winter outlook 2018/2019

summer review 2018

28 November 2018

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1 Executive Summary

Under normal conditions, ENTSO–E's pan–European assessment of electricity security of supply shows no risk of imbalance between generation and supply (inadequacy risk) during system–wide peak demand moments.

This Winter Outlook considers the unforeseen and delayed maintenance of generation units in Belgium announced in September 2018 and the respective countermeasures identified by the Belgian authorities. A monitoring of the adequacy situation in Europe and information sharing are ensured on a weekly basis at the technical level among TSOs through the Regional Security Coordinators (RSCs) and at the political level under the European Electricity Coordination Group (ECG) which gathers the European Commission, EU member states, regulators and technical experts.

In case of a cold spell, adequacy must be monitored closely in a region including Belgium, France, Northern–Italy, Central–Northern Italy and Slovenia; and this especially in January–February. In case of a cold spell combined with generation outage and moderate renewables infeed, the analysis shows that the above countries might be reliant on their own out-of-the-market measures or the solidarity of neighbouring countries activating theirs. Careful attention should be paid in case of decreas network availabilities or further decrease of generation availability.

<u>Focus on hydro reservoir</u>

At the start of this winter, hydro reservoir levels in Europe are near average.

<u>Power and gas sensitivity analysis</u>

A coordinated assessment with ENTSO-E's gas counterpart ENTSOG confirmed that a disruption to gas supply routes during a cold spell would not endanger electricity supply adequacy in Europe.

<u>Evolution of generation</u>

The Winter Outlook also analyses the evolution of the generation sources in Europe and confirms the decrease of conventional generation. The increase in renewables installed generation capacity is higher compared to last winter.

<u>Summer review</u>

Summer 2018 was marked by temperatures much higher than average, especially in Northern and Eastern Europe. This led to some local electricity supply disruptions in Czech Republic, Croatia and Greece.

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 of 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 ensure 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 in order 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 Winter outlooks are thus released with Summer reviews and the Summer Outlooks with Winter Reviews. This enables 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

[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 28 November 2018 and 31 March 2019. The Summer review examines the system adequacy issues registered between 30 May 2018 and 30 September 2018.

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 a 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 within the week ahead adequacy experimentation, which is a setup between TSOs and regional security coordinators (RSCs).

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

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

2.2 The European Generation Landscape

A pan-European generation capacity analysis reveals, compared to last year, an acceleration of Renewable Energy Sources' (RES) installed capacity and a slight increase of gas power capacity, while other thermal generation continues to decrease.

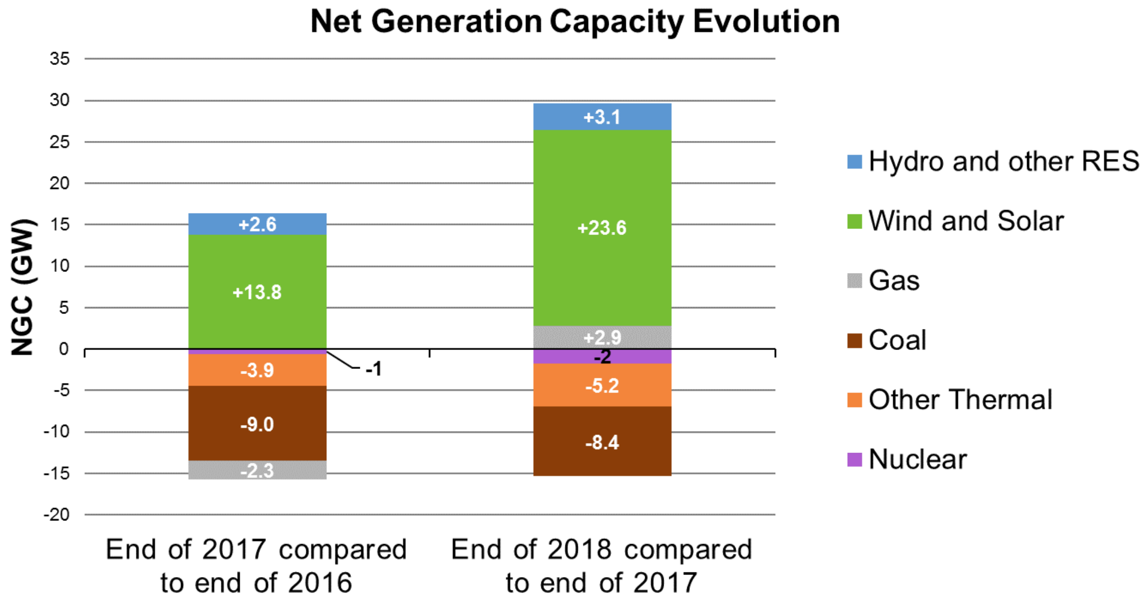


Figure 1: Evolution of net generating capacity per technology.

In the map given in Figure 2, net generation capacities (NGC) are displayed in absolute values (GW) for each study region. To ease comparison at the Pan-European level, a ratio of net generation capacity to expected highest demand (under normal conditions) in a respective region 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.

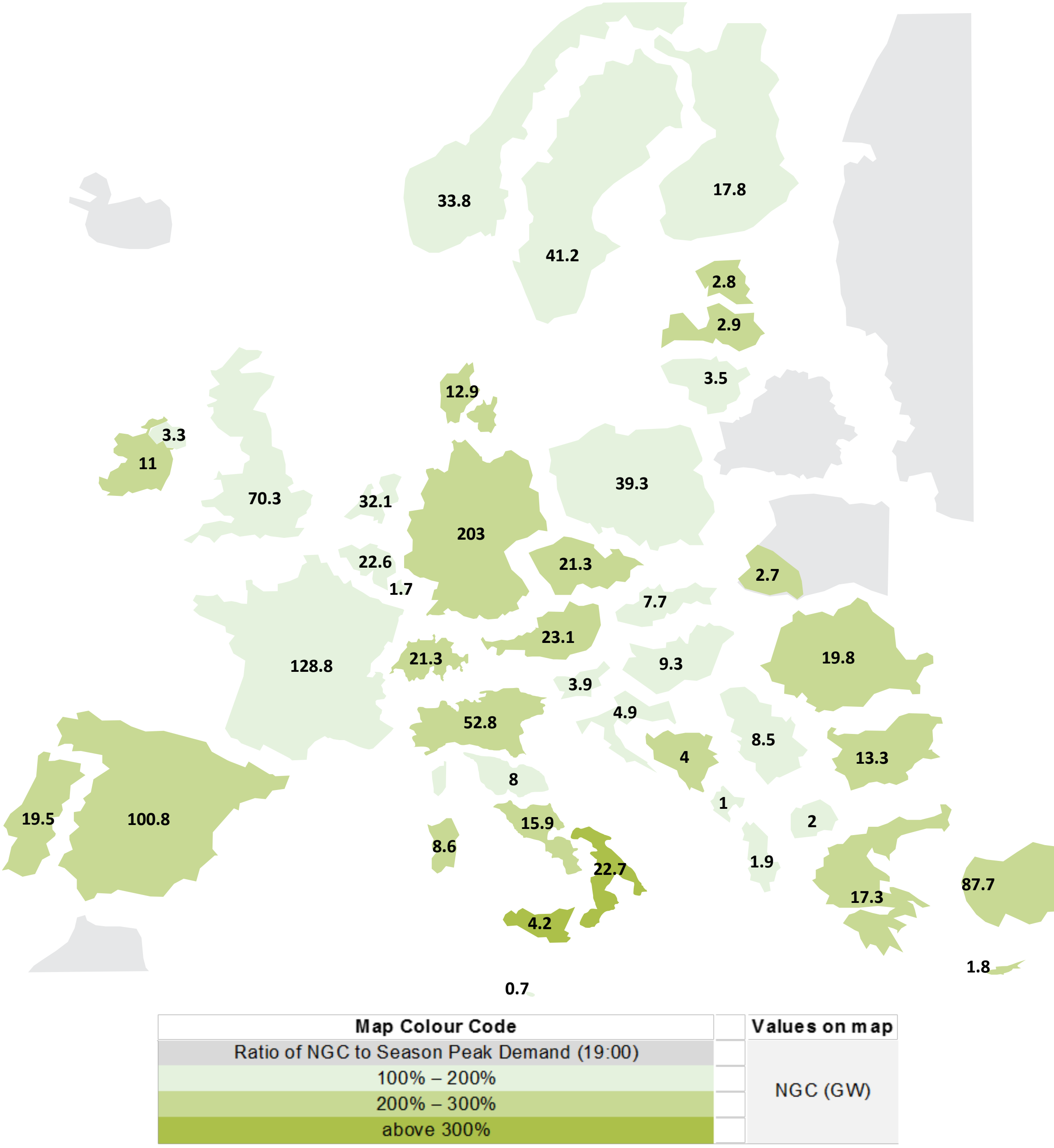


Figure 2: Net generating capacities (in GW) and colour according to its ratio to expected national peak demand in the winter season.

3 Winter outlook 2018/2019 – Upward Adequacy

The term ‘adequacy’ means the ability of a system to cover its demand. The current Seasonal Outlook adequacy assessment consists in analysing the ability of available resources in the market (generation, availability of imports, storage and demand side response [DSR]) to meet the demand by calculating the ‘remaining capacity’ (RC) under normal conditions and severe conditions.

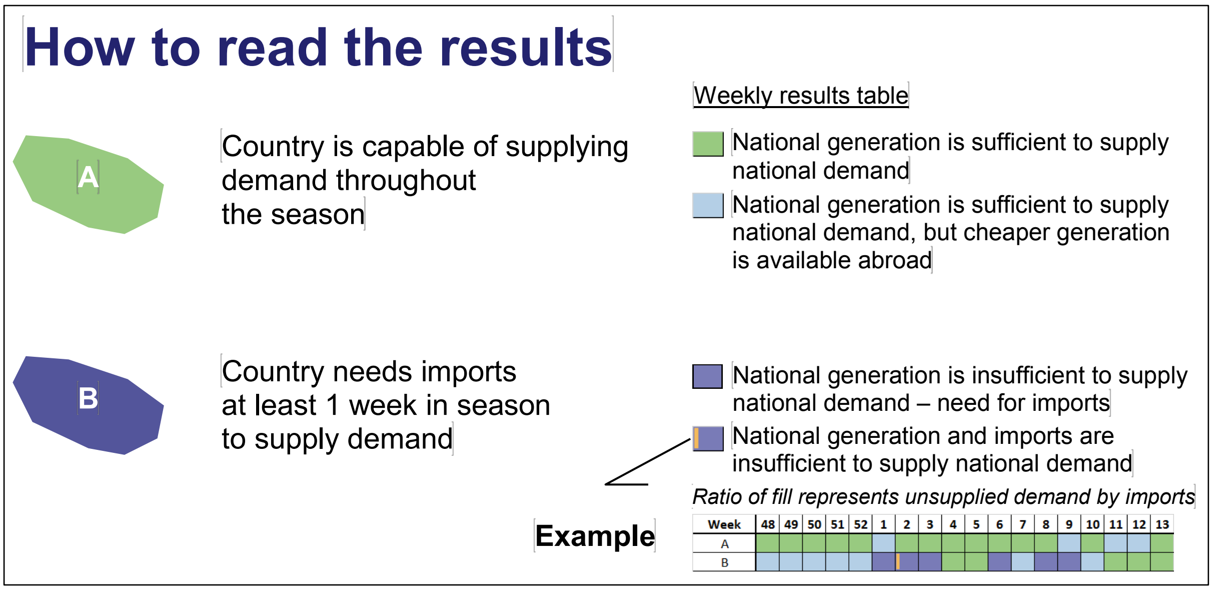
3.1 How to Read the Results

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 the whole season, the country is coloured green. Otherwise, the country is coloured purple (even if it faces issues in only 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 the event 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 was isolated.

In addition, a simplified merit-order approach[4] is 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.

[4] *The merit-order approach is only based on assumptions (Appendix 2). It may not represent real market situations.*



3.2 Adequacy Under Normal Conditions

Under normal conditions, generation capacities and available market-based DSR are sufficient to supply demand in all of Europe throughout the winter season, with only some countries requiring an import contribution.

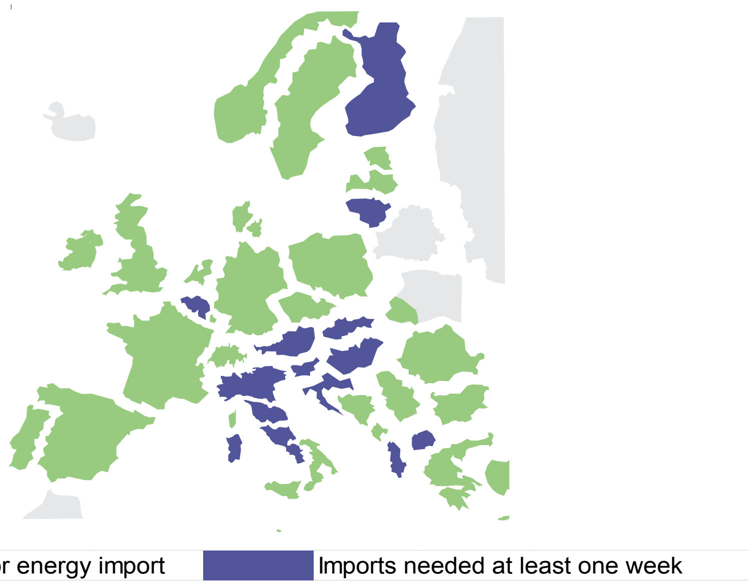
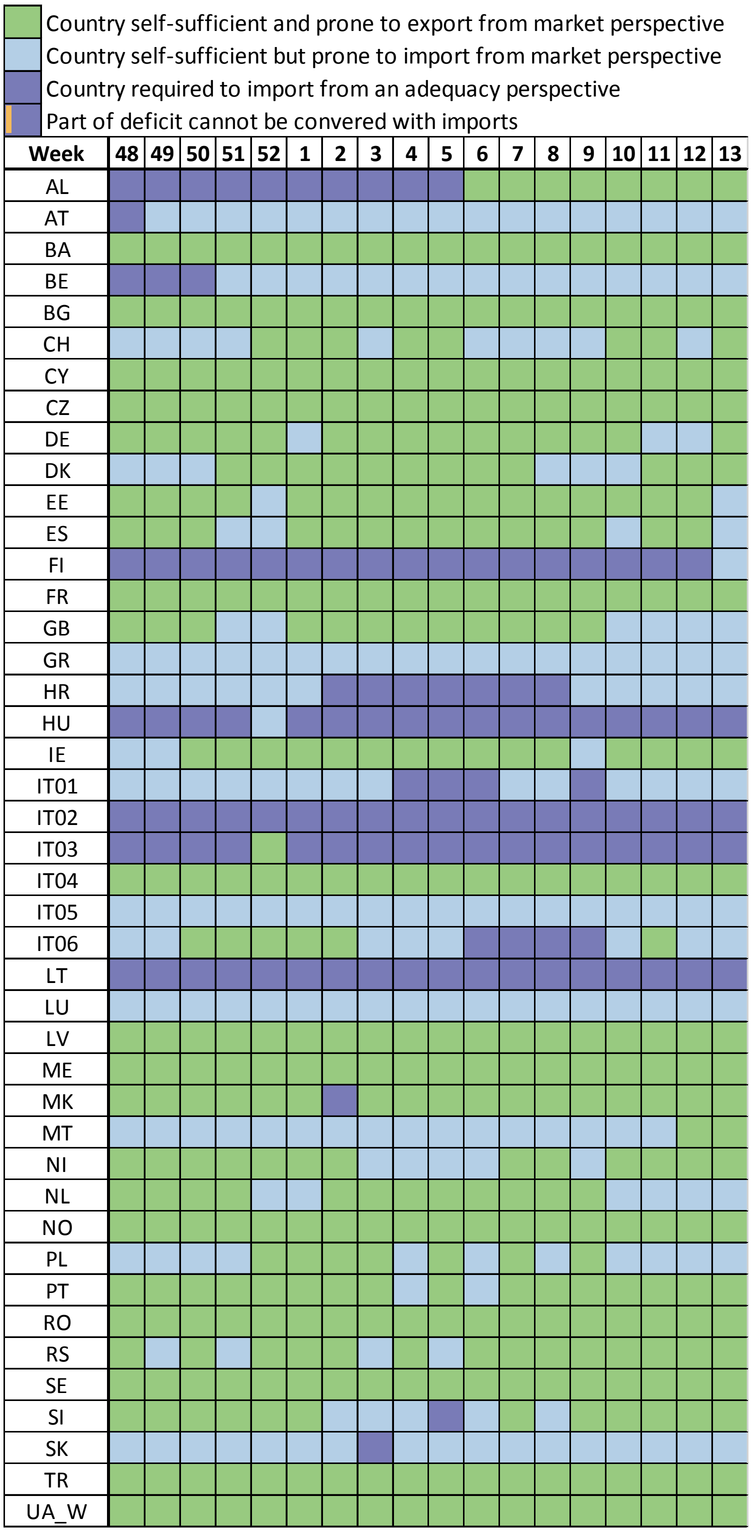


Figure 3: Adequacy under normal condition.

Further insight is provided in Table 1 presenting results in weekly resolution – no adequacy risks are identified during the coming winter at Pan-European synchronous peak time (19:00 CET). It also suggests that Finland, Hungary, Northern-Central Italy, Southern-Central Italy, Lithuania rely on imports throughout the season. Some countries would require imports in some specific weeks only and could be subject to adequacy issues under severe conditions at these weeks. Those countries are: Austria in week 48, Belgium in weeks 48 to 50, FYRO Macedonia in week 2, Slovakia in week 3 and Slovenia in week 5.

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



See Section 3.1 for details on how to read the results

3.3 Adequacy Under Severe Conditions

Since the January 2017 cold wave and outcomes of its dedicated report,[5] ENTSO-E has been assessing more severe situations. Firstly, all Europe is assumed to undergo a 1 in 20 years simultaneous set of extreme weather conditions – cold wave in winter and heat wave in summer. Secondly, all Europe is assumed to experience overall very low wind and solar irradiance conditions – (Percentile P5, cf. Appendix 2:3.1). This Winter Outlook uses the same approach; hence, severe conditions could be seen as a deterministic stress test for Europe's electricity system. In the future, implementation of a probabilistic approach for Seasonal Outlook with hourly resolution will improve the accuracy for assessing the global probability of adequacy issue, with both temporal and spatial correlation.

Results in Figure 4 suggest that under severe conditions, more countries would need imports to ensure adequacy compared to normal conditions. This is a result of a combination of two factors. First, higher demand due to a cold spell. Second, increased outages and lower variable generation availability.

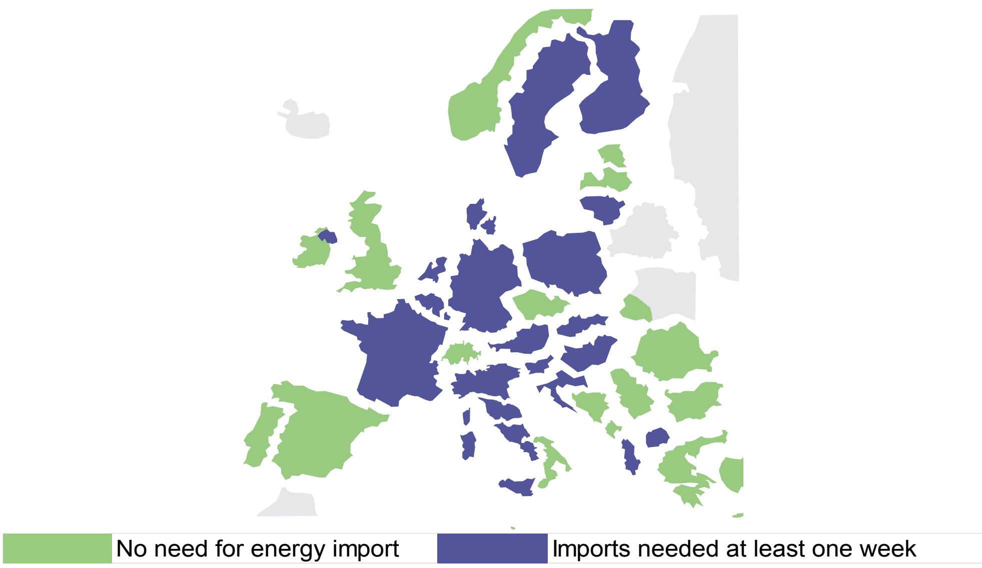
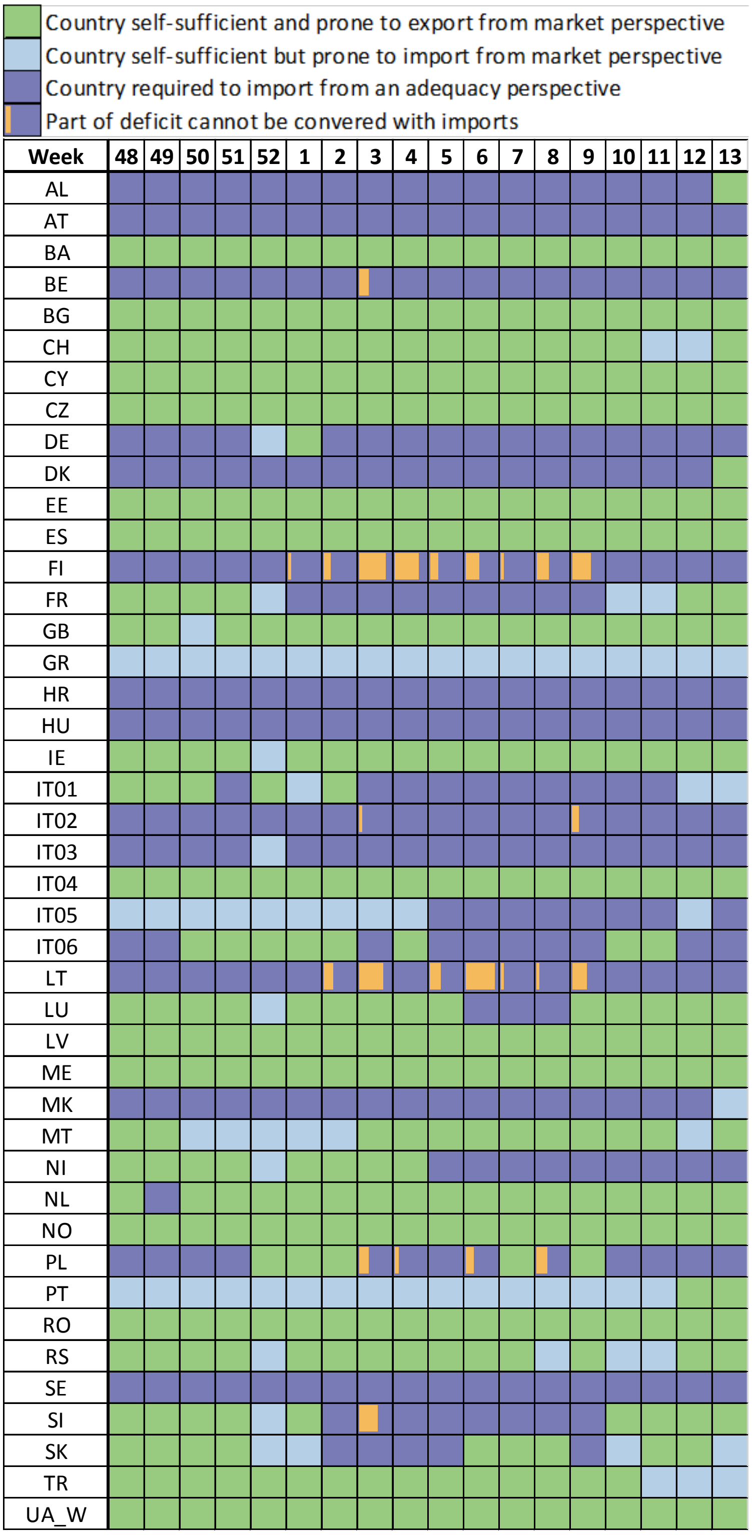


Figure 4: Adequacy under severe conditions.

Results on a weekly basis presented in Table 2 indicate that Belgium, Finland, Central-Northern Italy, Poland, Lithuania and Slovenia could face some adequacy issues at the beginning of 2019. It should be mentioned that the potential contribution of imports from Russia or Belarus has been neglected in the simulations (in addition to the disregard of strategic reserves).

[5] *Managing Critical Grid Situations – Success & Challenges*

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



See Section 3.1 for details on how to read the results

A more detailed analysis of the simulation results identifies that interconnectors are congested between regions of Europe where adequacy issues are observed and the rest of Europe. Three typical cases are observed (cf. Figure 5). In week 1, Finland, Estonia, Latvia and Lithuania import at maximum level from the rest of Europe. In weeks 2–5 interconnectors are congested between Spain, Ireland, Southern Italy, Bosnia and

Herzegovina, Serbia and Romania with the rest of Europe. In weeks 6–9, the situation is similar to the situation in weeks 2–5, but higher margins are available in the United Kingdom and congestion shifts from Ireland's interconnections to Great Britain's.

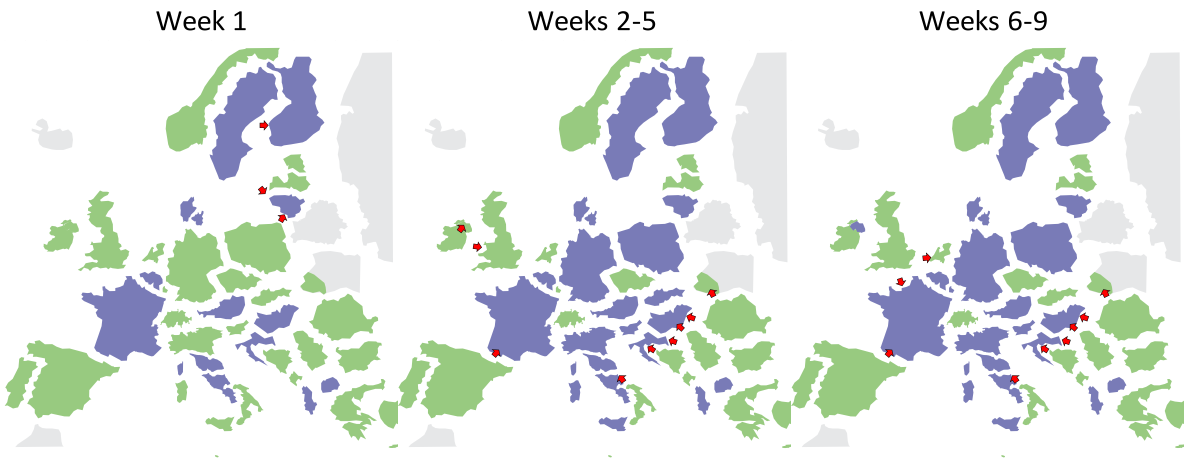


Figure 5 Regional isolation under severe conditions.

