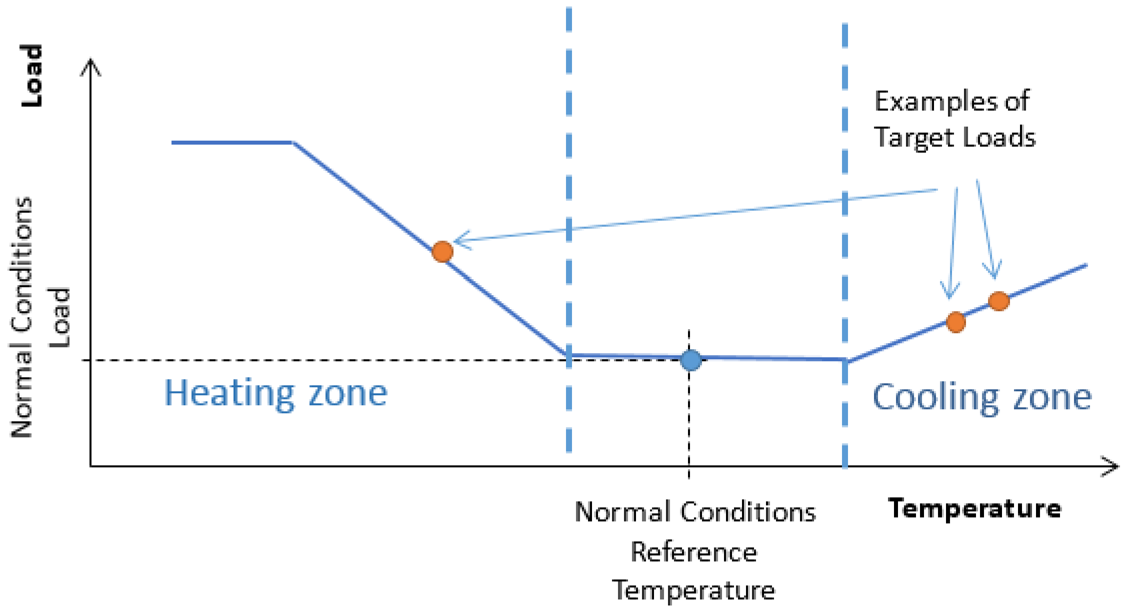
Regarding the downward adequacy analysis, the same approach is used, but using the 95th percentile value (that is exceeded only by 5% of records in collection).

3.2 Load Scaling

The submitted per-country load data are collected under normal and severe conditions. For each simulation, the per-country load needs to be scaled to a target temperature as given by the PECD. To this end, ENTSO-E calculated load-temperature sensitivity coefficients. A detailed description on how these coefficients were determined can be found in Appendix 3:. An ENTSO-E dedicated task force is further improving the load sensitivity factor data at the pan-European level.

The graph below shows how these coefficients, combined with the normal load conditions and temperature reference as a starting point, are used to scale the load to the target temperature of the concerned record.

To this end, when temperatures are concerned, the population-weighted average daily temperatures are used. Population-weighted daily average temperatures are considered since they are better suited for assessing the temperature dependence of the demand (see Appendix 3: for details).



Load-temperature sensitivity.

Please note that the above figure is only indicative, and the slope of the curve in the cooling zone can be (significantly) higher than that in the heating zone in some countries (e.g. Italy).

3.3 Import/export Capacity

The import/export capacities (NTC) represent an *ex ante* estimation of the seasonal transmission capacities of the joint interconnections on a border between neighbouring countries, assessed through security analyses based on the best estimation by TSOs of system and network conditions for the referred period. All contributors were asked to provide a best estimate of the NTC values to be used in each point in time. When two neighbouring countries provided different NTC values on the same border, the lowest value was used. Additionally, for the pan-European analysis, simultaneous importable and exportable limits are considered when relevant, capping the global imports or exports of a country.

4. Future Expected Improvements

In the constant improvement process further enhancements are striven for future Seasonal Outlooks:

- Investigate how to implement full probabilistic hourly calculations based on the Mid Term Adequacy Forecast (MAF) experience, considering Seasonal Outlook specificities regarding data and model requirements. For example, hydro reservoir modelling assumptions define expected reservoir content at end of period. The very limited time available for each Seasonal Outlook calculation (around one month) also shall be considered. The goal is to test the new approach for winter 2018/2019 in parallel to the current one, and to get new market modelling tool and methodology operational before Winter Outlook 2019/2020.