During these weeks, the available spare generation capacity and DSR from the rest of Europe are inaccessible to the importing region with scarcity. The total reliably available resources inside the scarcity region, including interconnectors, are insufficient to supply the total demand of this region. This finding shows 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 this large importing region or possibly shared between countries based on the solidarity principle (respecting interconnection constraints).

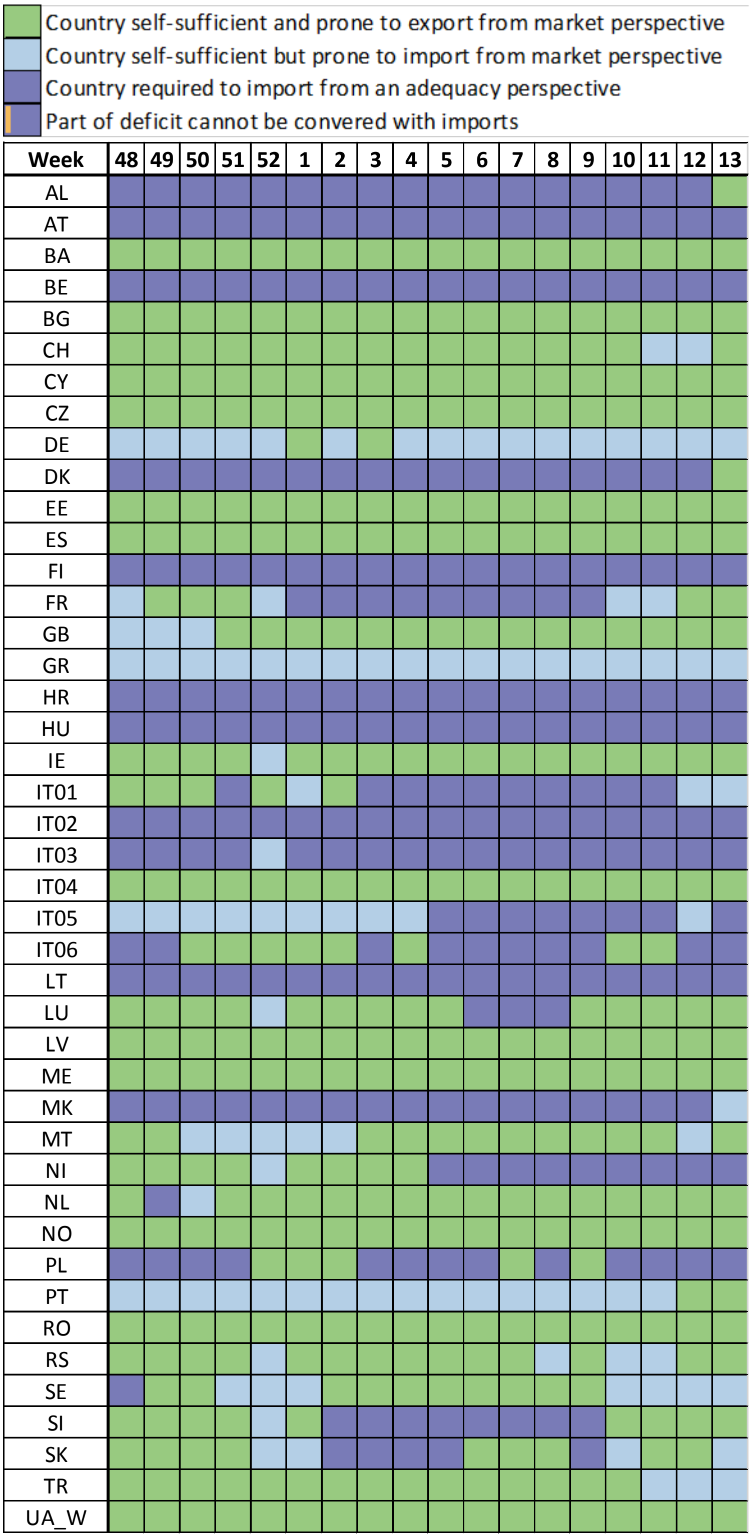
3.4 Sensitivity Analysis under Severe Conditions Considering Existing Strategic Reserves

The sensitivity analysis 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 the European electricity system would be sufficient to cover demand even under 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.

See Section 3.1 for details on how to read the results



3.5 Probabilistic Sensitivity Analysis

The adequacy study presented in prior sections indicates that no demand supply risk is identified under normal conditions but there is potential risk in the event of simultaneous severe conditions across Europe. A probabilistic sensitivity analysis assesses the expected probability of inadequacy risk during critical periods. This analysis has been performed for week 3 in 2019, as the risk is highest and covers the widest geographical region in Europe.

A pan–European analysis concludes there is around a 3% probability of having at least one hour with adequacy issues in at least one country on a typical Wednesday evening of the analysed week. This lack of resources could happen in one or more hours in the week, especially if the cause is a long cold spell. However, the global risk for the whole winter could be higher than the indicated 3%.

Figures 6–8 present the results of countries where risk is identified. They suggest that risks exist when temperatures drop significantly in Belgium, France and Italy. Belgium would be exposed to risk, especially when a temperature drop coincides with low wind generation. The adequacy situation in Italy is subject to temperatures in the country and also the situation in the neighbouring system.

Modification in the scope of countries with potential inadequacy risk could be observed compared to the list of countries identified in Section 3.3. In the probabilistic analysis, risks for Poland, Lithuania and Finland seen in the deterministic study were not confirmed. In contrast, the probabilistic approach detected potential risks in France where demand is highly sensitive to extreme low temperatures. Indeed, the probabilistic analysis uses historical correlated climatic variables that, first, are not all simultaneously extreme; second, in a specific country, the climatic variable can be worse than assumed under severe conditions.

Probabilistic simulation results of Belgium suggest inadequacy risk if the daily average temperature falls to -5°C and wind generation does not reach 30% of wind generation capacity.

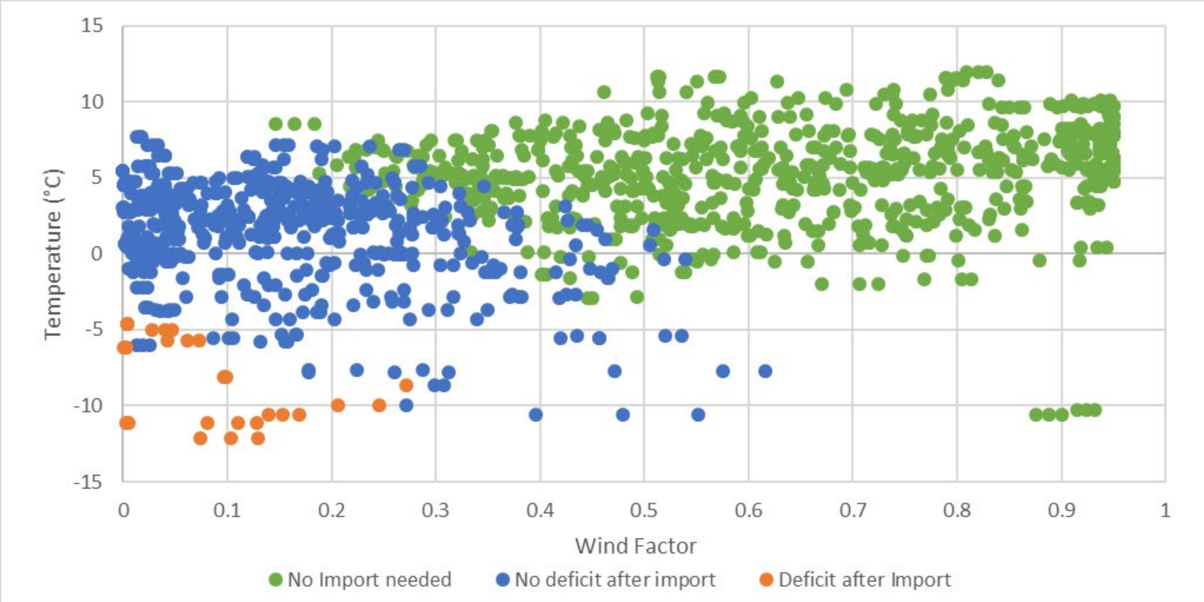


Figure 6: Probabilistic sensitivity analysis – week 3 in Belgium.

Probabilistic simulation results of France indicate that imports would be needed to France if the daily average temperature drops below 0°C. Adequacy risk could be expected if the daily average temperature reaches around -5°C. These weather conditions are linked to historical extreme weather conditions, such as the cold spell in 1985. However, the RTE (French TSO) national study with climate database adjusted for climate change indicates that these situations are unlikely to happen in the future (according to the French weather agency, Meteo-France).

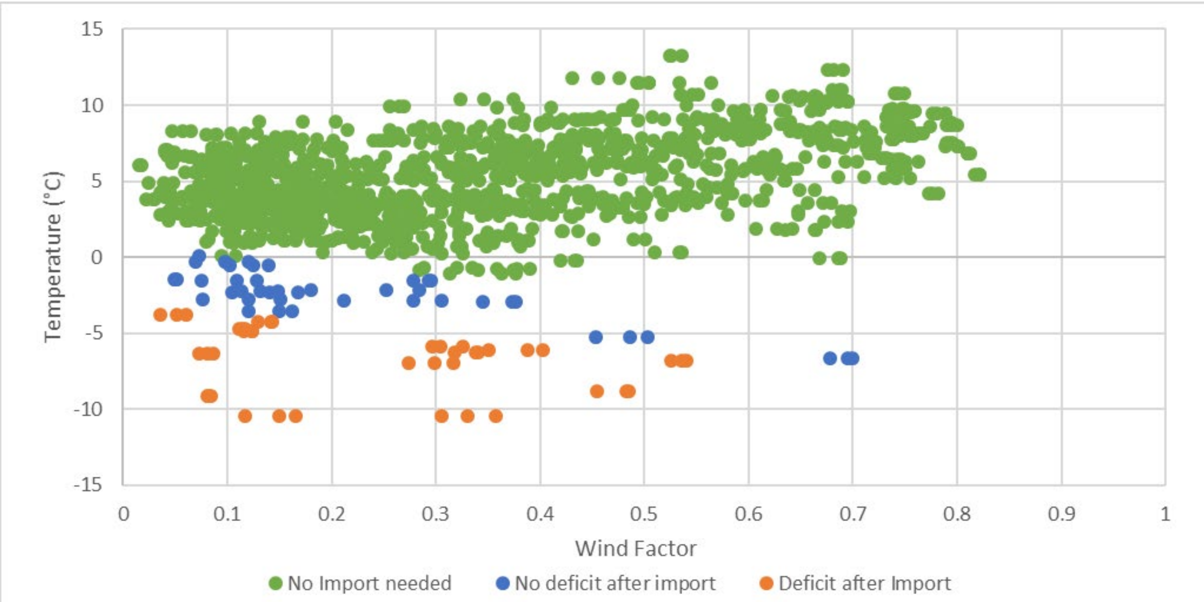


Figure 7: Probabilistic sensitivity analysis – week 3 in France.

Probabilistic simulation results of Italy (Northern and Centre-Northern) indicate an inadequacy risk when the daily average temperature reaches extreme lows in this area (-

3°C). However, some exceptions are observed, when a deficit after imports would be not expected when the temperature drops below threshold.

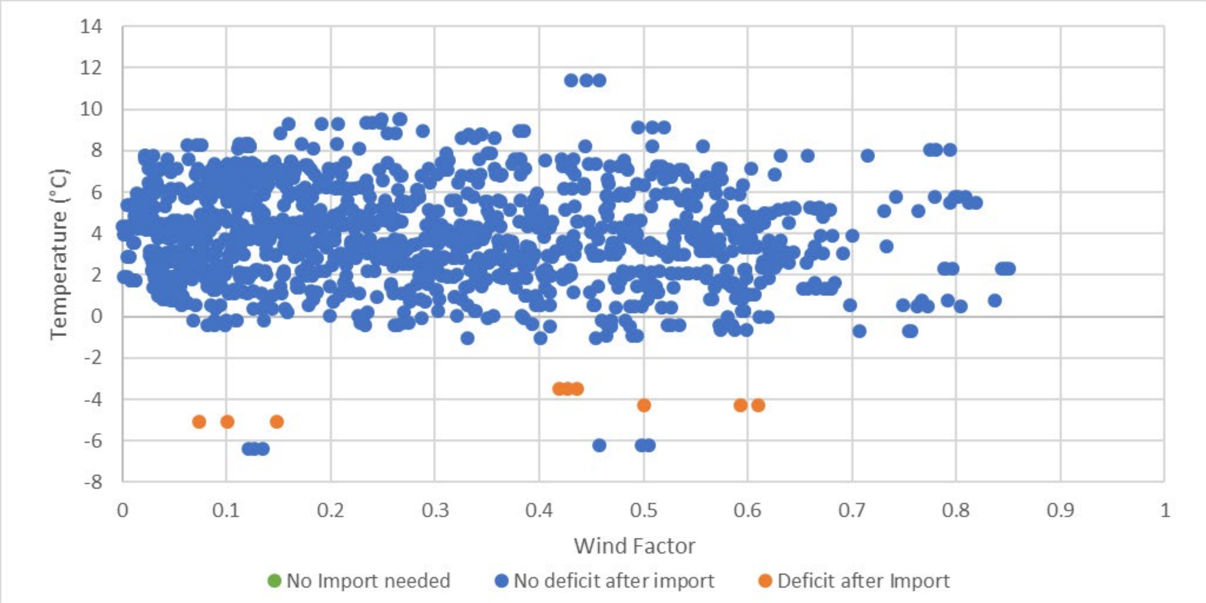


Figure 8: Probabilistic sensitivity analysis – week 3 in Italy (merged Northern and Central-Northern zones).

Detailed analysis shows that an adequacy risk in Italy is observed only when extremely low daily average temperatures are also experienced in the rest of Europe. The graph below depicts that a lack of capacity is expected in the Northern part of Italy in the event of an extreme cold spell widespread in Europe.[6]

[6]3 points with negative margins in Figure 9 represent 9 points in Figure 8. Some samples have the same daily temperature, but wind and PV generation conditions are different

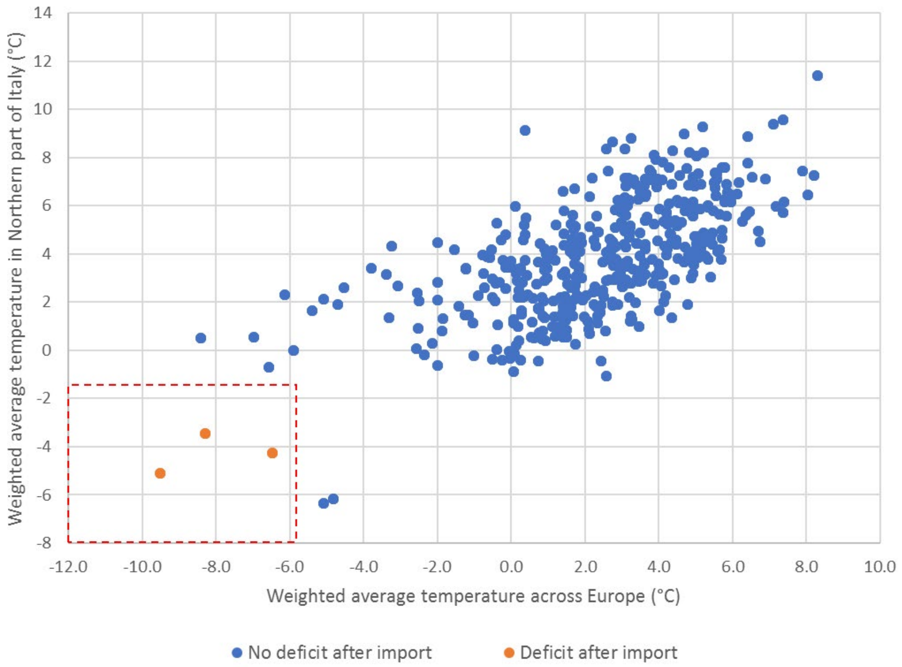


Figure 9. Impact of daily average temperatures in Europe and in Northern Italy region for adequacy situation in Northern Italy region.

4 Winter outlook 2018 – Downward Regulation

The probability of encountering an excess of inflexible generation grows with the increasing variable renewable generation and decreasing dispatchable generation in Europe (cf. Figure 1). Possible wind or PV curtailment could be needed at some low demand hours to keep the system stable when market participants (e.g. storage operators and active consumers) cannot consume any more energy or interconnectors are congested.

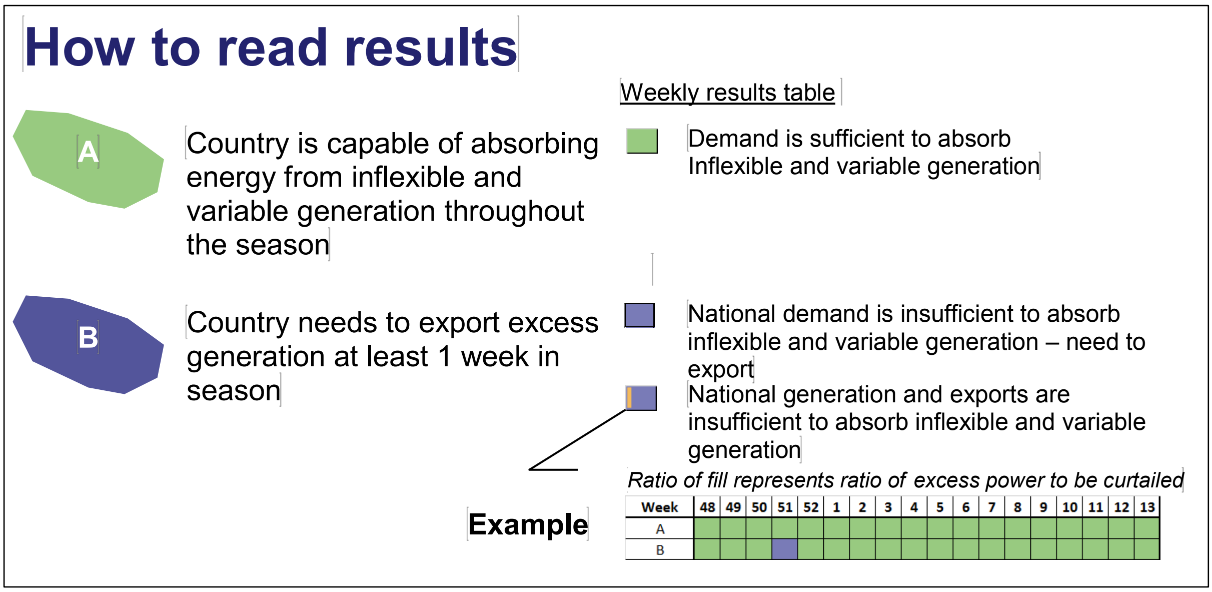
The downward regulation margins are assessed for, respectively, windy Sunday nights (very low demand and high wind) and Sunday daytime with high PV and wind generation. Variable generation values have been chosen as 95th percentile values of data samples taken from the PECD (cf. Appendix 2).

The reader should not consider the results in Table 4 and Table 5 as a representation of forecasted winter curtailment. They only indicate a potential risk in the event of very high wind and PV generation; and very low demand in all of Europe at the same time at a given day. Furthermore, wind and PV generation curtailment should not be perceived as a negative action. The practice of it allows the integration of high rates of renewable generation in power system and also indicates business opportunities for emerging technologies such as batteries.

4.1 How to Read the Results

Results in figures displaying maps within Section 4 present the 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 throughout the whole season. Countries are coloured purple if the generation surpasses the expected demand, meaning the country needs to export excess energy for at least 1 week in season.

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.



4.2 Daytime Downward Regulation

The results displayed in Figure 10 confirm the need for export at daytime when demand is low for countries with an important share of installed RES capacity compared to their demand. The daytime reference time point is considered as 11:00 CET for the whole study period except, week 13 in 2019 when it is 11:00 CEST.

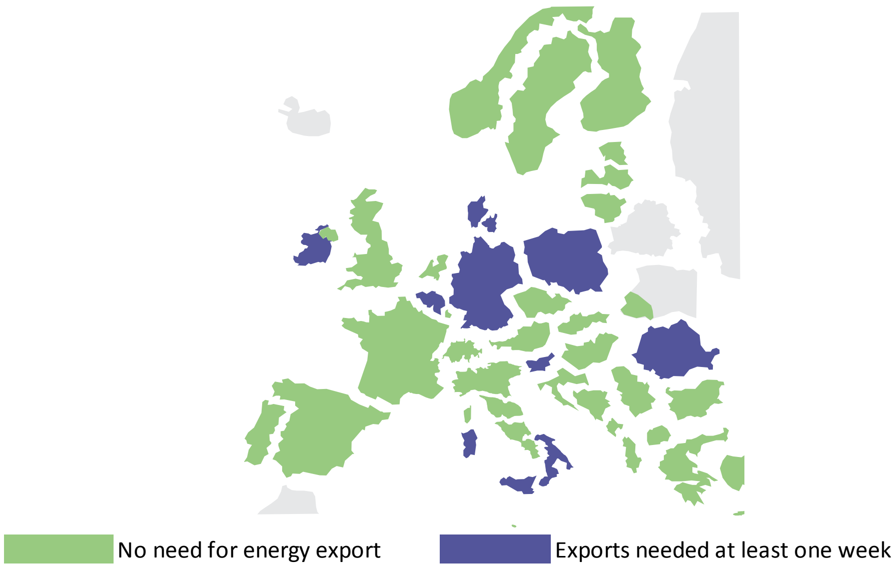
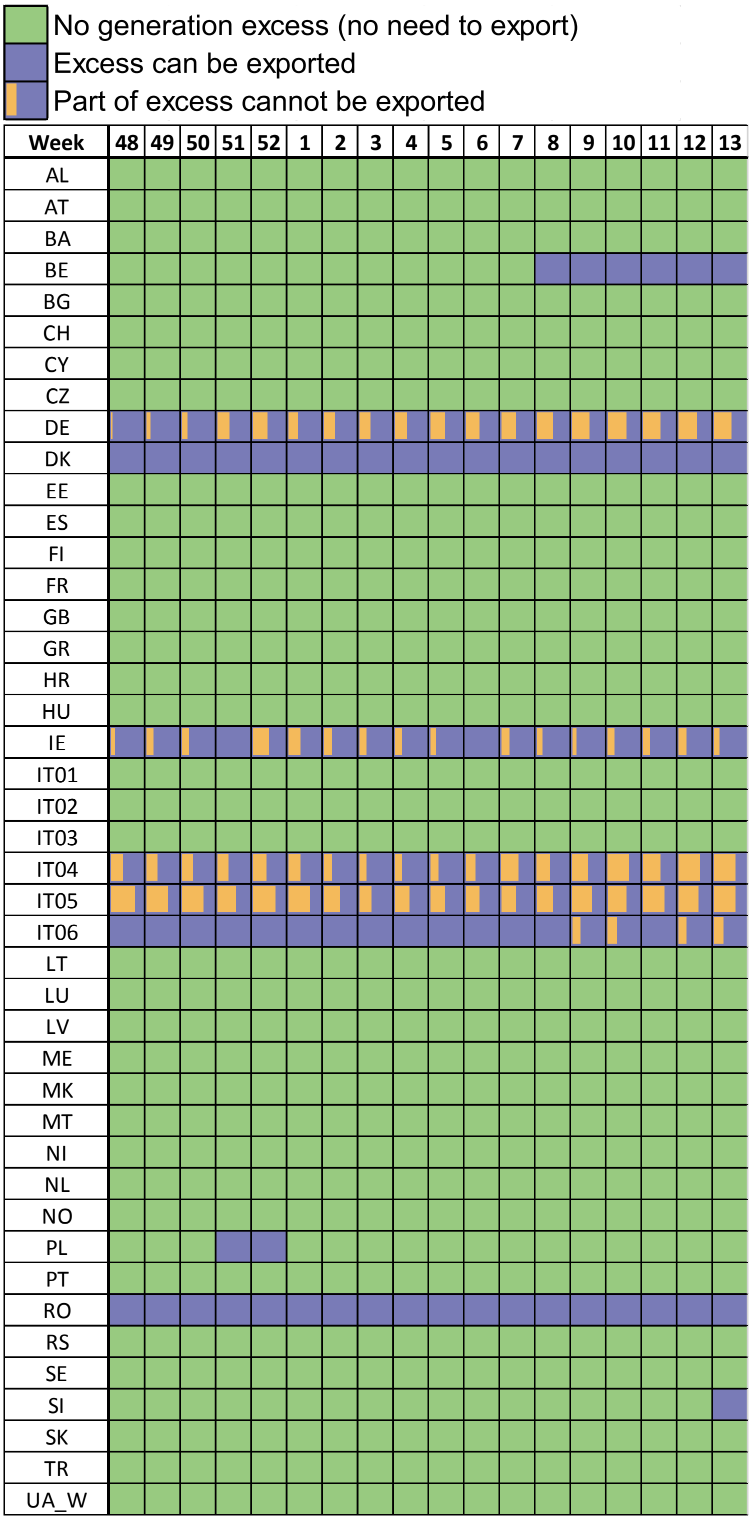


Figure 10: Daytime national downward regulation adequacy.

The weekly results in Table 4 indicate that curtailment of excess wind and PV may be needed in some countries to ensure system stability. Higher rates of curtailment are observed in some countries compared to the results of the Winter Outlook 2017/2018. This is a result of increased RES capacity in the last year.

Table 4: Daytime downward regulation adequacy.



See Section 4.1 for details on how to read the results

4.3 Night-time Downward Regulation

The results presented in Figure 11 show that all countries which may need to curtail wind or PV generation at day, may also need curtailment at night. Additional countries which may need to curtail inflexible generation are Finland, Great Britain, FYRO Macedonia, Northern Ireland and Sweden.

The night-time downward regulation adequacy corresponds to Sunday early morning (5:00 CET for the study period but 5:00 CEST for week 13 in 2019). Curtailment mostly relates to wind generation as no PV generation is expected at that time.

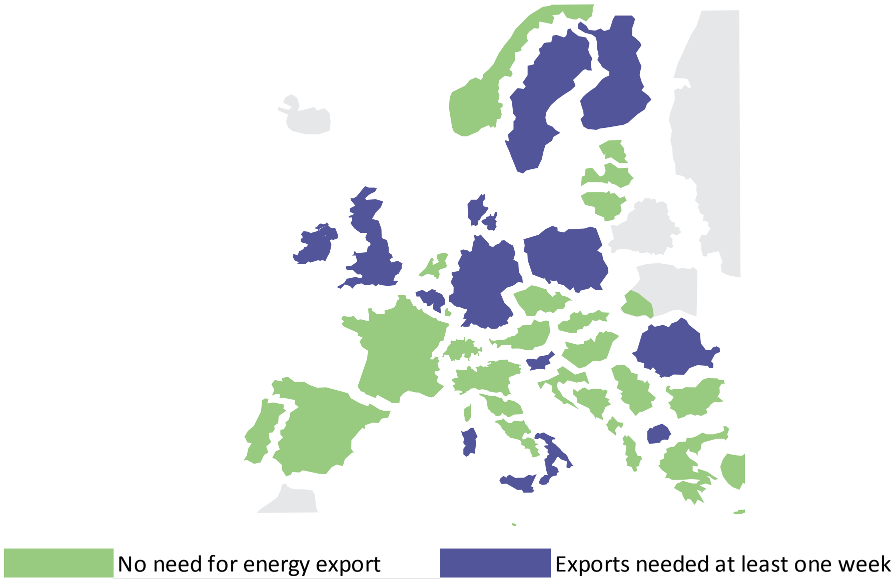


Figure 11: Night-time national downward regulation adequacy.

The weekly results in Table 5 are in line with results at daytime. It displays a potential increase of curtailment in several countries compared to last winter, which can be explained by the important increases of RES installed capacity.

See Section 4.1 for details on how to read the results

Table 5: Night-time downward regulation adequacy.

No generation excess (no need to export)
Excess can be exported
Part of excess cannot be exported

Week	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11	12	13
AL																		
AT																		
BA																		
BE																		
BG																		
CH																		
CY																		
CZ																		
DE																		
DK																		
EE																		
ES																		
FI																		
FR																		
GB																		
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PL																		
PT																		
RO																		
RS																		
SE																		
SI																		
SK																		
TR																		
UA_W																		

5 Overview of Hydro Reservoir Levels

This chapter presents an overview of the current reservoir levels in major hydro-generating countries, complementing the system adequacy study presented in this report. Hydro generation is considered in the adequacy analysis, yet only through a deterministic approach considering power availability at one synchronous peak time in week. The information presented in this section aims to give additional qualitative insight into energy rather than power; the current reservoir levels and their evolution this year compared to historical levels. This may highlight additional potential risks.

Reservoir levels in all studied countries at the end of October were near average. The summer period resulted in reservoir levels recovering to or maintaining average levels, after last winter saw a high amount of snow, especially in the Alps. Pronounced hydro reservoir level recovery has been observed in France and Switzerland since April. In Norway, a substantial decrease of hydro accumulation was recorded during the summer due to the heat wave, but in the course of autumn it has approached average levels again. However, river levels of Neckar and Rhine (southern Germany) were quite low after a very dry summer and a dry autumn beginning. This impose a risk of coal supply disruptions to power plants in southern Germany in case of cold and dry winter.

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

Reservoir levels in Italy are well above last year's when it was lowest recorded level for this period. During spring, an increasing trend has been evidenced and reservoirs recovered from the low levels seen in winter, though they slightly decreased earlier than in typical years due to the heat wave late summer.

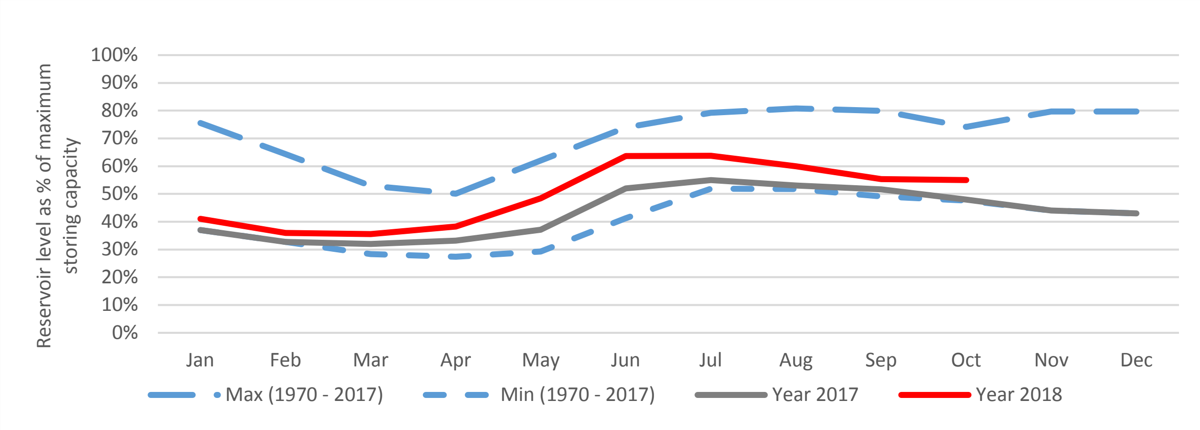

Figure 12: Reservoir levels in Italy.[7]

In France, the reservoir levels are close to average according to the latest available data. They have reached levels at the beginning of 2018 that were considerably lower than the recorded minimum values since 1997. From May until July, reservoir levels have followed a sharp recovery, reaching average levels in August and maintaining the average trajectory until the end of October.

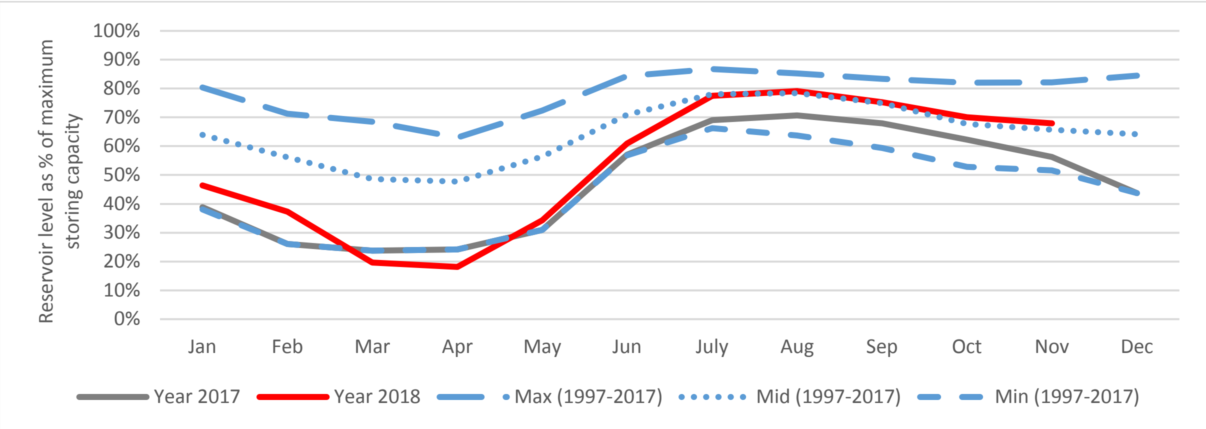

Figure 13: Reservoir levels in France.[8]

Hydro reservoirs levels in Spain were near historical minimum values until February, but have increased levels rapidly at the end of winter, reaching slightly above average levels around April and maintaining this trajectory until the end of October.

[7] *Based on data published by Terna*

[8] *Procured Based on data published by RTE*

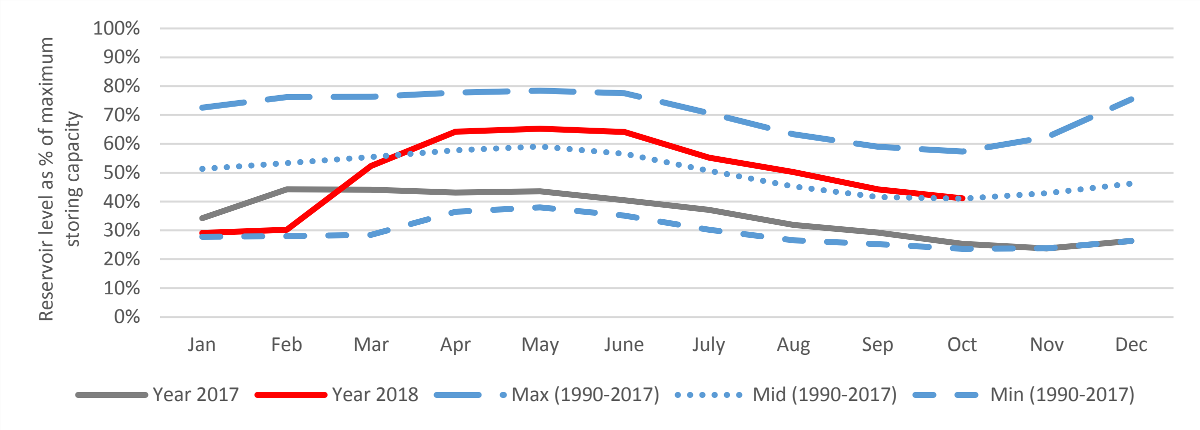

Figure 14: Reservoir levels in Spain.[9]

Reservoir levels in Switzerland at the beginning of the year were close to lowest recorded levels, but following the start of summer 2018, an increasing trend appeared and the levels approximated the recorded average values.

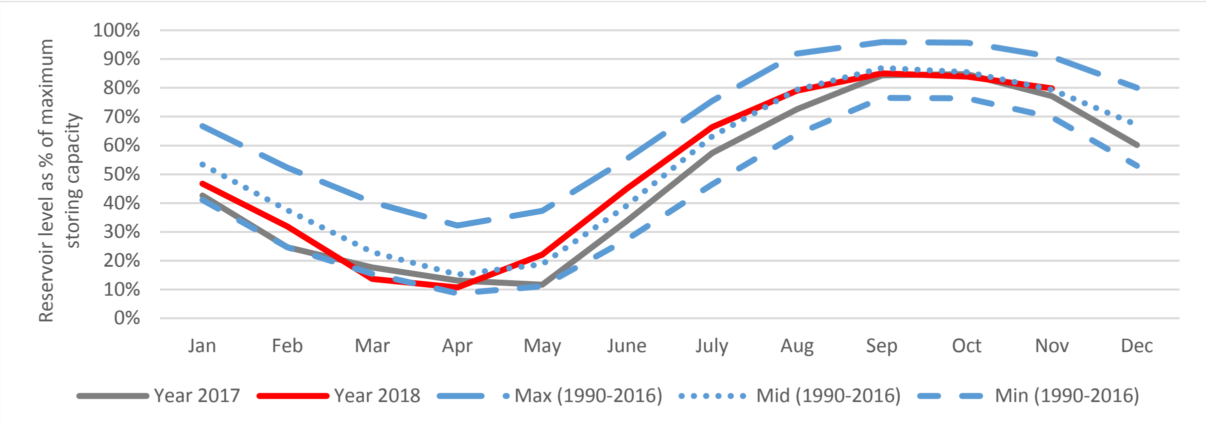

Figure 15: Reservoir levels in Switzerland.[10]

In January, Austria's reservoirs levels were high, but have been depleted rapidly until March when levels reached values lower than the minimum recorded values since 2001. During spring, reservoir levels have followed an increasing trend but at the end of summer are still below last year's values, though considerably higher than minimum recorded values.

[9] *Based on data published by REE*

[10] *Swiss Federal Office of Energy (BFE)*

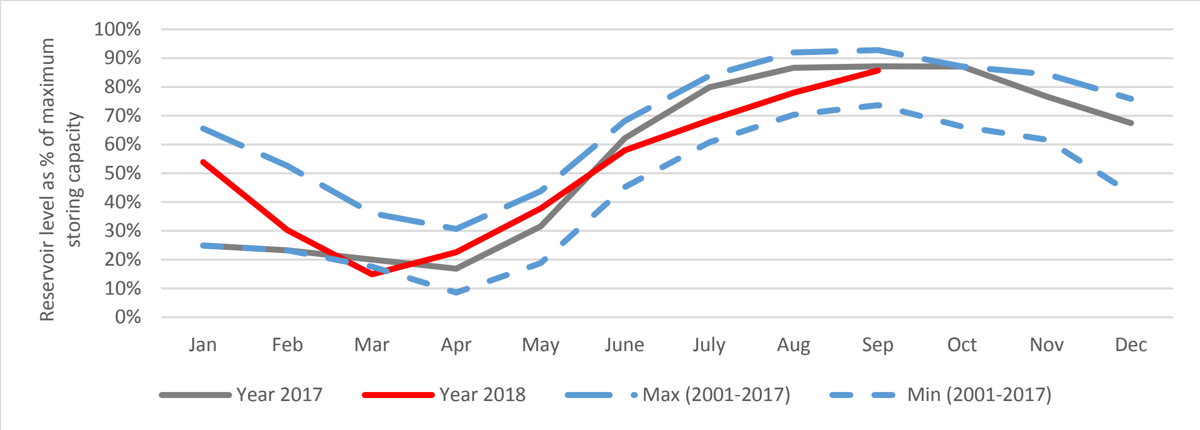

Figure 16: Reservoir levels in Austria.[11]

Hydro reservoir levels in Norway have followed the average trajectory until the beginning of summer, having deviated from this behaviour to lower levels, but have shown some recovery in September and October and are now only slightly below average levels.

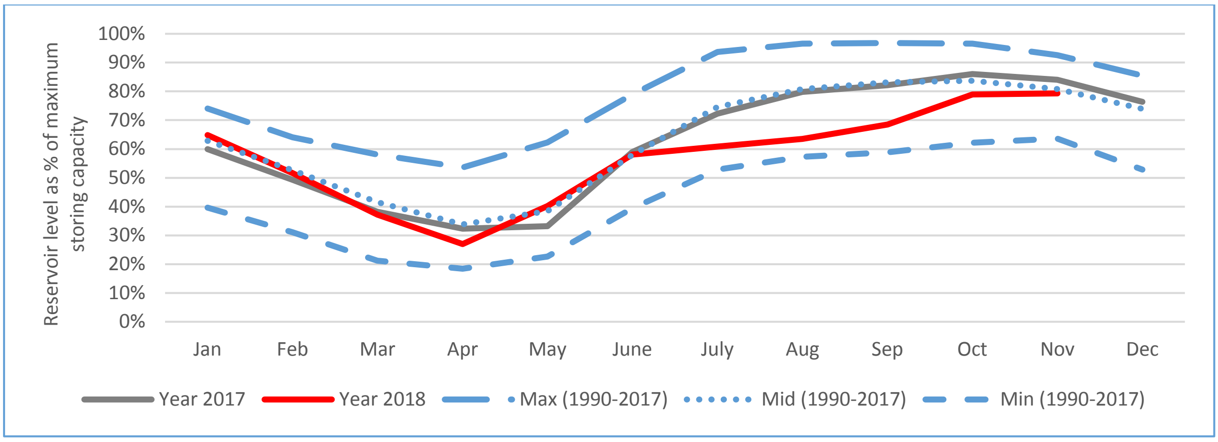

Figure 17: Reservoir levels in Norway.[12]

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

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

6 Gas Disruption Risk Analysis

6.1 Background

Since 2014, a gas disruption analysis has been performed in ENTSO-E's Winter Outlooks 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.

According to the Gas Regulation (2017/1938), an '*Union-wide simulation of gas supply and infrastructure disruption scenarios (…) shall be repeated every four years unless circumstances warrant more frequent updates*'.

In November 2017, ENTSOG issued a first edition of the Union-wide Security of Supply Simulation (Security of Supply report),[13] in which the association simulates supply and infrastructure disruptions under severe winter demand. The number of gas disruption scenarios was extended to different regions and risks compared to the studies performed so far.

Considering this new gas framework and changes and the future electricity Risk Preparedness Regulation that aims to include fuel shortage risks, the sensitivities related to the impact of gas shortages on electricity might be addressed in the Risk Preparedness framework rather than the Seasonal Outlook in the future.

6.2 Assessment for coming winter

ENTSOG published in October 2018 its Winter Supply Outlook 2018/2019[14], with four scenarios on gas supply route disruption: Ukraine, Belarus transit, Baltic-Finland, Algerian Pipes and LNG. These scenarios are built on gas disruption on the top of a 1 in 20 cold winter.

ENTSOG's report shows that the gas system would be robust in case of a Belarus and Algerian gas supply route disruption.

However, partial gas demand curtailment might be needed in South-East Europe in the event of Ukraine transit disruption. The same countries are at risk for gas demand

[13] *Union-wide Security of Supply simulation report*

[14] *Winter Supply Outlook 2018/2019 report*

curtailment as analysed last year[15], therefore conclusions presented in the previous year's electricity Winter Outlook[16] on Ukraine transit disruption could also be drawn this year.

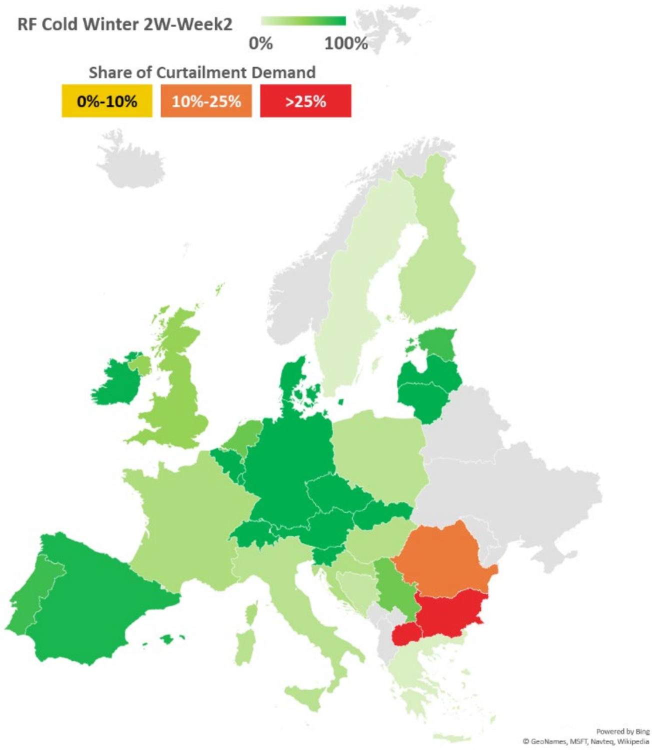

Figure 18: 2-Weeks cold spell (gas Remaining Flexibility and Curtailment Rate) for Ukraine gas transit disruption.[14]

In the event of gas supply route disruption from Russia to the region Baltics-Finland, Finland might experience a gas shortage. However, fuel replacement is available for Finnish gas power plants so this would have no impact on the electricity system.

[15] Winter Supply Outlook 2017/2018

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

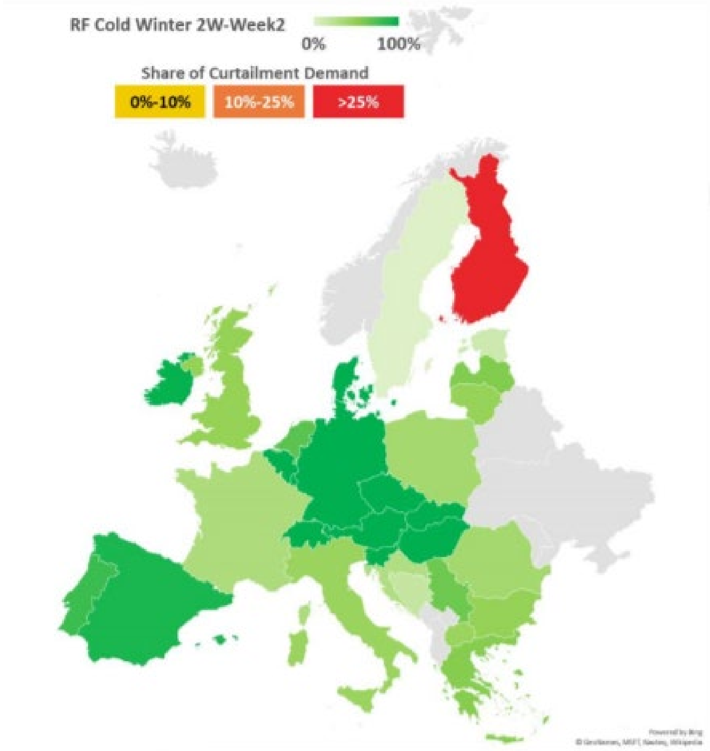

Figure 19: 2-Weeks Cold Spell results (Remaining Flexibility and Curtailment Rate) for Baltic States and Finland disruption.[14]

6.3 Conclusion: systems are resilient to gas disruption

The European Electricity System is confirmed as being robust in the event of a severe conditions demand with a gas transit disruption in Ukraine, Belarus, Algeria, or a disruption of gas import to the Baltic States and Finland. ENTSOG's outcomes show that it would mainly be the South-East Europe region that would possibly be exposed to a gas curtailment risk (the Ukraine transit disruption scenario being the most constraining). 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 remaining capacity; and
- Some gas fired generations could be switched to substitute fuels, or expected unavailable gas fired generation capacity is of a low order magnitude.

7 Summer 2018 review

The summer review is based on the qualitative information submitted by ENTSO-E TSOs in October 2018 to represent the most important events that occurred during summer 2018 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

Last summer was distinguished by above average temperatures in most of Europe throughout the whole summer season. There were periods of unusually high temperatures (heatwaves) – especially from mid-May to mid-June and from late July into August - with the area of increased warmth moving around Northern Europe, which saw temperatures some two degrees warmer than average. Central Europe was particularly affected, with average temperatures around 3°C warmer than usual, because it remained within this warm area throughout. Across the whole of Europe, between April and August, temperatures were 2°C above the 1981-2010 average; very likely making the region 1°C warmer than ever seen during the industrial era. Rainfall was far below average, though the anomalies were not as notable as those for temperature when considering this extended period.[17]

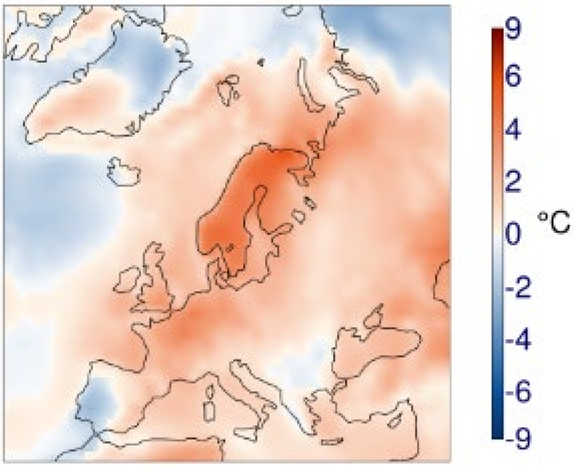

Figure 20: Surface air temperature anomaly for July 2018 relative to the July average for the period 1981-2010.[17]

[17] Copernicus Climate Change Service - The long hot summer just past

7.2 Specific Events and Unexpected Situations During the Past Summer

This warm and dry summer in Northern and Central Europe had some impacts on the electricity system, especially:

- Powerplant outages and generation limitations were common this summer. Generation limitations were linked to the legal obligations on usage of cooling water under a certain temperature level;
- PV generation was lower than could be expected with so many sunny days, due to efficiency loss when the temperature rises. Wind production was also below historical average;
- Several fires occurred which led to limited transmission capacities.

In addition, several local events were monitored last summer:

- In May, lack of downward regulation occurred in Sweden. A special downward regulation order was issued to nuclear units after all resources available in market were used;
- Demand in Croatia lost access to electricity supply during a storm on 9 June. The storm has caused element unavailability in the transmission system. The disturbance lasted for half an hour. Estimated unsupplied energy is 50 MWh;
- Demand in Czech Republic lost access to the electricity supply several times this summer due to the false trigger of the protection system in the distribution system. Supply disruption lasted for only a few minutes and unsupplied energy was below 20 MWh;
- Energinet (Danish TSO) experienced balancing problems in July due to a fire in the Hovegaard 400 kV substation. As a result, all interconnection availability had to be limited for a couple of hours until normal operation was restored;
- The two biggest nuclear blocks in Finland were disconnected on 18 July because of a fire in a substation. No electricity supply issues were recorded during the event, but were anticipated for the following day. Upward regulation reserves were activated in response and no supply disruptions were recorded;
- On 22 August, 600 MW of demand were disconnected in Greece due to an incident in the Transmission System;
- Problems to maintain voltage levels within operation limits were recorded in southern Germany. The situation was a result of the limited availability of fossil fuel

power plants. Appropriate measures were taken to ensure safe operation of power system;

- In July 2018, Continental Europe TSOs started applying a collective compensation programme due to power imbalances in Serbia, Macedonia, Montenegro (SMM block) and specifically Kosovo*[18], causing frequency deviations. These measures allowed a normal situation to be maintained. However, ENTSO-E calls for a political resolution of the dispute that caused the deviations to ensure a long-lasting solution to the problem.

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[18] 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.*

Appendices

Appendix 1: Individual Country Comments on the Winter outlook and Summer reviews

Albania: Winter outlook 2018/2019

There is no foreseen event or issue to endanger system adequacy in winter 2018/2019. Mainly system adequacy will be fulfilled by hydro generation and the firm imports contracted by the DSO.

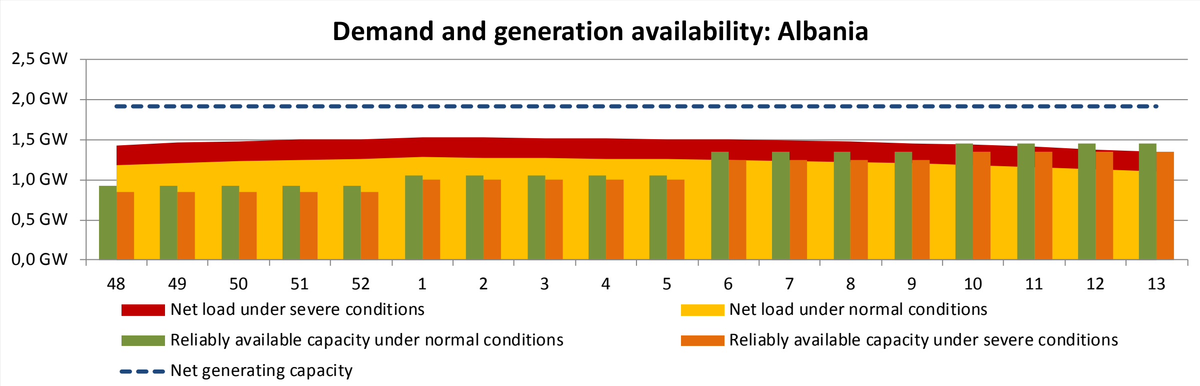
Dependency on imports in Albania has decreased in recent years. First, the installed generation capacity has steadily increased. Second, national demand has slightly decreased.