- Prepare the future implementation of the Clean Energy Package, especially Risk Preparedness Plan regulation, through coordinated methodology development with the week-ahead adequacy project.

Appendix 3: Daily Average Temperatures for Normal Weather Conditions – Reference Sets

1. Calculation of a Country Population's Weighted Monthly/daily Average Temperatures

The steps for calculating the normal population weighted monthly average temperatures are as follows:

1. Collect data for the number of population ($\mathbf{NP_{country}}$) based on the latest census of each country.[38]

2. Define the number of cities in each country to be weighted ($\mathbf{NC_{weighted}}$). The lower threshold for calculating the weight is set to 3,000,000 inhabitants.

$$NC_{weighted} = INT(\frac{NP_{country}}{3000000}) + 1$$

3. Take data for the population ($\mathbf{CP_i}$) of each of the first $\mathbf{NC_{weighted}}$ biggest cities (cities preliminarily arranged in descending order by number of inhabitants)

4. Define the weighting coefficient (Ki) of each city using the formula:

$$\boldsymbol{K_i} = \frac{\boldsymbol{CP_i}}{\sum_i \boldsymbol{CP_i}}, \ i = 1 \text{ to } \mathbf{NC_{weighted}}$$

5. Collect data for the normal monthly average temperatures of the selected cities:[39]

$\boldsymbol{NMAT}_{ij}$, *i* = 1 to $\mathbf{NC_{weighted}}$, *j* = 1 to 12 (1 = January, 2 = February, ….)

6. Define the country population weighted normal monthly average temperatures

$\boldsymbol{CPWNMAT_j} = \boldsymbol{K_i} \times \boldsymbol{NMAT}_{ij}$,

i = 1 to $\mathbf{NC_{weighted}}$, *j* = 1 to 12 (1 = January, 2 = February,..)

38 The source of data for the number of the countries and the corresponding cities population is www.citypopulation.de

39 Source: the climatology database of the World Meteorological Organization (WMO), based on 30 years of observation (www.worldweather.org). There is also free access to these data via many other specialised Websites for meteorological information.

The resulting population weighted normal daily average temperatures, which will be derived from the population weighted normal monthly average temperatures, are obtained as:

$$\boldsymbol{CPWNMAT_{ij}}$$

j = 1,2,3,……, $ND_{i\ month,}$ i = 1 to 12 (1 = January, 2 = February,..)

ND_{imonth}- number of days of month j

1. Assign the population weighted normal monthly average temperatures $\boldsymbol{CPWNMAT_{ij}} = \boldsymbol{CPWNMAT_{j}}$

to the dates corresponding to the middle of each month:

$CPWNDAT_{1\ 16} = CPWNDAT_{1}$ 16 January

$\boldsymbol{CPWNDAT_{2\ 14}} = \boldsymbol{CPWNDAT_{2}}$ 14 February

$CPWNDAT_{3\ 16} = CPWNDAT_{3}$ 16 March

$CPWNDAT_{4\ 15} = CPWNDAT_{4}$ 15 April

$CPWNDAT_{5\ 16} = CPWNDAT_{5}$ 16 May

$CPWNDAT_{6\ 16} = CPWNDAT_{6}$ 15 June

$CPWNDAT_{7\ 16} = CPWNDAT_{7}$ 16 July

$CPWNDAT_{8\ 16} = CPWNDAT_{8}$ 14 August

$\boldsymbol{CPWNDAT_{9\ 15}} = \boldsymbol{CPWNDAT_{9}}$ 15 September

$CPWNDAT_{10\ 16} = CPWNDAT_{10}$ 16 October

$\boldsymbol{CPWNDAT_{11\ 15}} = \boldsymbol{CPWNDAT_{11}}$ 15 November

$\boldsymbol{CPWNDAT_{12\ 16}} = \boldsymbol{CPWNDAT_{12}}$ 16 December

2. Define the population weighted normal daily average temperatures $\boldsymbol{CPWNMAT_{ij}}$

by linear interpolation between the 12 values corresponding to mid-month dates

3. Calculate two values for the annual average temperature (AAT) based on the two sets of data:

$$AAT_{\text{monthly}} = (\sum \boldsymbol{CPWNMAT_{i}/12}) \text{ , i = 1 to 12}$$

$$\boldsymbol{AAT}_{\textbf{daily}} = (\sum\sum \boldsymbol{CPWNMAT_{ij}/365}), \text{ i = 1 to 12, j = 1 to ND}_{\text{i month}}$$