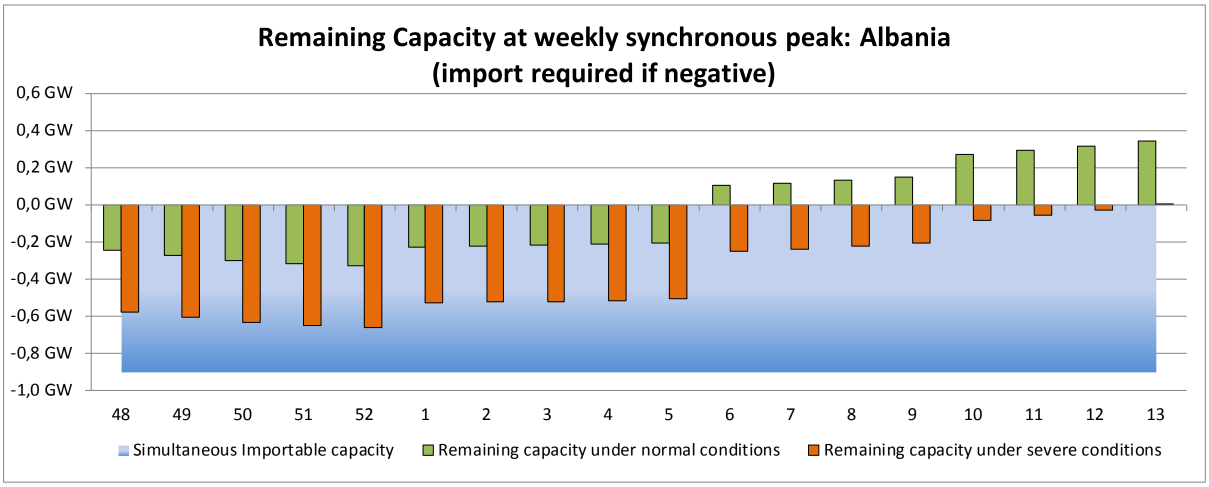
Nevertheless, the maintenance schedule is optimised to ensure sufficient cross–border capacity for imports and exports.

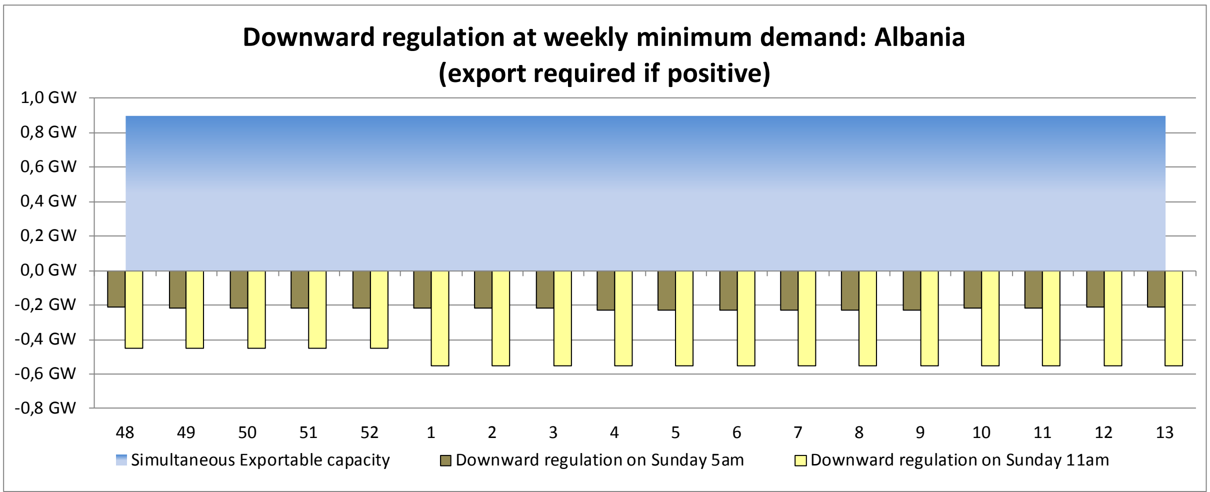
Regarding transmission system availablity, OHL 400 kV Koman-KosovaB, is considered in operation (all agreements are prepared on our side and countersigned).

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







Albania: Summer review 2018

This year's summer season is considered a normal one (maximum temp 39°C), related to ambient temperatures and with the main indicative parameters of our power system.

Inflows in the Drin River cascade, which is the main source of the country's generation, were within historical average values, considering the high inflows in the first quarter of 2018. The 'good' hydro levels helped us maintain high levels in the reservoirs of this cascade, and consequently to maintain a high level of hydro reserve. The full utilization of 220 kV network caused an increase in network losses from 39.7 GWh to 45.7 GWh, equivalent to an increase of 13%.

No adequacy or downward regulation issues were identified during the past season.

Austria: Winter Outlook 2018/2019

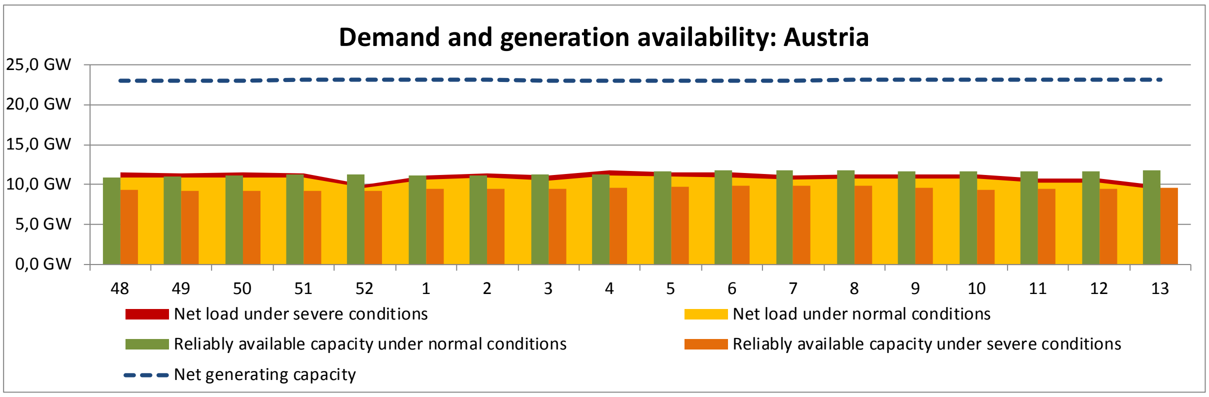
NTC values of 4.9 GW in both directions for Austria–German border are considered for the first time in the Winter Outlook 2018/2019 study. This was done because, on 1 October 2018, the Austria–German–Luxemburg bidding zones were split into two bidding zones – Austria and Germany–Luxemburg. For the analysis, the generation capacities of the control block APG are considered, which is not exactly covering the geographical area of Austria.

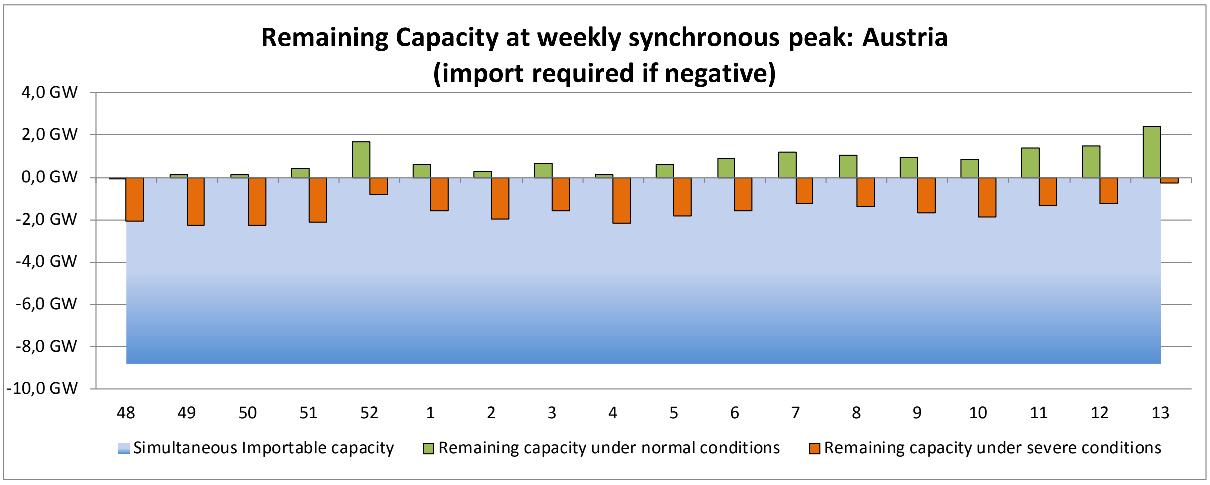
The reliable available power of pumped storage powerplants (PSPs) was calculated considering the statistical data of generated energy by Austrian Pumped Storage Power Plants (PSPs) in a normal year and in a dry year (normal and severe conditions respectively). These energies were divided by 60 h for each week in order to account for the energy constraints of this type of power plant, seasonal inflows and the sustainable exploitation of a PSP. This 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.

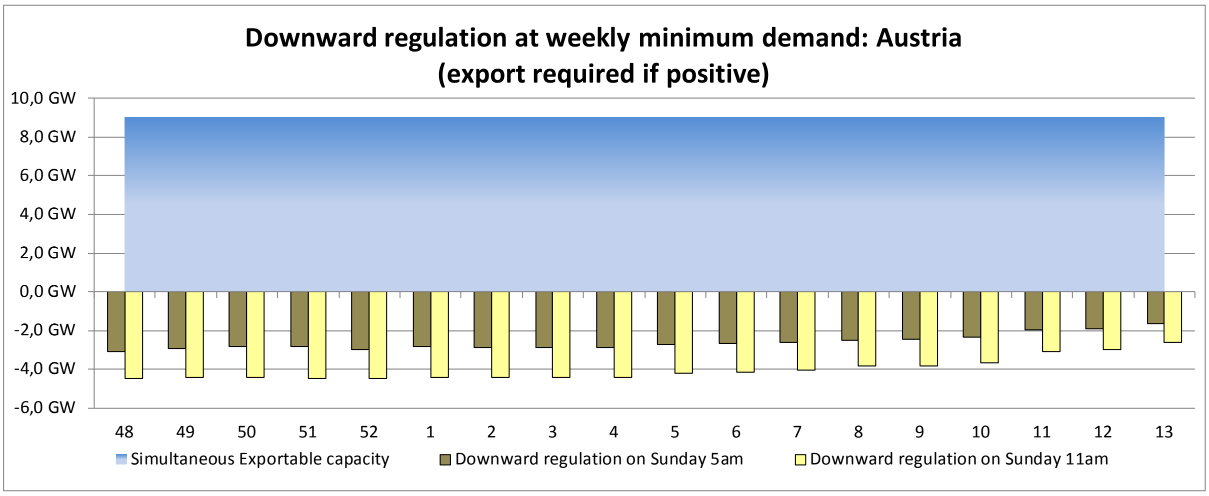
Potential critical periods and foreseen countermeasures

The remaining capacity is around 0 GW for the first weeks under normal conditions. It only increases towards the last study period and reaches 2.4 GW in week 13, 2019. Under severe conditions, especially in the last weeks of 2018, the remaining capacity indicates a deficit of up to 2.28 GW. This is a consequence of available generation capacity decrease compared to Winter 2017/2018 due to the mothballing of thermal power units.

The situation could worsen in the event of a sustaining dry period (such as September 2018).







Austria: Summer review 2018

This summer period was the warmest since 1767, when monitoring activities started. The temperature curve exceeded the mean of 1981–2010 by 2.6°C.

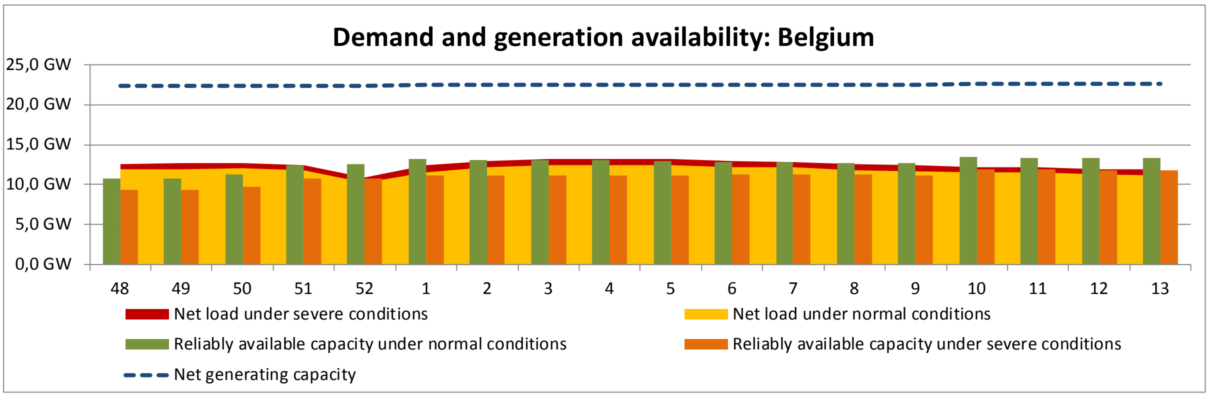
Thus, hydro production was low in the second half of the summer and, as a further consequence, some thermal production units had to reduce their generation due to legal limitations to cool some rivers.

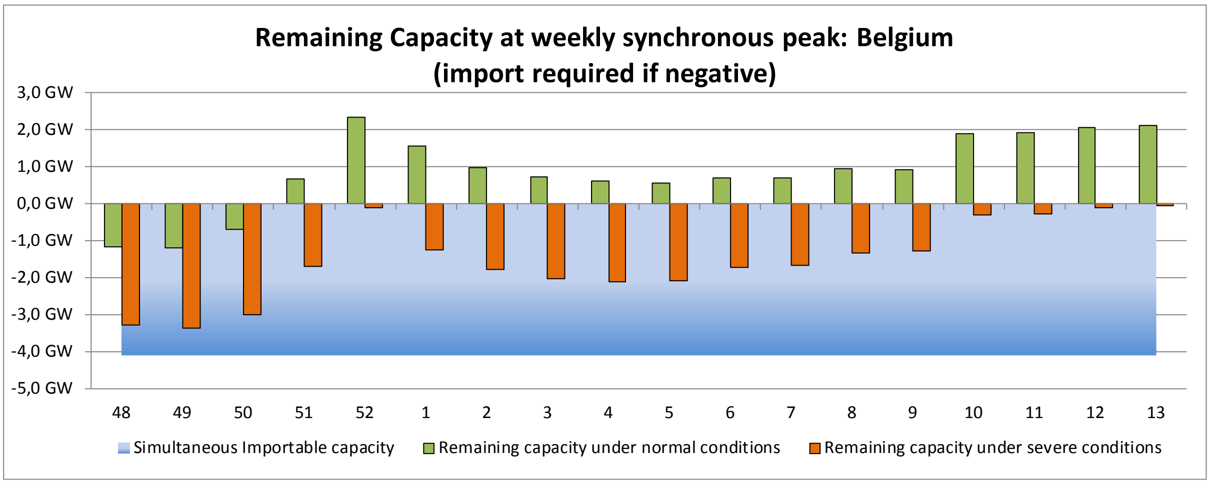
Belgium: Winter Outlook 2018/2019

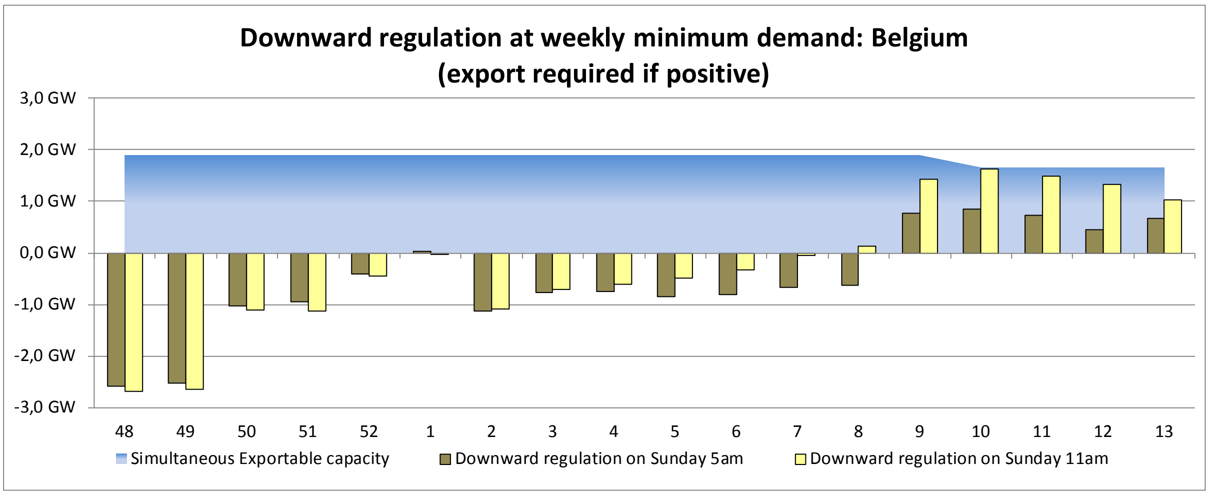
Potential critical periods and foreseen countermeasures

The Belgian power system will depend strongly on import for the winter 2018/2019. The import need for December goes over 3 GW under severe conditions due to the unexpected unavailability of multiple nuclear power plants. In December, 2 GW of the nuclear generation is expected to start up again (Doel 1, Doel 2 and Doel 4), which leads to an import need of 2 GW under severe conditions in January. The simultaneous import capacity for Belgium is set to 4.1 GW, which corresponds to the 95th percentile of the maximum import of Belgium resulting from the flow based market coupling. This import can only be guaranteed if Belgium can import from the Netherlands and France. For December, this should normally be the case if the flow based market coupling works well. For January and February, the adequacy situation will be strongly dependent on the expected return of several nuclear units in Belgium and the adequacy situation in France.

For winter 2018/2019, Belgium did not contract any strategic reserves based on calculations made during the summer. However, after the announcement of 3 GW additional unavailability of nuclear units, 750 MW additional measures have been found in a task force led by Federal minister of Energy Marghem which is working on the government's behalf. These 750 MW of additional measures are already taken into account in the results.





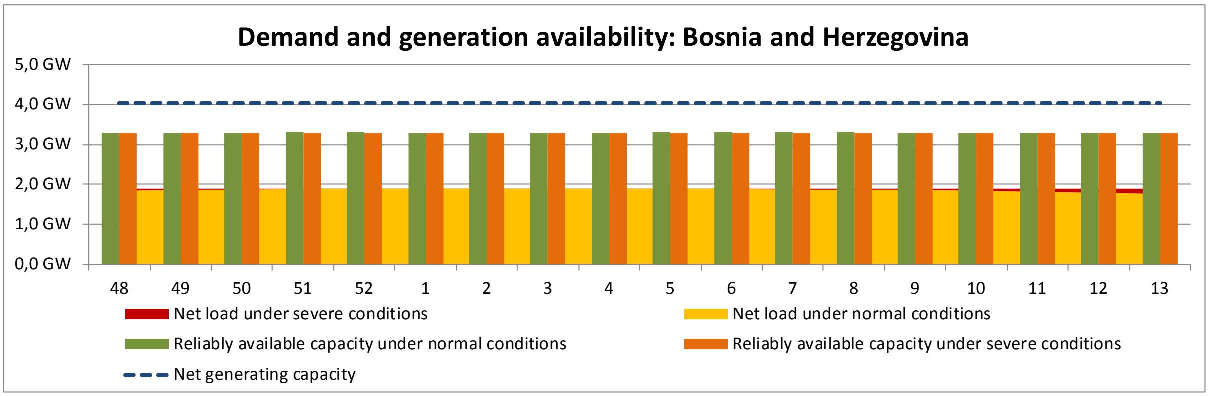


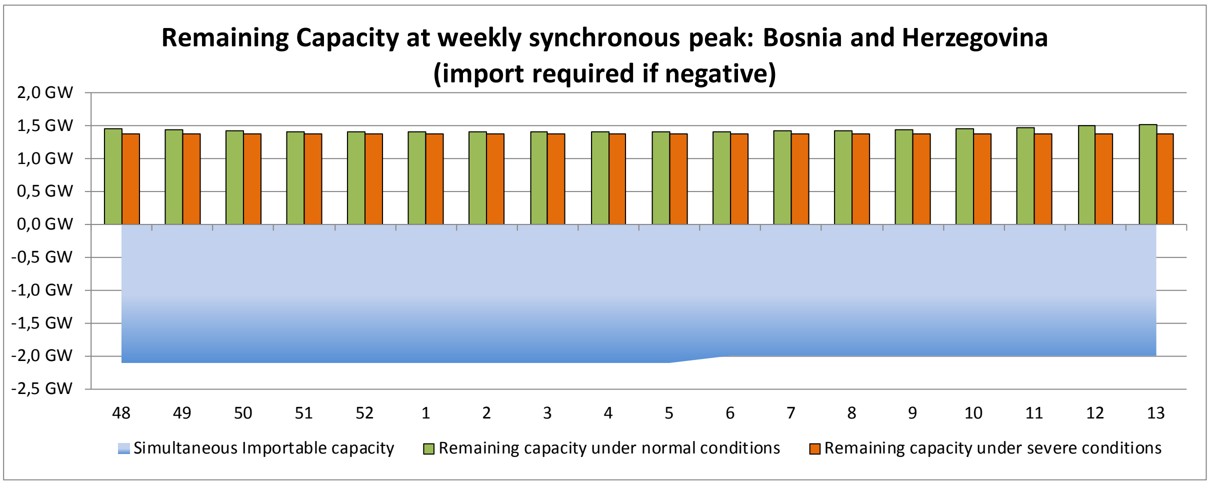
Belgium: Summer review 2018

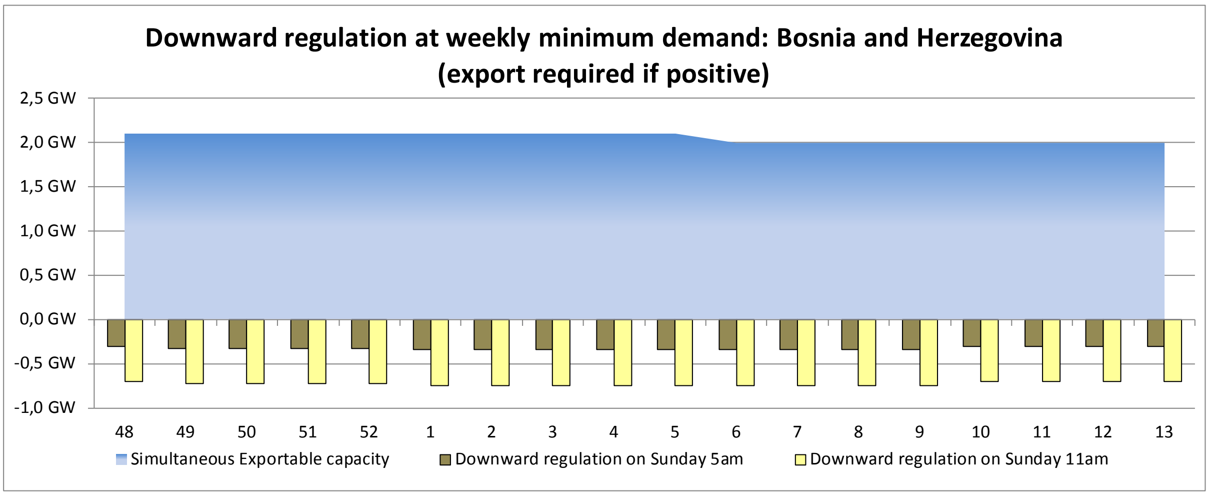
No adequacy or downward regulation issues were identified during the past season.

Bosnia and Herzegovina: Winter Outlook 2018/2019

Regarding power system adequacy in Bosnia and Herzegovina for the winter 2018/2019, we do not expect any problems. We predict that in the next winter period, our consumption will stay at approximately the same level as last year, and a positive power balance is expected.





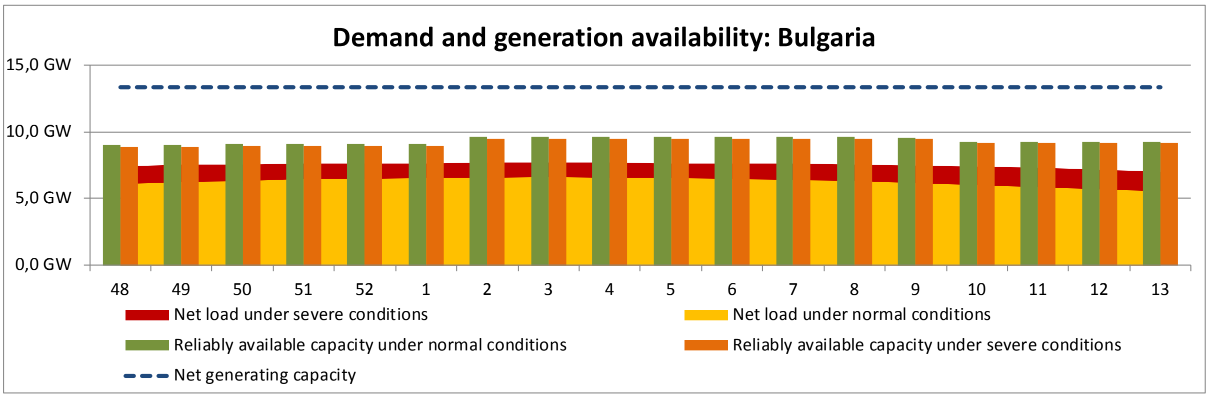


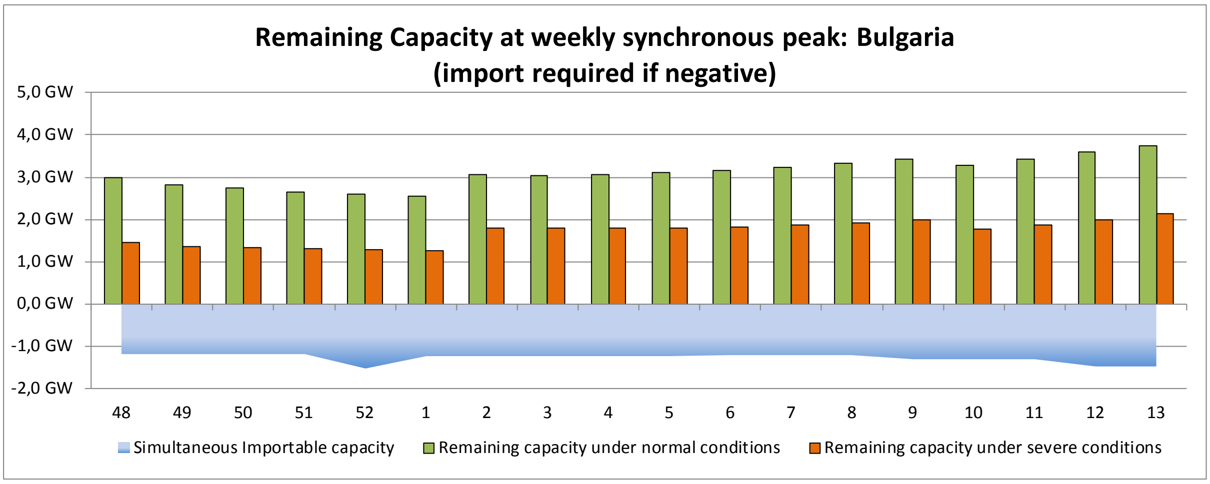
Bosnia and Herzegovina: Summer review 2018

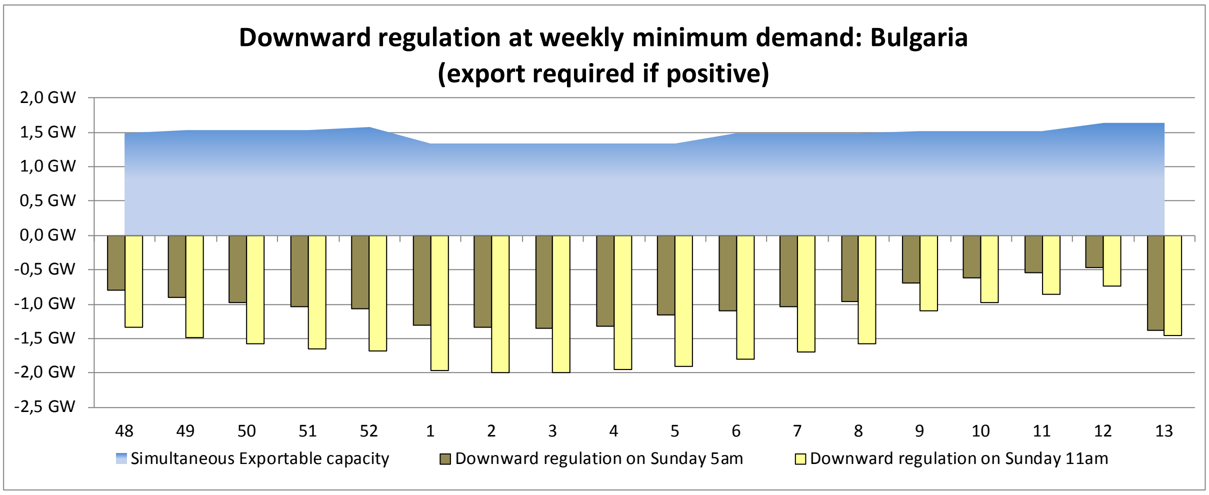
During the summer period of 2018, there were no unexpected situations that affected the power system in Bosnia and Herzegovina. The minimum load of 847 MW was registered on 18 June at 4:00, while the maximum demand was registered on 26 August at 21:00, and it was 1688 MW. Monthly power balances were positive during this period.

Bulgaria: Winter Outlook 2018/2019

No adequacy issues are expected for the upcoming winter period in Bulgaria. There are no power plant maintenance delays. The change of primary fuel from hard coal to natural gas and re–commissioning of three units in Varna Thermal Power Plant ensures additional 600 MW of additional available capacity. Furthermore, demand response schemas are being implemented which can provide around 100–120 MW of reserve.







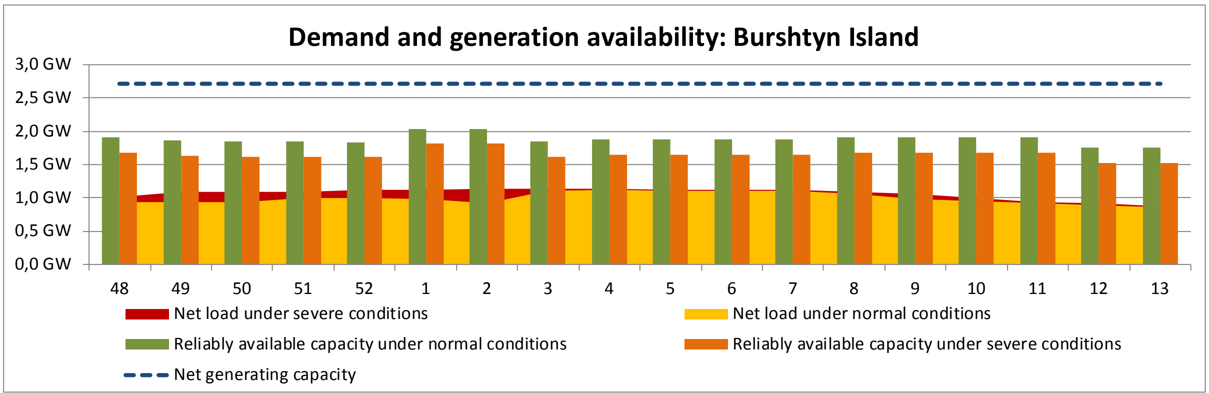
Bulgaria: Summer review 2018

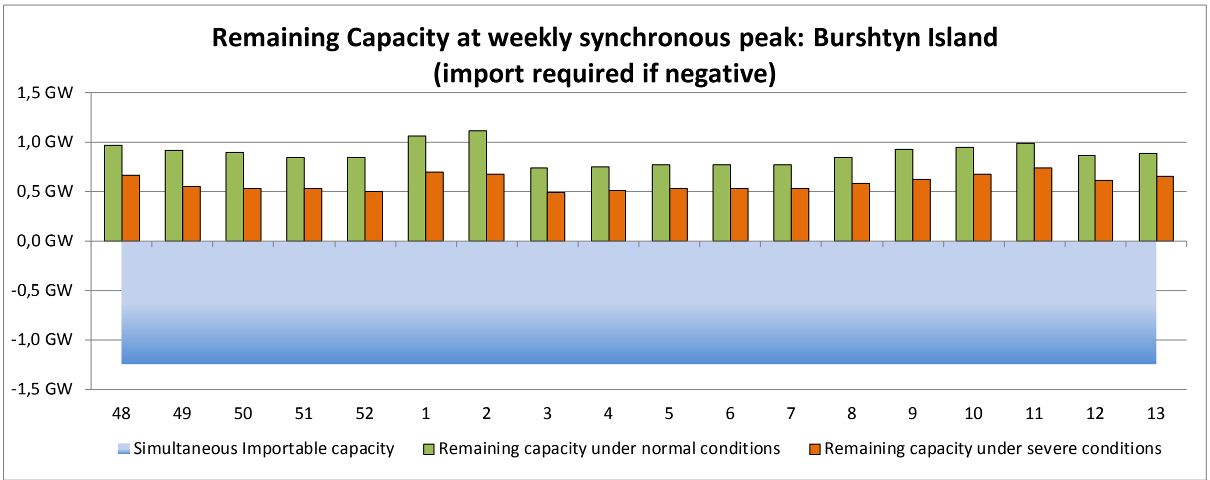
No adequacy issues were identified in Bulgaria during the last summer season. There are no critical situations and unexpected events to report. Demand during June, July and August was about the same as in 2017.

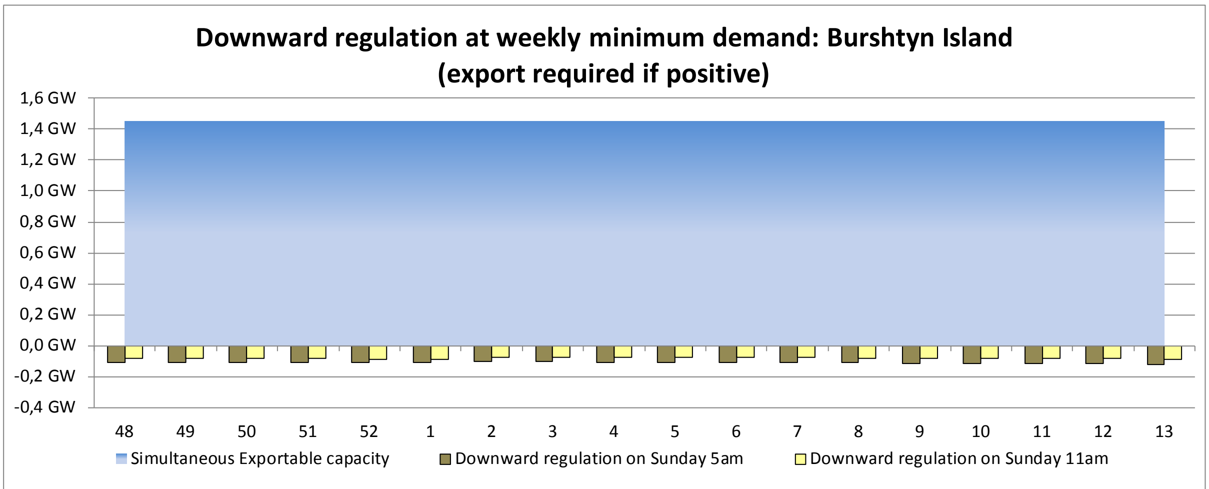
Burshtyn Island: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







Burshtyn Island: Summer review 2018

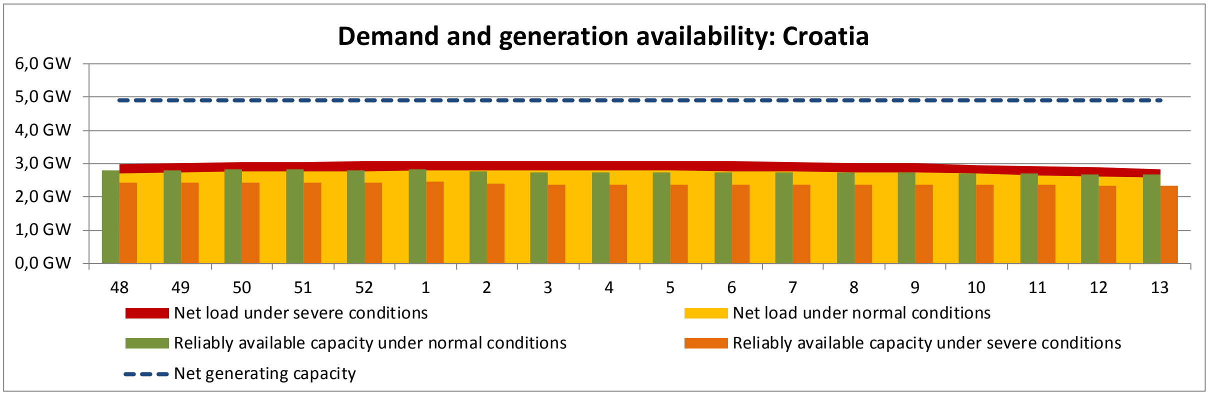
No adequacy or downward regulation issues were identified during the past season.

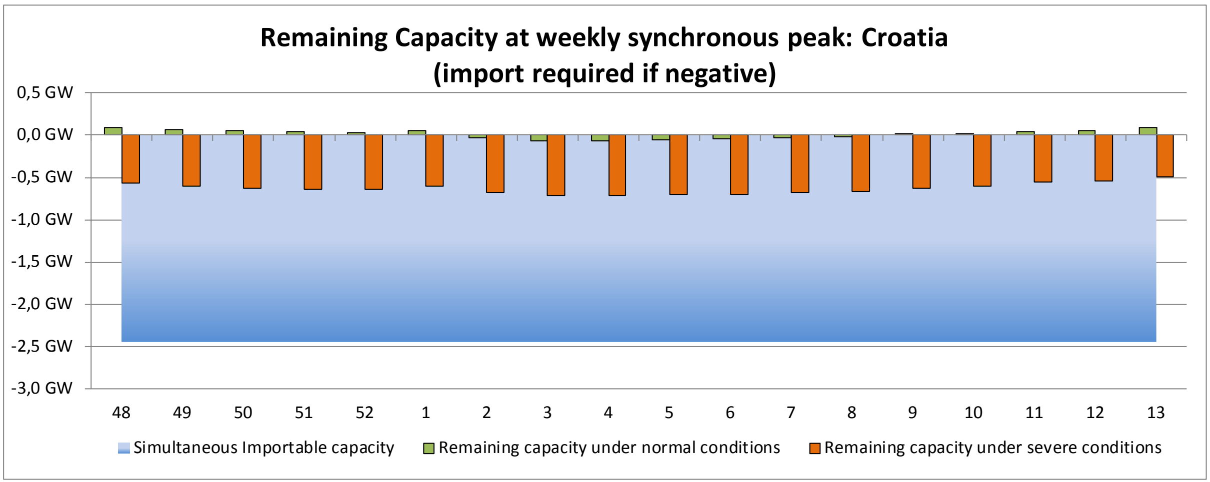
Croatia: Winter Outlook 2018/2019

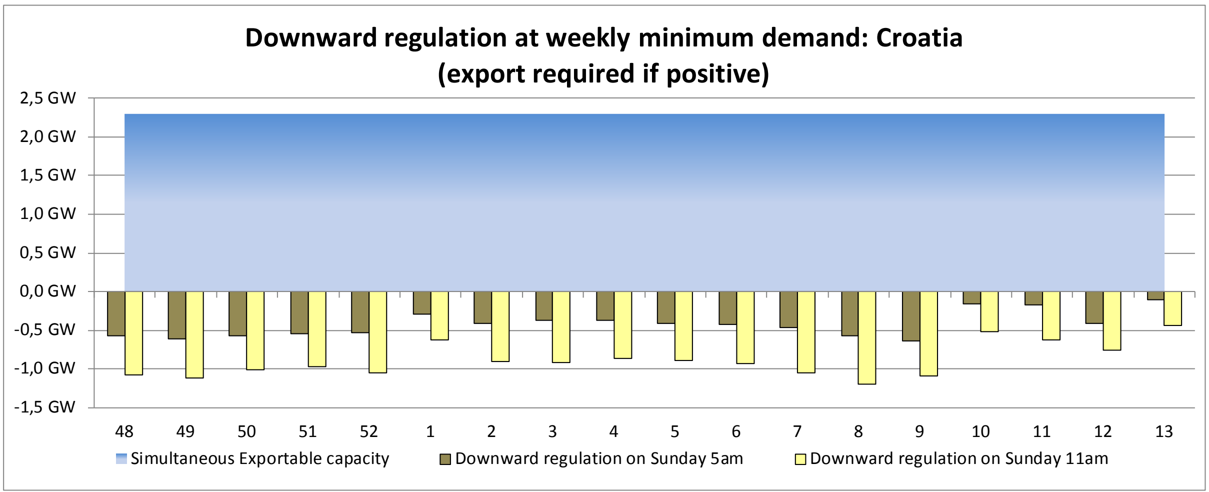
Potential critical periods and foreseen countermeasures

As in previous years, the Croatian power system will need to import energy, despite installed generation capacity exceeding the maximal expected demand. Imports could be more economically efficient compared to the dispatch of expensive thermal units. Furthermore, the electricity supply could be endangered by the absence of rainfall. Expected transmission capacities are satisfying, so both the import and transit of energy can be performed.

According to the experiences from March 2018, problems with downward regulation can occur in periods of intense inflows into hydro storages in the presence of strong wind.







Croatia: Summer review 2018

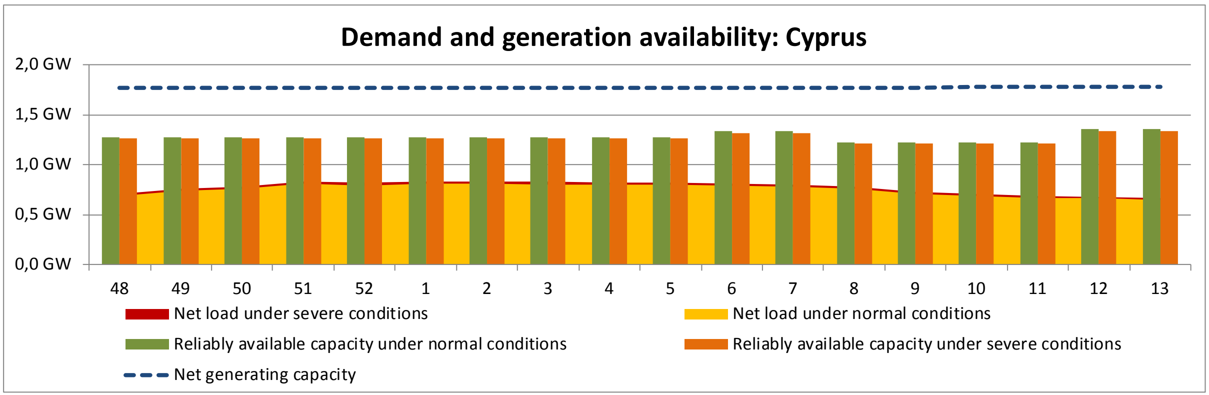
Although last summer was characterised by very high air temperatures, peak demand and consumed energy were slightly lower than in summer 2017. Croatia had to import significant amounts of energy, because of the lack of water in storages and the unavailability of many thermal units. Nevertheless, there were no substantial disturbances in supply. On 9 June 2018 a storm caused the south-eastern part of the transmission network to be out of operation and around 50 MWh of energy not to be supplied. The situation was normalized after half an hour by the re–switching of all network elements.

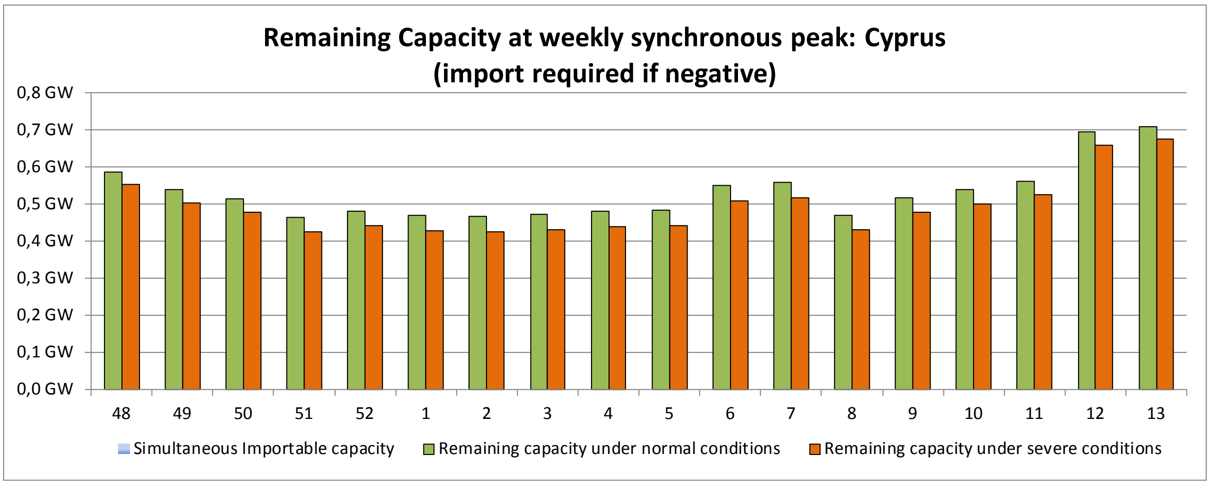
No downward regulation issues were identified during the past season.

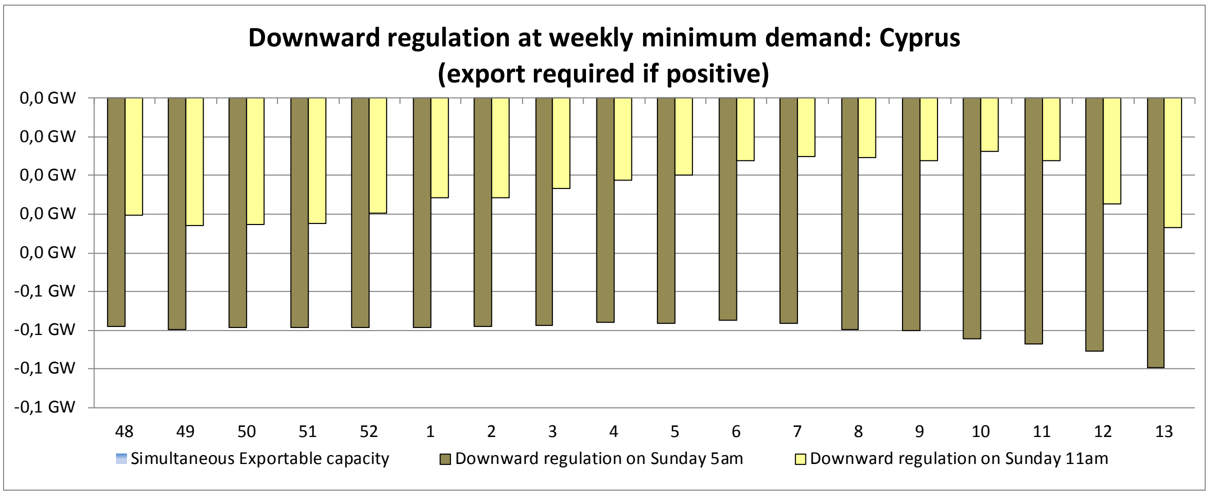
Cyprus: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







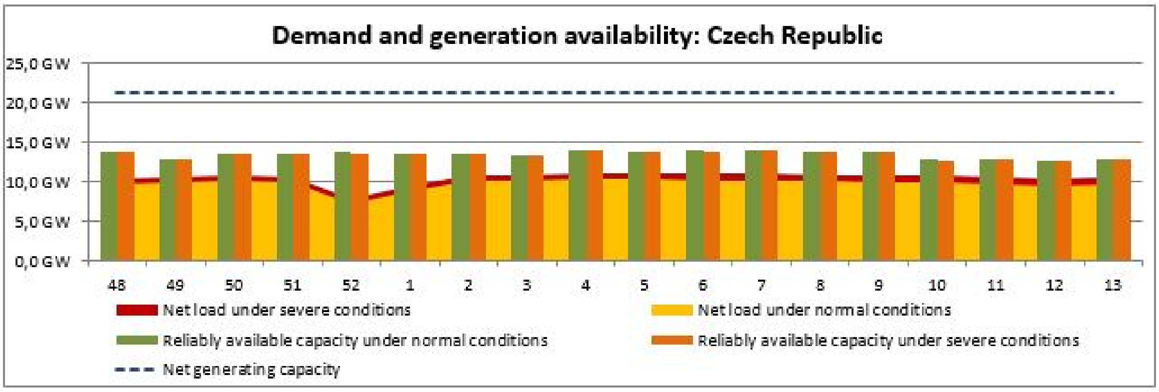
Cyprus: Summer review 2018

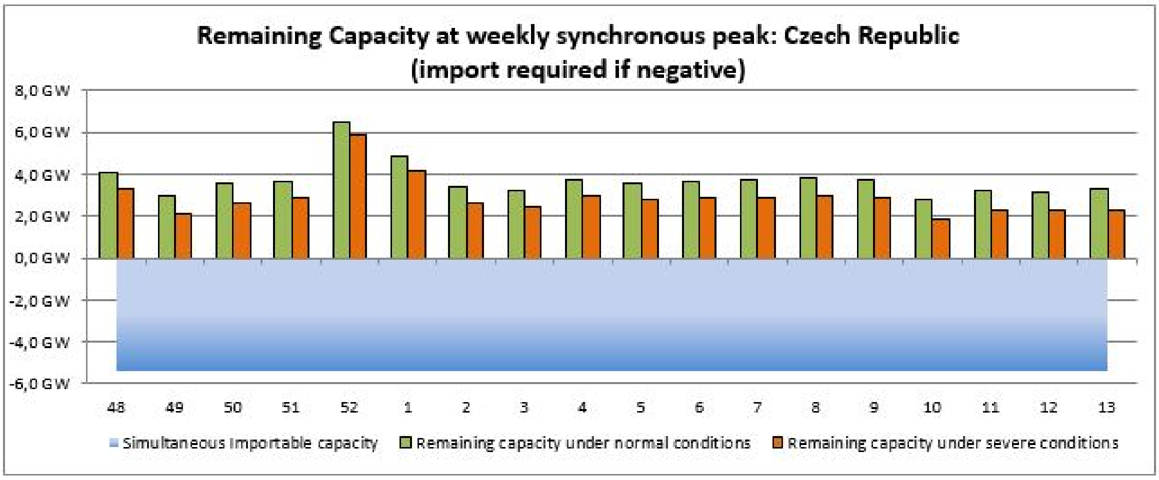
No adequacy or downward regulation issues were identified during the past season.