4. Calibrate $\boldsymbol{CPWNMAT_i}$ to reach the equality:

$$AAT_{\text{daily}} = AAT_{\text{monthly}}$$

by shifting $\boldsymbol{CPWNMAT_{ij}}$ up or down with the correction value:

$$DT_{\text{shift}} = (AAT_{\text{monthly}} - AAT_{\text{daily}}) / 365$$

Polynomial 6-th order approximation is applied to the time series of $\boldsymbol{CPWNMAT_{ij}}$ (i = 1 to 12, j = 1 to NDi month). The resulting set of 365 smoothly approximated values is ready to be used as the first reference set for the Normal Daily Average Temperatures valid for Normal Weather conditions $\mathbf{TEM_{REF\_SET1}}$

2. Methodology for load sensitivity calculation

Because of the clearly defined diurnal pattern of the activities typical for the residential and business customers, the temperature sensitivities of hourly loads experience similar profiles—lower values during the night and higher values during the 'active' hours of the day. The highest temperature sensitivity is observed for the peak loads during the working days, and since this is the reference load for the short-term and long-term adequacy reports, the method for calculating the sensitivity of this type of load is presented below. The steps of calculation for any country are as follows:

1. Define the peak load for every day of the reference year;
2. Remove values for Saturdays, Sundays and official holidays for the assessed country from the time series of peak loads (P_{peak}) and daily average temperatures (T_{avd}), creating in this way resulting time series only for working days;
3. Arrange the daily average temperatures in ascending order with the corresponding arrangement of the peak load values;
4. Using a step-wise linear regression iteration procedure, the following two important points are defined (for countries concerned by cooling need in winter):
    - **saturation temperature for cooling zone** ($\mathbf{T_{satur}}$)—this is the value above which a further increase of the temperature does not cause an increase in the

electricity demand (practically all available cooling devices have been switched on). This saturation concerns few countries in Southern Europe.

- **starting temperature for the cooling zone (T_{start})**—this is the value above which the cooling devices are started.

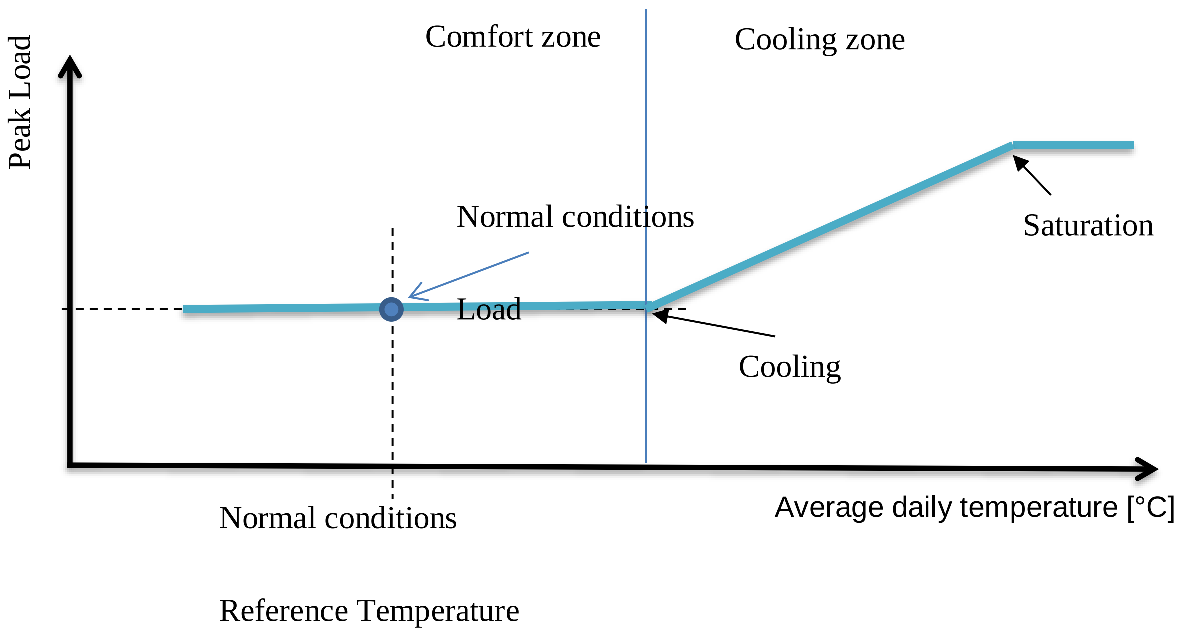
5. Model the relation between the peak load and the daily average temperature in the range T_{start} **-** T_{satur} by simple linear regression:

$$P_{peak} = a + b^* T_{avd}$$

where the regression coefficient **b** being the **peak load temperature sensitivity** is valid for the cooling zone.