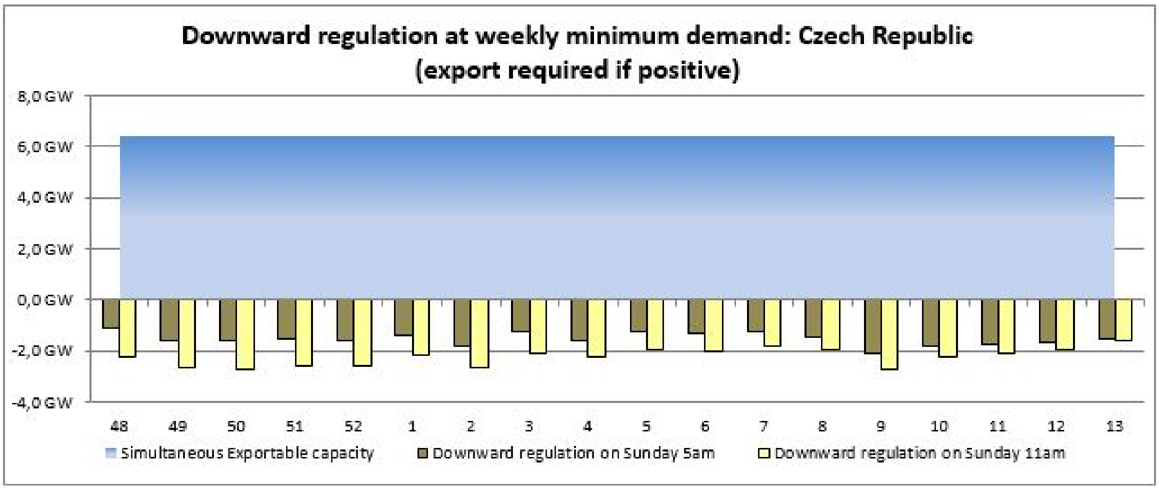
Czech Republic: Winter Outlook 2018/2019

CEPS (Czech Republic TSO) is not expecting any generation or system adequacy problems during the upcoming winter period. Compared to last winter, the interconnection capacity has been increased with Germany and Slovakia due to reinforcements of the transmission system.

Total NGC has not changed noticeably. There has only been a minor increase due to the commissioning of small plants and technological upgrades in some of the existing power plants.







Czech Republic: Summer review 2018

No significant adequacy or downward regulation issues were identified during the past season. The heat wave in July and August brought tropical temperatures well over 35°C and over 28°C on daily average. The average temperature was 2.4°C above normal during the season.

Some disruptions on TSO–DSO interfaces occurred due to DSO's distance protection system activations. One event occurred on 4 August, when protection on DSO's 110 kV line disconnected a TSO transformer and caused a 9-minute disruption, resulting in a total of 17 MWh of unsupplied energy.

Denmark: Winter Outlook 2018/2019

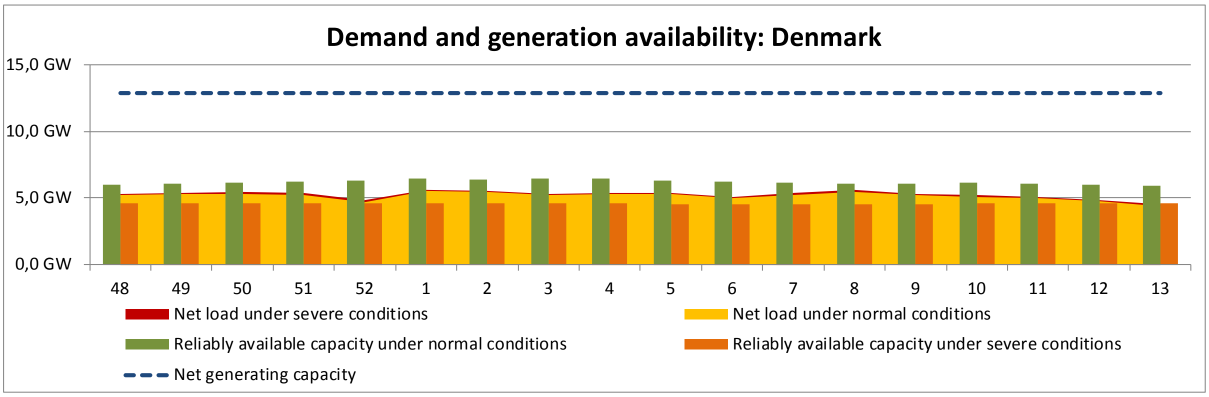
Potential critical periods and foreseen countermeasures

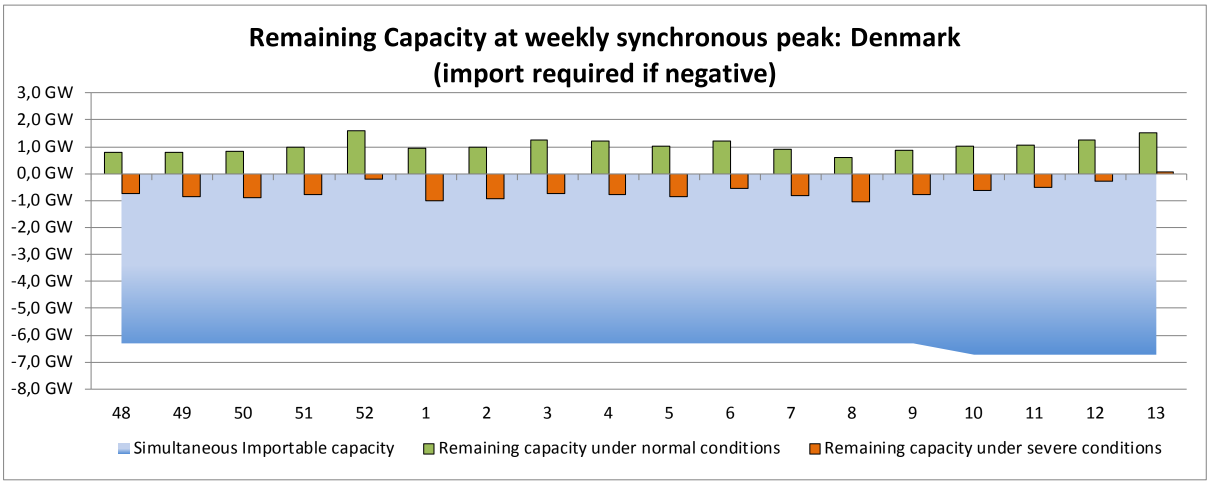
Energinet (TSO in Denmark) expects a stable winter. First, the generation availability is expected to be adequate. Expected outages, limitations on power plants and interconnectors are at a minimum. Second, Energinet does not expect problems with downward regulation. Normally, there is a large amount of downward regulation, especially when wind generation is high.

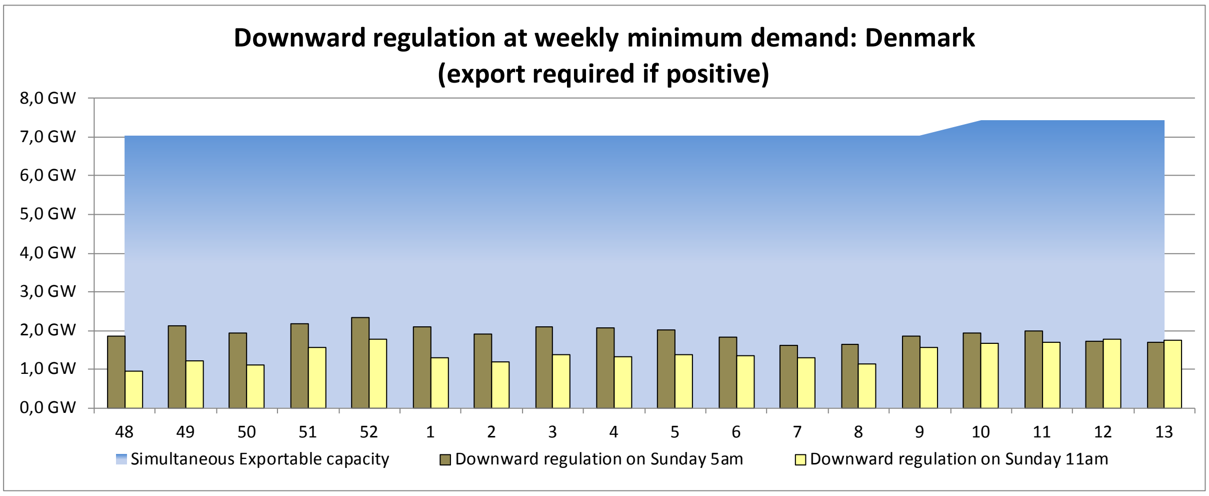
In periods with high wind generation, Energinet expects countertrade on the border between Western Denmark and Germany (DK1–DE). The reason for this is a simultaneous high amount of wind production in the northern part of Germany and Denmark.

The amount of countertrade on the DK1–DE border is expected to increase, especially in periods with a high amount of wind production, due to the joint declaration agreement between TenneT Germany (TTG) and Energinet. The agreement increases guaranteed cross–border capacity to the marked from 700 MW to 900 MW on 1 January 2019.

Energinet expects to down-regulate the countertraded amount in DK1 and/or DK2.







Denmark: Summer review 2018

The summer 2018 was characterized by a heat wave during May, June and July. The heat wave limited utilization of substations and lines due to the risk of overheating.

The transmission capacity between Denmark and the other Nordic countries was limited in some periods due to planned maintenance, failure and risk of overheating electricity network elements. In particular, the capacity between Eastern Denmark (DK2) and Sweden (SE4) was limited, decreasing the average available cross–border capacity to levels lower than in the last four summers.

The main reasons for the lower capacity were a combination of a failure on an interconnector, planned outage due to the installation of new interconnection cables and the risk of overheating. Another reason for the lower capacity is internal congestions along the West Coast line in Sweden. This has limited the transmission capacity from both Western Denmark to Sweden (DK1→SE3) and Eastern Denmark to Sweden (DK2→SE4) to a varying degree, thus resulting in low average available cross–border capacity.

The transmission capacity between DK2 and DE has been very limited due to a failure on the interconnector cable during maintenance on the German side.

Slightly over average cross–border capacity between DK1 and DE was recorded compared to recent years. Furthermore, countertrade energy amount increased by 134% in 2018 compared to 2017.

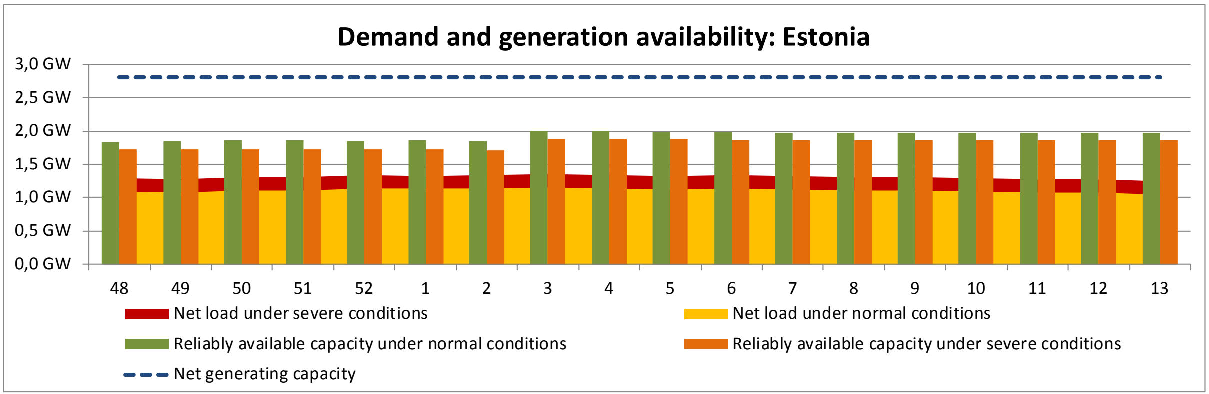
Higher than average electricity prices in Denmark were observed in the summer period compared to last year due to the combination of the weather conditions, high CO2 prices and import–export capacity limitations .

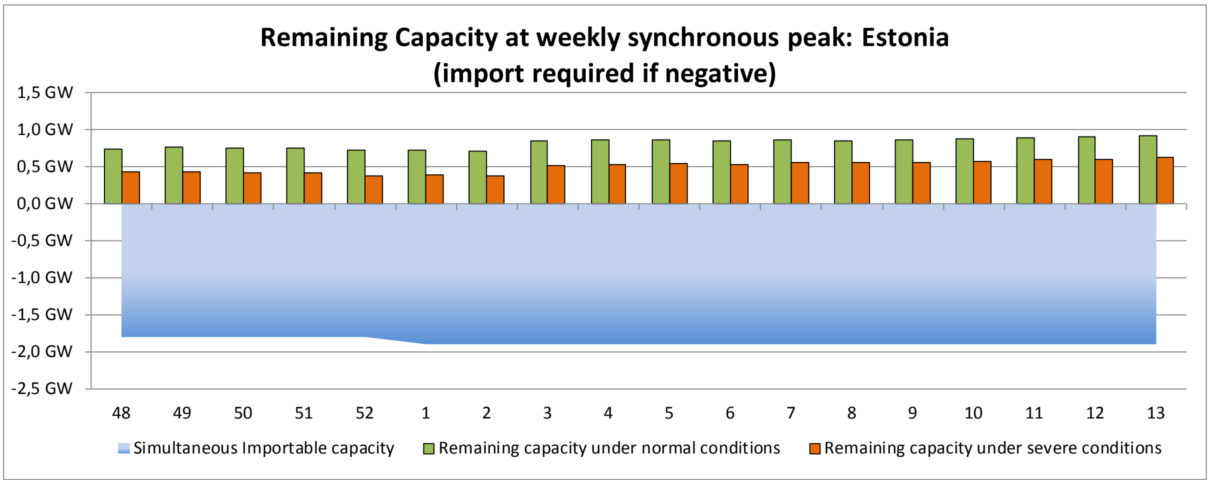
In July there was a major disturbance at the 400 kV substation Hovegaard in DK2. Fire in a component of the substation caused problems with the power balance in DK2 and led to the subsequent limitations of all interconnection capacities. The fire did not spread to other components and within a couple of hours normal operation was restored.

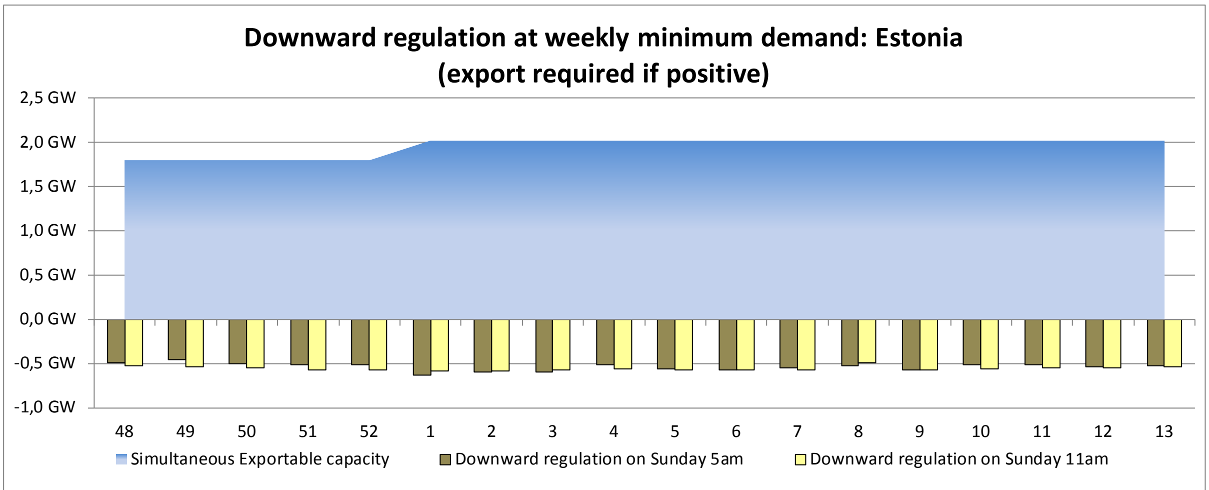
Estonia: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

The most critical period is considered to be the end of January and the beginning of February, weeks 4–6, when outdoor temperatures are lowest demand might increase most. Despite this, there is expected to be enough production capacity in the system, therefore no adequacy issues are foreseen for the upcoming winter. The maintenance schedule of the generation units are minimal.







Estonia: Summer review 2018

The average temperature of this summer season was 2.27°C higher and the precipitation was much lower than the many years' average. The prices in Estonia compared with last season were higher due to lower hydro availability in Nordics. However, no major disturbances occurred and no adequacy issues were identified in Estonia.

Finland: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

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

Compared to the previous winter, the situation has remained similar. Peak demand estimate under severe weather conditions is about 15.2 GW.

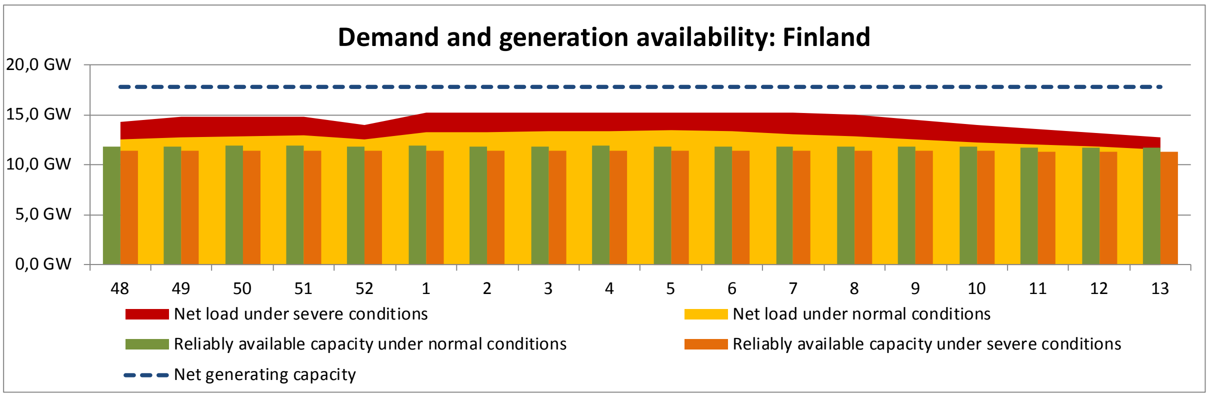
Available generation capacity without peak load reserve (Finnish strategic reserve) is expected to be the same, 11.3 GW, as in the previous winter. Wind power capacity has increased slightly but that has only a minor influence on the estimated available generation.

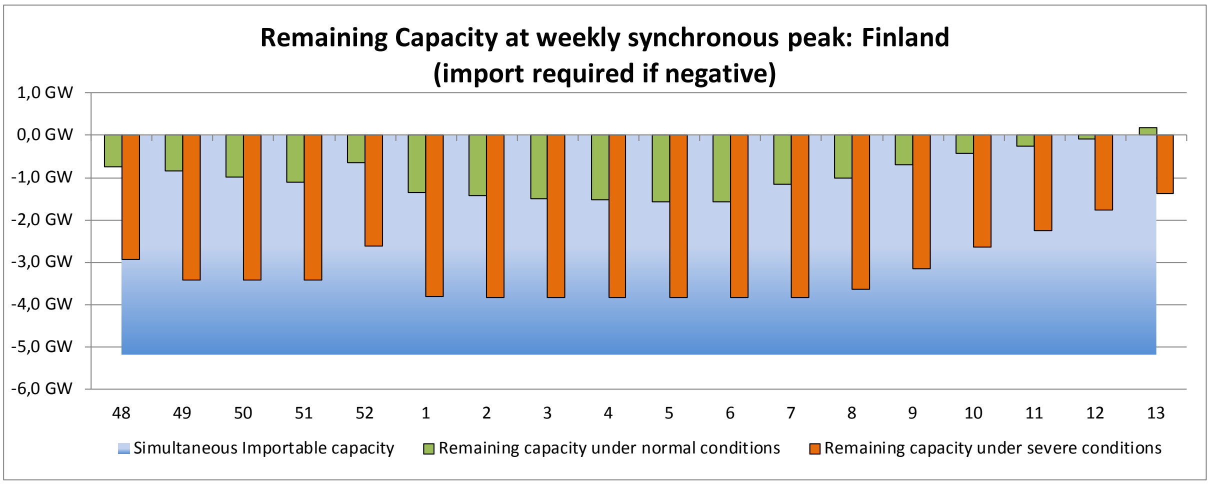
The 3.2 GW deficit is expected to be met with import from neighbouring areas. However, in the event of a major power plant or interconnection failure in a cold period, there is the risk of a power shortage.

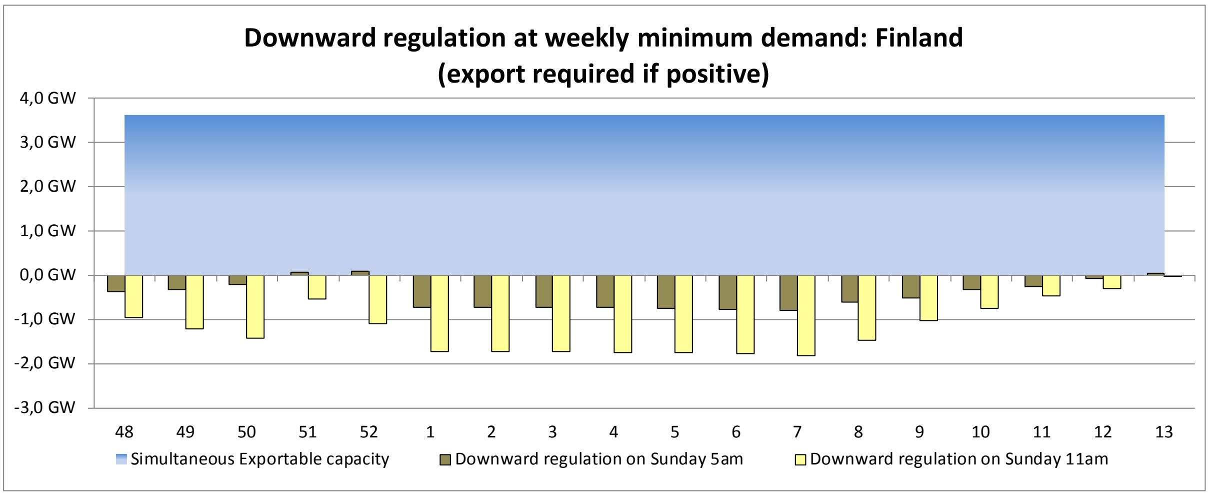
Import is needed to cover the demand during peak hours. The maximum deficit in severe conditions including strategic reserves is 3.2 GW from weeks one to seven. The import capacity on interconnections, 5.1 GW, is sufficient to meet the deficit.

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

In the coming winter during minimum demand and maximum wind conditions, there is the risk of oversupply situations where down-regulation or export is needed to balance the system.







Finland: Summer review 2018

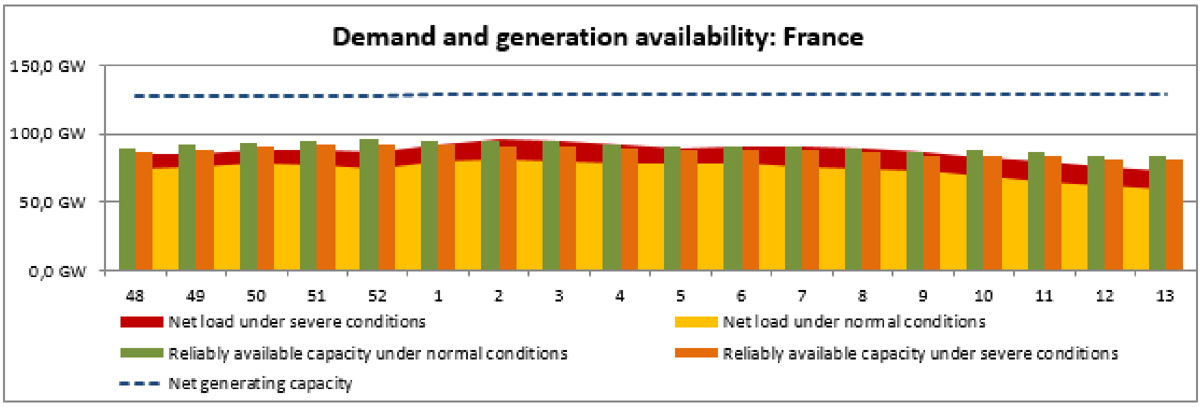
There was neither adequacy problems nor deviations from expectations during summer 2018.

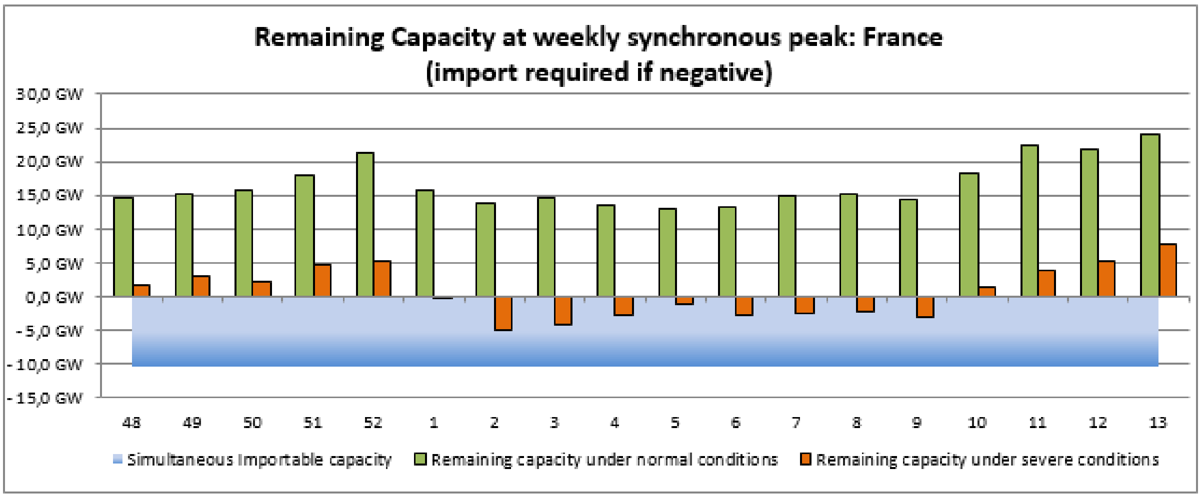
Several overhauls of both production units and transmission lines were carried out in summer time as planned. During these periods, system operation followed normal procedures.

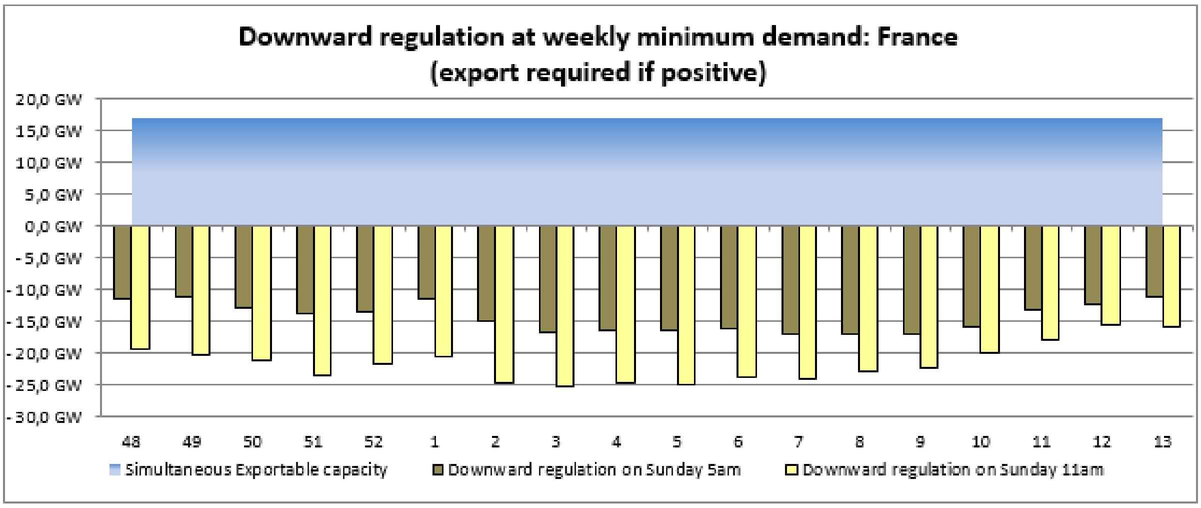
On 18 July, a current transformer explosion and fire at the substation resulted in the loss of the two biggest nuclear units in Finland. Due to the prognosis for power balance during the following morning, Fingrid declared a risk of power shortage. Up-regulation was activated and supportive power was bought from neighbouring areas. Regardless of the large deficit in generation capacity, the system state was maintained as normal during the incident.

France: Winter Outlook 2018/2019

This winter, France expects the situation to be quite similar to last year. The nuclear maintenance plan is in the average of the last 10 years, except from mid–January to mid–February where the availability is less favourable than last year. However, the margins are tighter than last winter, considering also the shutdown of the last fossil oil plant early 2018 (0.6 GW).

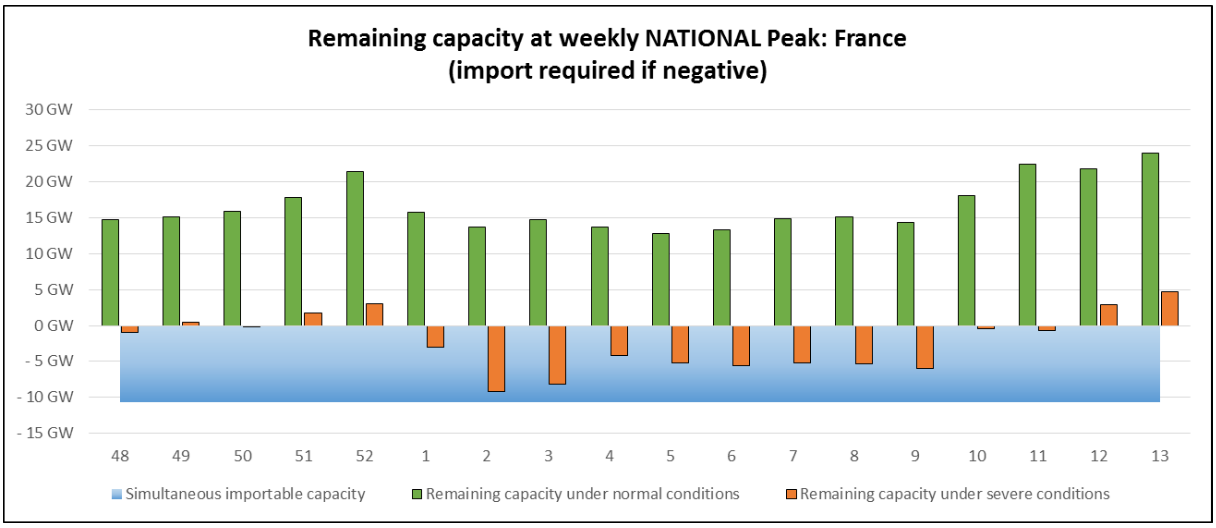






Potential critical periods and foreseen countermeasures

French adequacy greatly depends on weather conditions, as a drop of national temperature by -1°C can lead to an increase in demand by 2.4 GW. Under severe conditions (1–in–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 demand at pan–European synchronous peak time (19:00 CET). It should be borne in mind that under most severe conditions and due to the dependence on weather conditions, the French demand can be volatile within the same week. Daily 95th percentile value of national peak demand in France could reach 100.3 GW in week 2, which would raise the need of imports to 7.5 GW. Moreover, these minimal needs for imports will not fully meet the French requirements for upward margin. To fulfil these, the need for imports would reach 9 GW in week 2, as shown in the graph below.



As of now, the Belgian nuclear situation does not put France at risk regarding adequacy issues, considering that the plants would be back in operation in December.

France: Summer review 2018

General comments on past summer conditions

This summer has been the 2nd warmest since 1900, with several heat waves affecting the country. This led to higher consumptions in July and August compared to 2017.

Even though the precipitations were 10% under normal conditions, hydraulic generation increased significantly compared to last year (+47.9% in June and +24.1% in July and August). Solar generation increased compared to last summer, due to weather conditions, with a new record of 1438 GWh in July.

Nuclear generation increased compared to summer 2017, leading to a significant reduction of the fossil production. However, in August occasional nuclear generation limitations were necessary to respect environmental constraints, with no additional margin issues.

Overall, the net position of RTE has been oriented to exports over the summer.

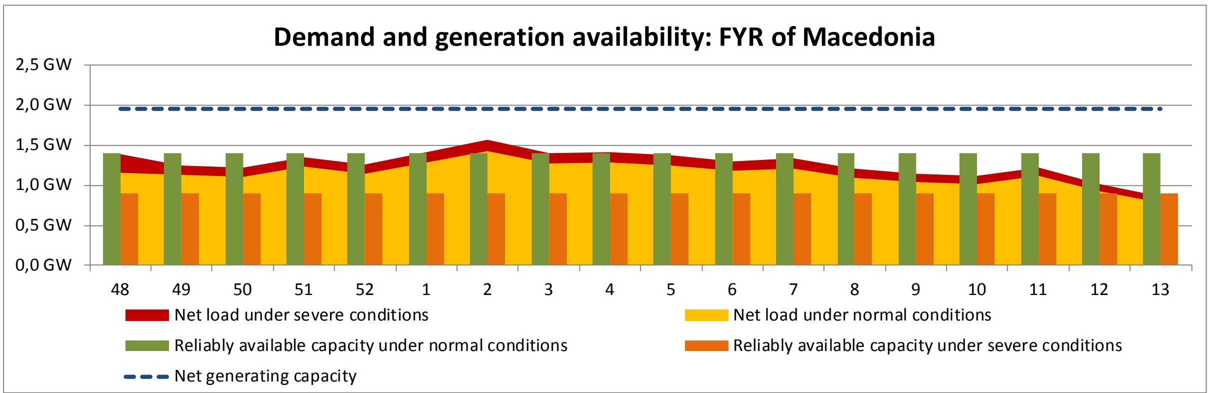
<u>Specific events and unexpected situations that occurred the past summer</u>

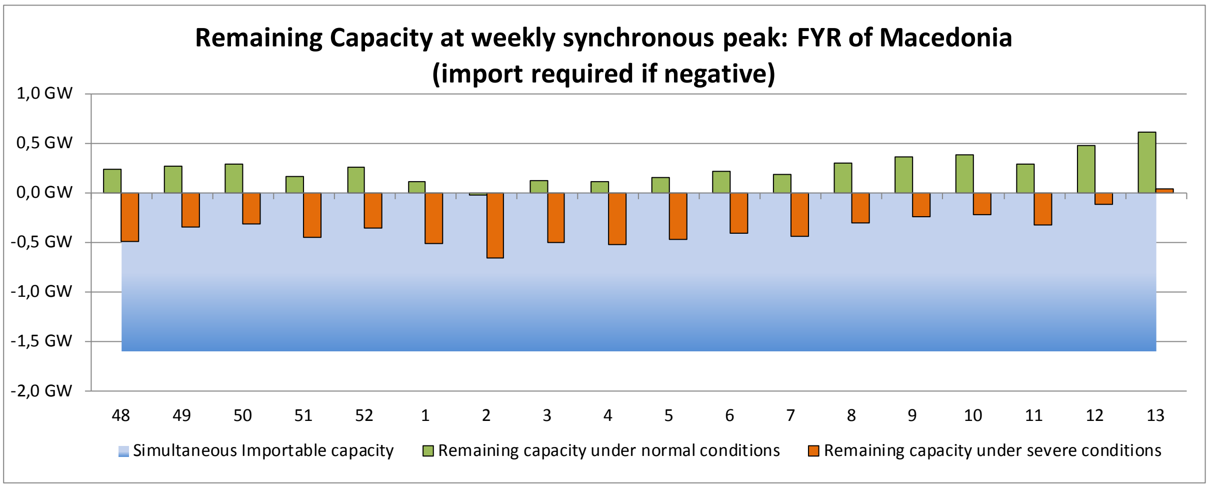
Several balancing mechanism’s warning alerts have been announced in the summer due to low downward regulation margin. A sufficient margin is necessary to balance the system in case of demand or generation contingency. This was mostly due to the low flexibility of production unit dispatched in the day-ahead market and some delays in flexible production unit maintenance.

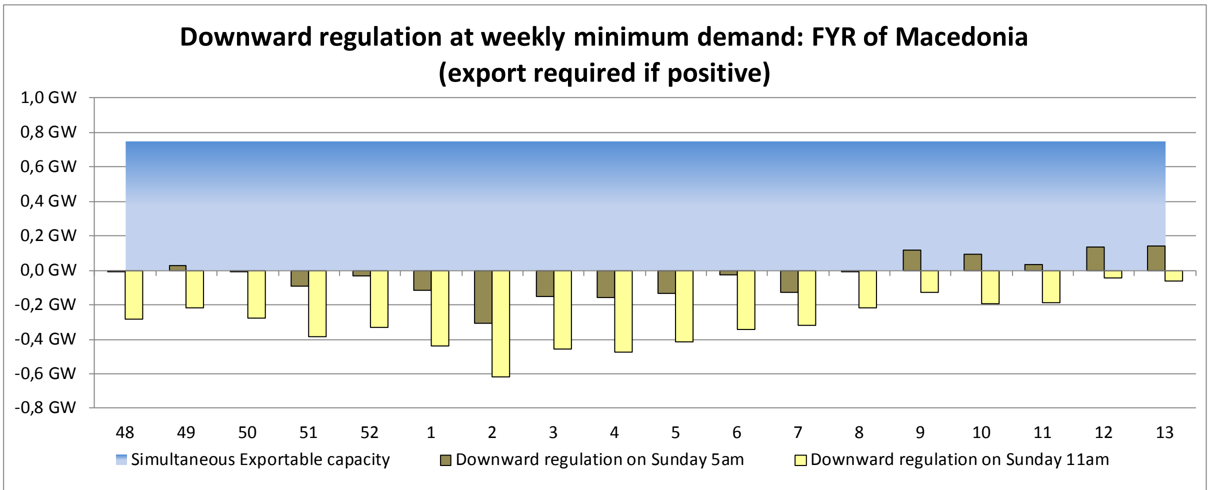
FYR of Macedonia: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

Expected available transmission capacity is sufficient to meet the needs for energy imports and exports for the coming winter. The maintenance schedule of the generation units are minimized. No problems in the transmission network are expected because all the maintenance work was finished during the summer period.







FYR of Macedonia: Summer review 2018

No significant unexpected events of local or regional character occurred during the summer period this year in the Macedonian Power System with . All scheduled maintenance and overhauls works were completed according to the plans. Interconnection was available during the whole period and the system did not face any difficulty with regards to NTC quantity, cross–border allocation or with market participants.

Germany: Winter Outlook 2018/2019

The balance between generation and demand is generally expected to be maintained during the winter period under normal conditions. Under severe conditions, adequacy could be dependent on imports and/or use of strategic reserves and out of the market demand side response.

A longer cold spell in combination with dry weather conditions and low water levels in rivers in southern Germany, as in winter 2016/2017, could limit the availability of remedial actions. This is especially relevant considering recorded dry summer and beginning of autumn this year after which water levels are relatively low in Neckar and Rhine rivers, which could affect coal supply to power plants.

The 'strategic reserves' in the data collection sheet contain:

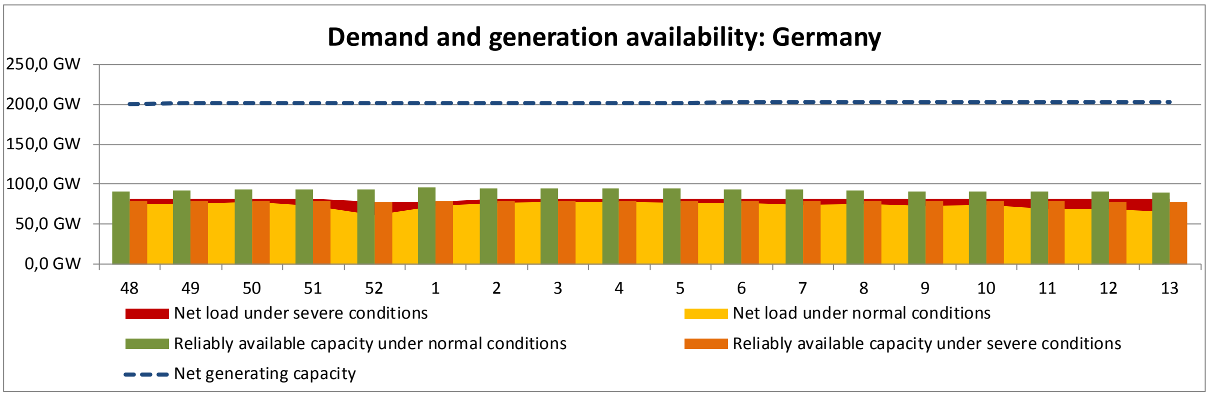
- Lignite units in stand–by ("Sicherheitsbereitschaft"): was set to achieve the climate protection targets. Lignite fired power plant blocks with a total capacity of 2.7 GW will go step by step to standby mode for backup purposes. 1.9 GW of this capacity are in this backup mode already. The lead time in which the power plants are completely available is 240 hours;
- Grid reserve: is used to resolve congestions and contains different types of power plants located in Germany;
- Out of the market Demand Side Response: with the Ordinance on Interruptible Load Agreements (AbLaV) interruptible demand can be obliged to take measures to maintain grid and system security. For the purpose of AbLaV, interruptible demand are defined as consumption units, which can reliably reduce their demand for a fixed capacity upon request by the German TSO. Currently, about 1 GW of interruptible demand are available.

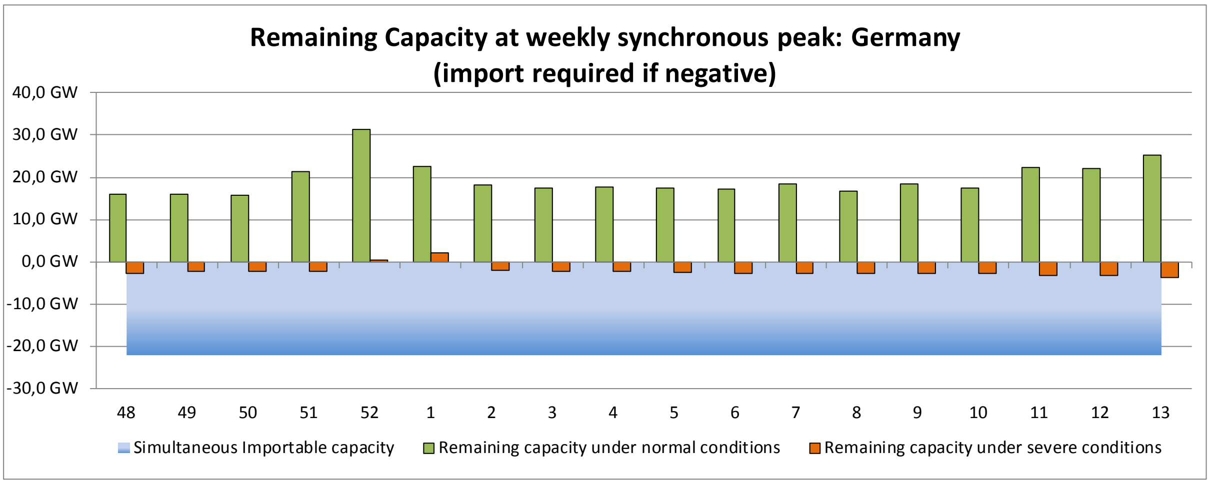
Most critical periods for maintaining adequacy margins and countermeasures

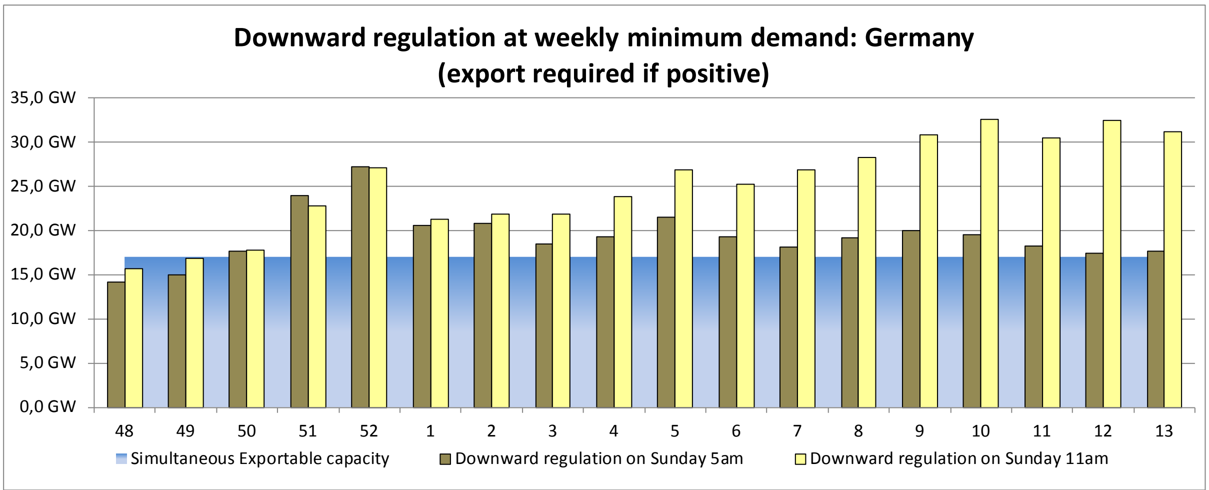
The period around Christmas and the turn of the year could potentially be critical due to a possible oversupply of the German control area. However, that was not the case in previous years due to the improved market behavior of the balancing responsible parties, but dedicated measures are available, if necessary. There are, for example, extended possibilities to reduce the wind power feed–in in such situations. In situations of high RES feed–in in the north and high demand in the south of Germany, the necessity of remedial actions to maintain (n–1)–security on internal lines and on interconnectors is expected. The introduction of a congestion management at the border between Germany and Austria on 1 October is expected to decrease the need for remedial actions with foreign countries.

Most critical periods for downward regulation and countermeasures

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 in order to mitigate any negative effects on the network. Therefore, no critical situations are expected.







Germany: Summer review 2018

General comments on past summer conditions

In this year´s summer there were no significant events concerning the system adequacy. According to the German weather forecast service ("Deutscher Wetterdienst", DWD), the months of July and August were again exceptionally warm paired with very low precipitation, which led to extreme drought. The average mean temperature in July was 20.2°C, which is 2.2°C more than the average of the years 1981 to 2010. The highest temperature was 38.0°C, the lowest temperature was 0.1°C.

Specific events and unexpected situations that occurred during the past summer

There were measures taken to maintain a permissible voltage level last summer, mainly on weekends and because of longer non–availabilities of fossil power plants in southern Germany.

The combination of exceptionally warm weather and low precipitation led to high temperatures of the rivers Rhine and Neckar. These critically high water temperatures caused the reduction of power infeed or even the unavailability of several power plants in southern Germany. Water temperature at some power plants stayed barely under the official limit. Reaching limit would have caused a shutdown of fossil power plants at the affected locations. To limit the effects a minimal set of power plants has been defined in southwestern Germany to maintain system security. This could have significantly reduced the redispatch potential in southern Germany. Thus, the warm river water posed a risk but did not lead to adequacy problems during the summer.

Great Britain: Winter Outlook 2018/2019

General comments and specific assumptions

The National Grid (NG–TSO in Great Britain) expects the supply margins in winter to be comfortable and higher than last year. Generation capacity, connected to the transmission system, is 70.3 GW, which is similar to last year, while NG expects lower demand under the same conditions.

The demand under normal conditions is 30 years average. The demand under severe conditions is 1 in 20 figure. Customer Demand Management (CDM – Demand Side Management in Great Britain) is expected to be available under severe conditions.

The forced outage rate under normal conditions is the average of the last 3 years. Under severe conditions, it corresponds to the highest value of the last 3 years.

Most critical periods for maintaining adequacy margins and countermeasures

Under normal conditions, the highest demand is 47.5 GW in week 50 (12 December 2018). In week 50, the corresponding remaining capacity is 7.8 GW, the lowest forecast surplus for winter 2018/2019. However, it is expected that even this week, GB will still be able to export via the interconnectors under normal conditions.

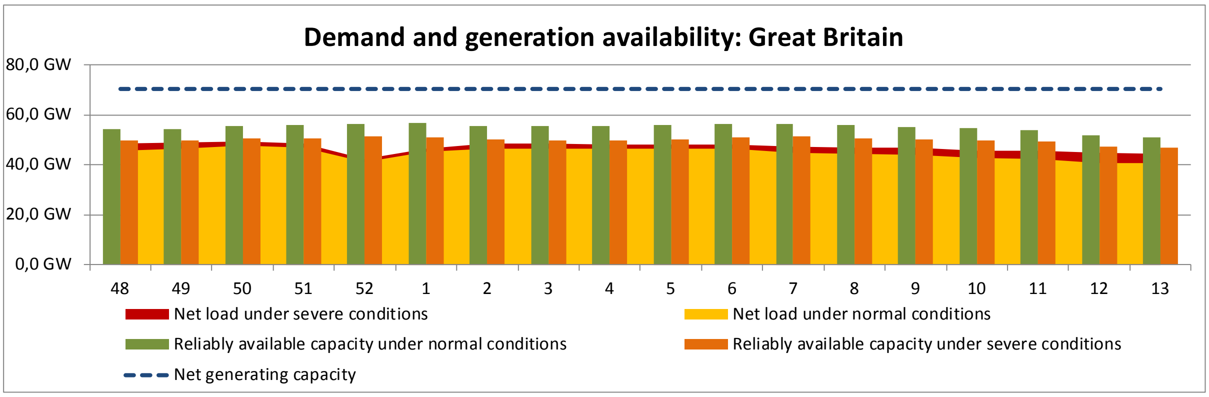
Under severe conditions, the highest demand estimate is 49.20 GW in week 50 (12 December 2018). The corresponding remaining capacity is 1.2 GW. However, the lowest remaining capacity (0.8 GW) is expected in week 49 (5 December 2018). Nevertheless, some exports via the interconnectors could be still be accommodated.

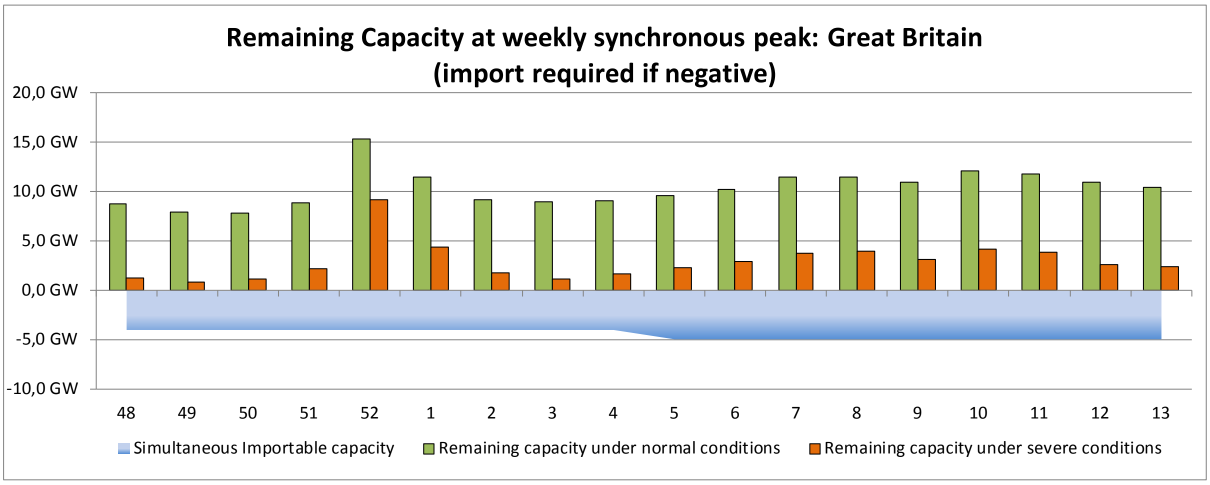
There is no planned maintenance on the interconnectors throughout the winter.

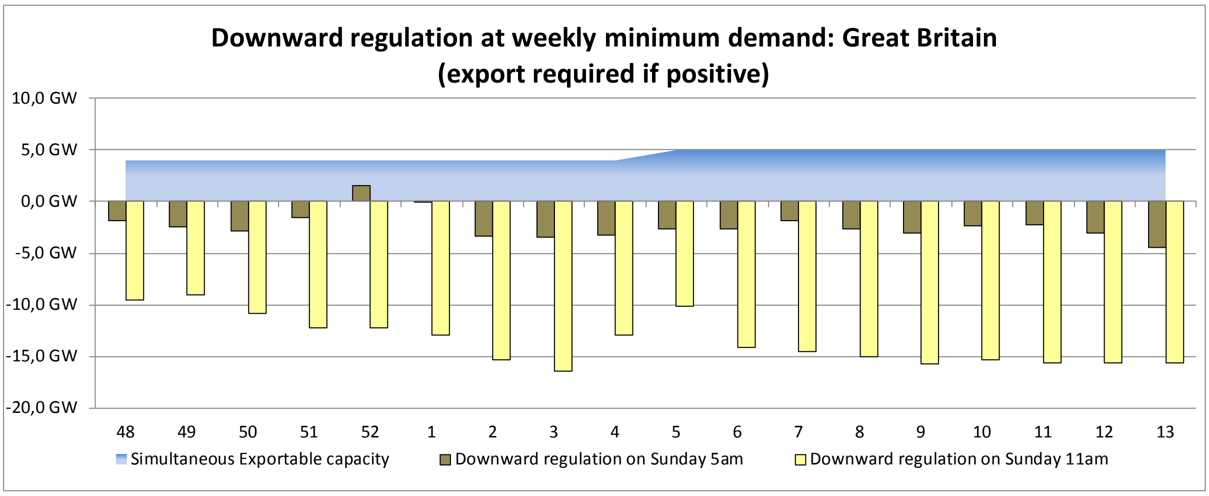
Most critical periods for downward regulation and countermeasures

The highest lack of national downward regulation capabilities at night is 1.5 GW in week 52 (30 December 2018). This is expected due to the low demand around the Christmas holiday which could barely reach 20.8 GW. Some action may be required on the flexible wind generators if exports are not sufficient.