In this calculation, the rescaled values of the population weighted normal monthly average temperatures T_{avd} are used.

The figure below provides a visual explanation of the main points above.



Appendix 4: Questionnaires Used to Gather Country Comments

1. Seasonal Outlook Questionnaire Template

Individual country comments: general situation
Overview about the general situation, also compared to previous years, and highlighting specifics such as: *- high levels of maintenance in certain weeks;* *- low hydro levels;* *- low gas storage; and* *- any event that may affect the adequacy during the period.*
Most critical periods for maintaining adequacy, counter-measures adopted and expected role of interconnectors.
Most critical periods for downward regulating capacity, counter-measures adopted and expected role of interconnectors in managing an excess of inflexible generation.
A short description of the assumptions for input data
Please describe concisely: *1) Which assumptions were taken for calculating NORMAL and SEVERE conditions (e.g. if an average daily temperature for normal conditions different from population weighted daily values provided) and how the outage rates have been calculated;* *2) How the values of NTC have been calculated;* *3) Treatment of mothballed plants: under what circumstances (if any) could they be made available?;* *4) Issues, if any, associated with utilising interconnection capacity e.g. existence of transmission constraints affecting interconnectors for export or import at time of peak load (such as maintenance or foreseen transit or loop flows); and* *5) Are there any energy constraint issues particularly for hydro based systems or any other fuel supply issues which could affect availability (e.g. gas supply issues)?*

2. Seasonal Review questionnaire template

General commentary on the conditions of last period: recalling main features and risk factors of the Outlook Report, please provide a brief overview of the last period:
General situation highlighting specifics such as: *- main trends and climatic conditions (temperatures (average and lowest compared with forecast), precipitation, floods/snow/ice);*
Specific events that occurred during the last period and unexpected situations:
Please report on specific events that occurred during the last period and unexpected situations, i.e.: *- **generation conditions:** generation overhaul (planned, unplanned), gas/oil/availability, hydro output, wind conditions (above or below expectations, extended periods of calm weather), specific events or most remarkable conditions (please specify dates)* *- **extreme temperatures**;* *- **demand:** actual versus expectations, peak periods, summary of any demand side response (DSR) used by TSOs, reduction/disconnections/other special measures e.g. use of emergency assistance, higher than expected imports from neighbouring states;* *- **transmission capacity/infrastructure:** outages (planned/unplanned), reinforcement realised, notable network conditions (local congestion, loop flows etc.);* *- **interconnection capacity/infrastructure:** import/export level, reliance on imports from neighbouring countries to meet demand (you can refer to http://www.entsoe.net/); commentary on interconnector availability and utilisation; and* *- **gas shortages***

Appendix 5: Glossary

Bidding zone: The area where market participants can exchange energy without capacity allocation.

Capacity factor: The ratio of the available output capacity and installed capacity over a period of time for various types of power plants (used primarily to describe renewable output in this report).

Control area: Part of the interconnected electricity transmission system controlled by a single TSO.

Demand side response (DSR): Demand offered for the purposes of, but not restricted to, providing Active or Reactive Power management, Voltage and Frequency regulation and System Reserve.

Dispatchable or controllable generation: Sources of electricity that can be dispatched at the request of power grid operators or of the plant owner.

Distribution system operator (DSO): Responsible for providing and operating low, medium and high voltage networks for regional distribution of electricity.

Downward regulation margin (also **Downward regulation capability):** Indicator of the system flexibility to cope with an excess of generation infeed during low demand time.

Downward regulation reserve: The Active Power reserves kept available to contain and restore System Frequency to the Nominal Frequency and for restoring power exchange balances to their scheduled value.

Forced (or unscheduled) outage: The unplanned removal from service of an asset for any urgency reason that is not under operational control of the respective operator.

Generation adequacy: An assessment of the ability of the generation in the power system to match the Load on the power system at all times.

Load: Load on a power system is the net consumption corresponding to the hourly average active power absorbed by all installations connected to the transmission grid or to the distribution grid, excluding the pumps of the pumped-storage stations. 'Net' means that the consumption of power plants' auxiliaries is excluded from the load, but network losses are included in the load.

Load management: The load management forecast is estimated as the potential load reduction under control of each TSO to be deducted from the load in the adequacy assessment.

Must run generation: The amount of output of the generators which, for various reasons, must be connected to the transmission/distribution grid. Such reasons may include: network constraints (overload management, voltage control), specific policies, minimum number of units needed to provide system services, system inertia, subsidies and environmental causes.

N-1 criterion: The N-1 criterion is a rule according to which elements remaining in operation after failure of a single network element (such as transmission line / transformer or generating unit, or in certain instances a busbar) must be capable of accommodating the change of flows in the network caused by that single failure.

Net generating capacity (NGC): The NGC of a power station is the maximum electrical net Active Power it can produce continuously throughout a long period of operation in normal conditions. The NGC of a country is the sum of the individual NGC of all power stations connected to either the transmission grid or the distribution grid.

Net transfer capacity (NTC): The NTC values represent an *ex ante* estimation of the transmission capacities of the joint interconnections on a border between neighbouring countries, assessed through security analyses based on the best estimation by TSOs of system and network conditions for a referred period.

Non-usable capacity: Aggregated reduction of the net generating capacities due to various causes, including: temporary limitations due to constraints (e.g. power stations that are mothballed or in test operation, heat extraction for CHPs); limitations due to fuel constraints management; limitation reflecting the average availability of the primary energy source; power stations with output power limitation due to environmental and ambient constraints.

Pan-European Climate Database: An ENTSO-E database containing per country and per hour load factors for solar, onshore and offshore wind. It also includes geographically-averaged hourly temperatures. ENTSO-E produced, in 2016, a new version of the database covering 34 years (1982–2015) instead of 14 years. More neighbouring countries of ENTSO-E perimeter were added.

Phase shifter transformer (PST): A specialised form of transformer for controlling the real-time power flows through specific lines in a complex power transmission network.

Pumping storage capacity: NGC of hydro units in which water can be raised by means of pumps and stored, to be used later for the generation of electrical energy.

Reference points: The dates and times for which power data are collected. Reference points are characteristic enough of the entire period studied to limit the data to be collected to the data at the reference points.

Regional security coordinators (RSC): RSCs are entities created by TSOs to assist them in their task of maintaining the operational security of the electricity system.

Reliably available capacity (RAC): Part of NGC that is actually available to cover the load at a reference point.

Remaining capacity (RC): The RC on a power system is the difference between the RAC and the Load. The RC is the part of the NGC left on the system to cover any programmed exports, unexpected load variation and unplanned outages at a reference point

Renewable energy source (RES): Energy resources that are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves and geothermal heat.

Run of river: A hydro unit at which the head installation uses the cumulative flow continuously and normally operates on base load.

Severe conditions: These are worse-case scenarios each TSO would expect once in more than 20 years. For example, the demand is higher than under normal conditions and the output from variable generation is very low while there may be restrictions in thermal plants that operate at a reduced output under very low or high temperatures.

Short and medium-term adequacy (SMTA): Week ahead to day ahead adequacy calculations currently in implementation, and to be performed by the RSCs.

Simultaneous exportable/importable capacity: Transmission capacity for exports/imports to/from countries/areas expected to be available. It is calculated by taking into account the mutual dependence of flows on different profiles due to internal or external network constraints and may therefore differ from the sum of NTCs on each profile of a control area or country.

Synchronous profile: A profile means a geographical boundary between one bidding zone and more than one neighbouring bidding zone. Synchronous indicates that it is managed at the same time.

System services reserve: The capacity required to maintain the security of supply according to the operating rules of each TSO. It corresponds to the level required one hour before real time (additional short notice breakdowns are already considered in the amount of outages).

Time of reference: Time in the outlook reports is expressed as the local time in Brussels.

Transmission System Operator (TSO): A natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.

Variable generation: The generation of RESs, mostly wind and photovoltaic, whose output level is dependent on non-controllable parameters (e.g. weather).