At daytime, no downward regulation issues could be expected. The lowest downward regulation capabilities reach 9.0 GW in week 49 (9 December 2018).







Great Britain: Summer review 2018

<u>General comments on 2018 summer conditions</u>

Margins during the summer were comfortable and manageable. Summer 2018 in GB was much warmer, drier and sunnier than normal.

Specific events and unexpected situations that occurred during the last summer

The Deeside Power Gas generator (500 MW) was decommissioned. No new conventional generation was commissioned during the summer.

There were several planned outages on the French interconnector: Bipole 1 (18 June–29 June) and Bipole 2 (3 September–14 September). There were also planned outages on Britned interconnector: Pole (14 May–16 May), Bipole (17 September–19 September).

The lowest system demand was 15.8 GW on 29 June 2018 at 5:30. The lowest daytime demand was 19.0 GW on 28 June 2018 at 14:30.

The highest PV generation was 9.4 GW on 30 June 2018.

No EMNs (Electricity Margin Notices) or CMNs (Capacity Market Notices) were issued. However, some localised NRAPMs (Negative Margin Notices) were issued in GB.

Greece: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.

The most critical period during winter is the 2nd half of December and January. Heavy snowfall events and decreased temperatures can lead to an increase in system demand. Moderate imports are needed to meet our operating criteria under normal conditions.

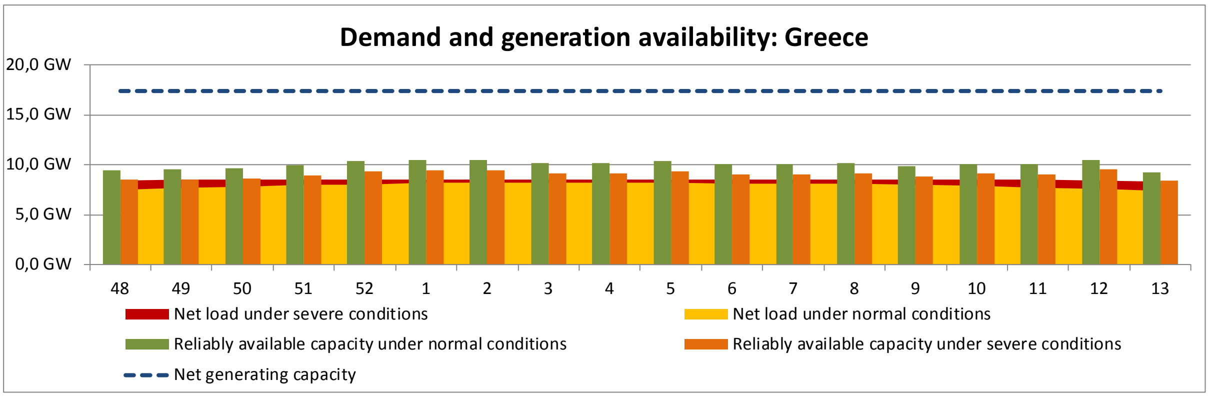
The role of interconnectors is currently important for generation adequacy, mainly in the cases of the gas supply problems. For those situations, there is the possibility of using bi–fuel operation as an alternative fuel (diesel).

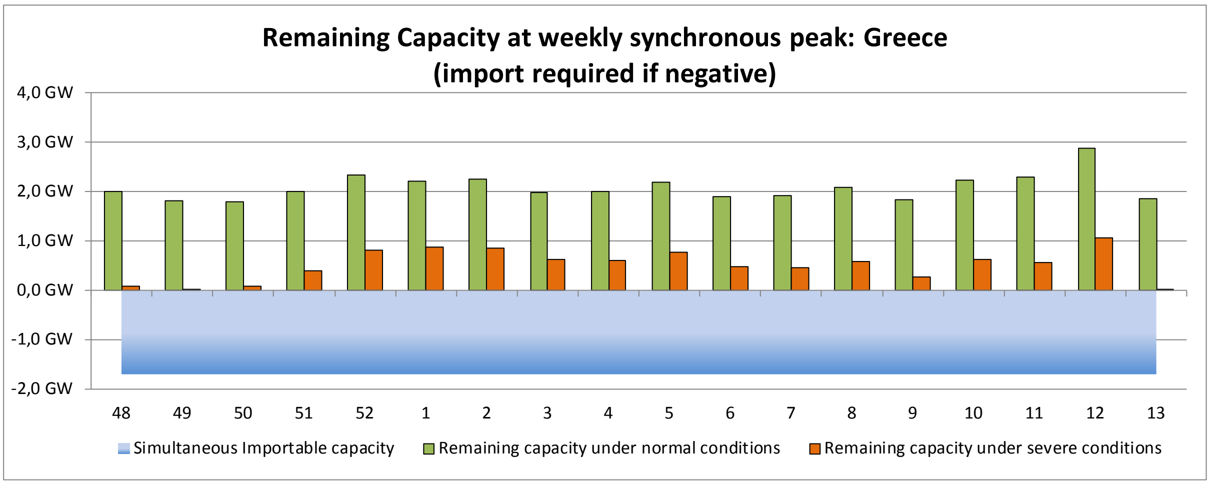
The most critical periods for downward regulating capacity are usually from 00:00 to 06:00, mainly on weekend days.

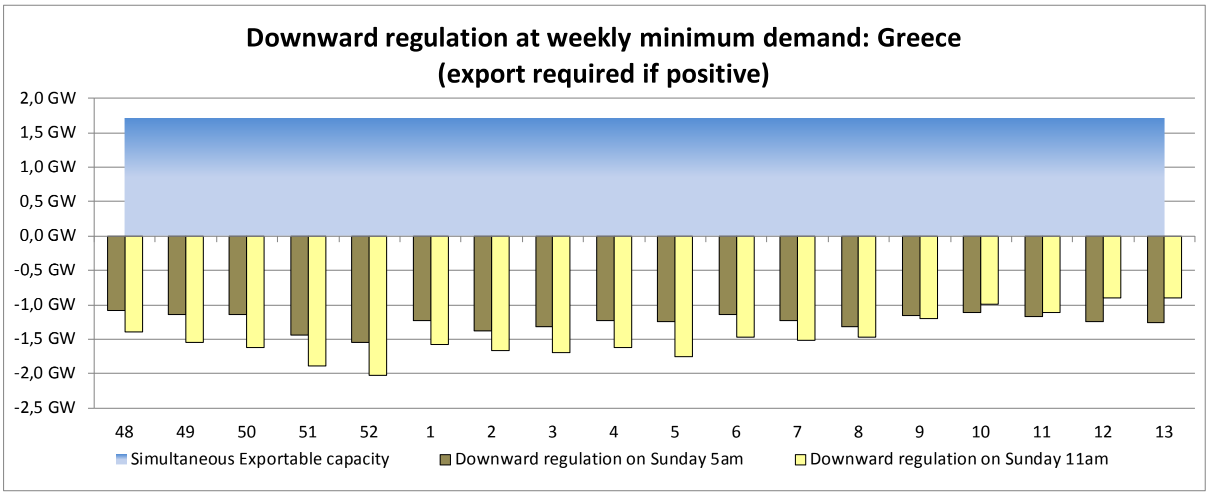
The countermeasures adopted are:

- Request of sufficient secondary downward reserve.
- Use of Pump Units.

The interconnectors are not being used for reserve exchange.







Greece: Summer review 2018

No adequacy or downward regulation issues were identified during the past season.

During last summer, there were normal climatic conditions without any extreme events and the temperature ranged between the normal levels for the season.

A new generation unit was registered on the Generation Units Registry with nominal production of 500 MW.

Hydro generation were moderate during the summer.

During the summer, some fire incidents occurred, affecting the transmission capacity. On 22 August 2018, an incident occurred in the EHV substation of Pallini, on the 150 kV area (3–phase short circuit). The consequence of the incident were a disconnection of the consumers for 55 minutes. Estimated energy not supplied is 300 MWh.

In March 2018, the islands of Cyclades were connected to the Greek continental system.

Hungary: Winter Outlook 2018/2019

Despite the growing uncertainty on both the generation and demand side, as a result of market development on the one hand, and the promotion of intermitted generation on the other, the Hungarian power system does not expect adequacy issues for the coming winter. However, there are a few risks that must be carefully managed by the TSO. These risks are:

- Based on the experience of previous winter periods, there is a possibility that the generating units may have difficulties due to the extreme cold temperatures. Mainly, the frozen solid fuel could cause problem in coal fired systems. In extreme conditions, this can even cause 1000 MW capacity outage;
- Hungary usually imports electricity between 2 and 3 GW at daily peak demand. The major part of this import is necessary to guarantee system adequacy under normal and severe conditions. 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 PV generation in the Hungarian system cause higher uncertainty in operational planning periods and real time system operation. The NGC of PV may exceed 1 GW in the first part of 2019;
- The Hungarian electricity system is significantly dependent on the gas imports. In the event the gas supply wanes or terminates, then the operation of gas–fired power plants could become unpredictable, which in extreme conditions can cause up to 3000 MW capacity unavailability. In such a scenario, available electricity imports from Ukraine are expected to decrease as well due to gas shortages in the region. The unavailability of the needed capacity in this rate for a relatively long period of time cannot be compensated by domestic sources nor by additional import. In the event 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 a further decrease of imports as a consequence of available capacity limitation in the gas–fired power plants of the adjacent electricity systems.

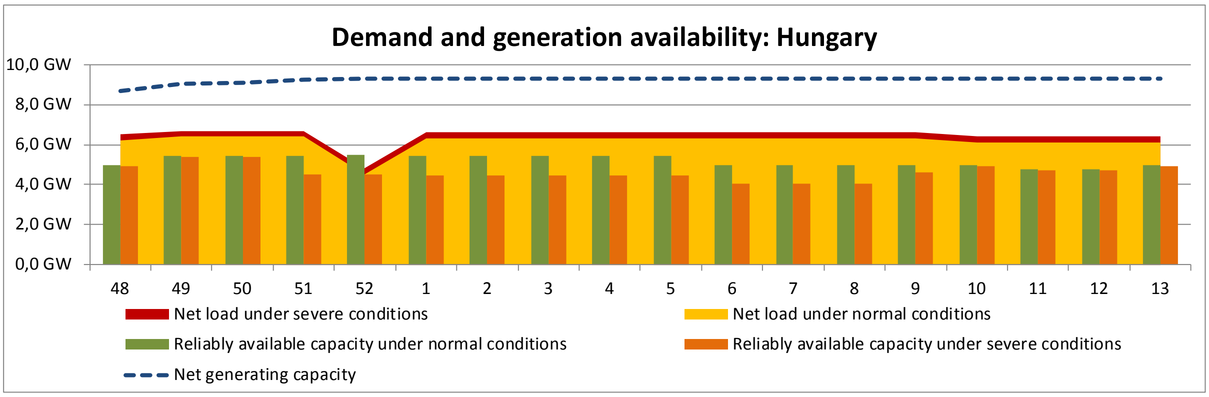
Most critical periods for maintaining adequacy margins and countermeasures

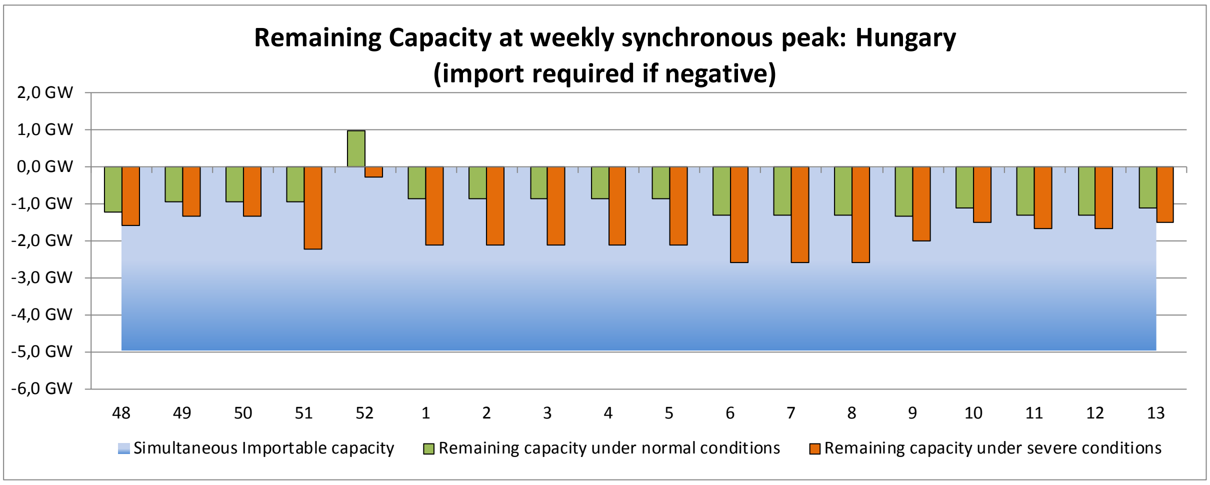
Maintenance during the winter period is very low, owing to performed and planned maintenance outside of the high demand period of the year. The highest capacity under maintenance is about 690 MW from 13 March to 22 March.

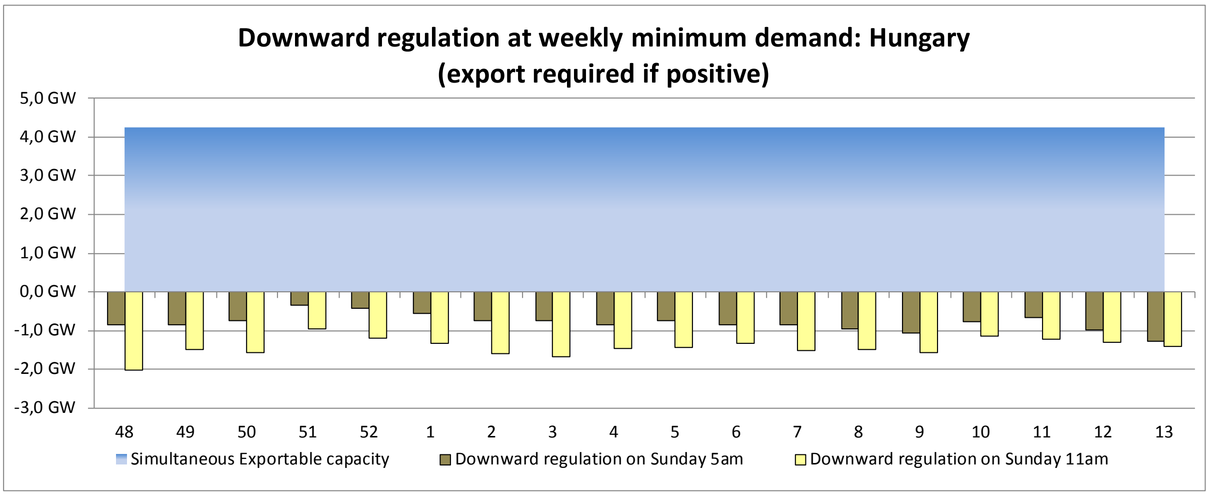
Most critical periods for downward regulation and countermeasures

In the Hungarian electric power system, the required adequacy margin can be guaranteed only by a considerable amount of imports. Several years are necessary to overcome this historical feature, as a result of missing competitive and flexible generation units.

The most critical periods for downward regulation would be during the holiday period 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 2018

General comments on 2018 summer conditions

Summer temperature of 2018 was similar to the latest years. Therefore, no major change in the system peak demand was recorded. However, there was an increase of energy demand. Outages of generators were rather low. The grid was reliable.

Specific events and unexpected situations that occurred during the last summer

In August, the recorded demand was higher than expected, because the average temperature was higher than normal in this month.

The peak demand in summer was almost the same as last summer (6358 MW and 6357 MW respectively).

There were no significant generation outages. The only outages were between 50 and 700 MW.

Iceland: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.

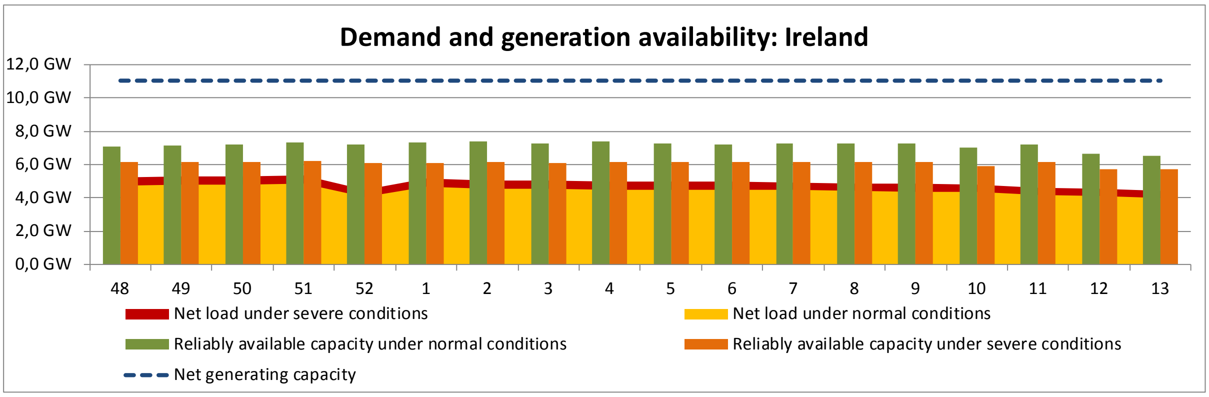
Iceland: Summer review 2018

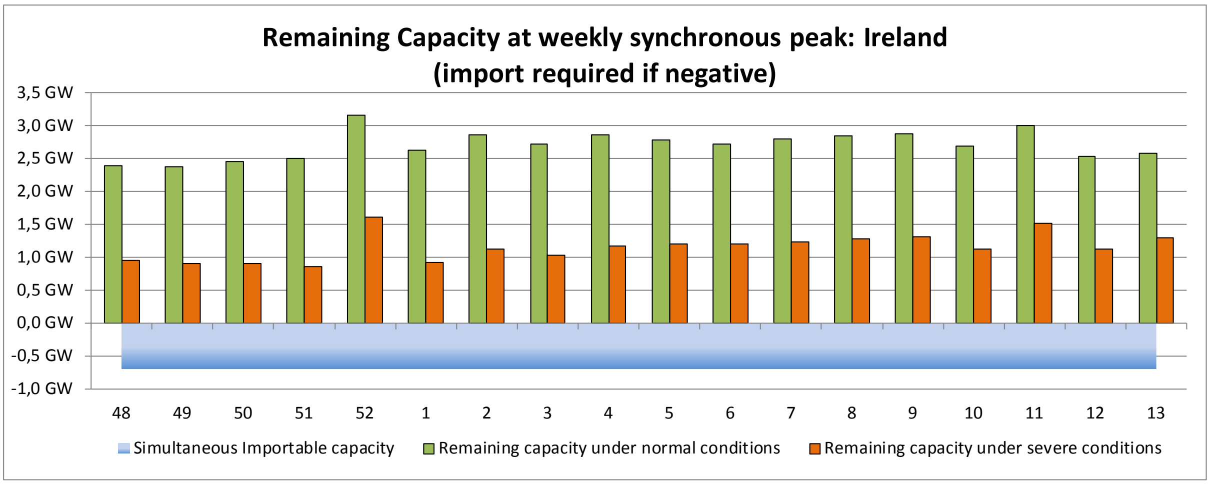
No adequacy or downward regulation issues were identified during the past season.

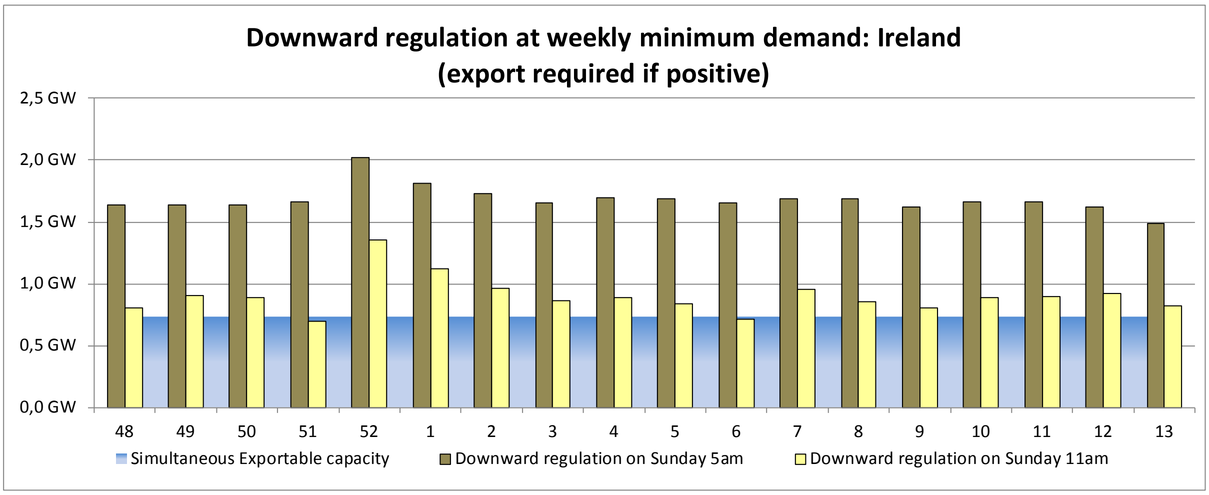
Ireland: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

Adequate generating capacity is expected for the coming winter period.







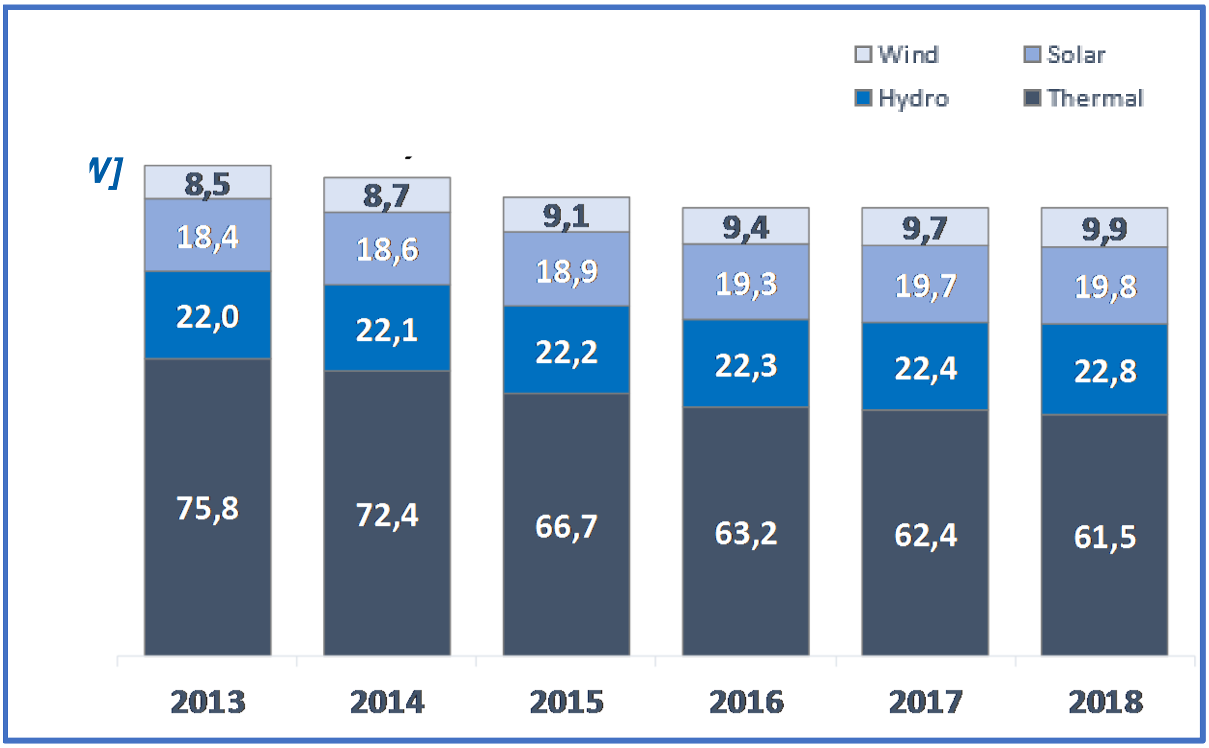
Ireland: Summer review 2018

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

There were no specific events or unexpected situations. The security of supply was maintained throughout the summer period.

Italy: Winter Outlook 2018/2019

In recent years, the Italian Power System has faced a significant reduction of the conventional (thermoelectric[19]) power fleet. The growth of variable (e.g. wind and PV) generation, together with an average demand decrease, is putting commercial pressure on traditional generators, leading to the decommissioning of several power plants. Between 2013 and 2018, the following phenomena affected the power system operation and adequacy in Italy: about 15 GW installed generation was phased out. The total amount of available capacity in the market conventional power plants fell from 76 GW down to 61.5 GW and an additional 3.1 GW conventional power capacity is not available due to environmental issues and other constraints. This trend can be observed in the figure below. This phenomenon affects the power system adequacy in Italy and some important warning signals in terms of adequacy were already registered in the past in particular during summer 2015 and winter 2016/2017.



Grid reinforcements, developed by the Terna (Italian TSO) in recent years, helped to smooth out some effects caused by the power plants' decommissioning (especially in the main islands).

[19] *Including geothermal, biomass and bioenergy power plants*

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 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 weeks 3–9, while internal grid constraints still limits the full transfer of the excess of capacity from the Southern Italy to the North, available import from neighbouring countries could become unable to cover the needs of this Northern area due to a wide–spread scarcity situation in Europe. Hence, for the next winter, relevant risks for the Italian power system's adequacy are expected in the case of severe conditions.

High renewables production (wind and solar) during low demand 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. Southern Italy, Sicily and Sardinia).

Concerning the external risk of 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.

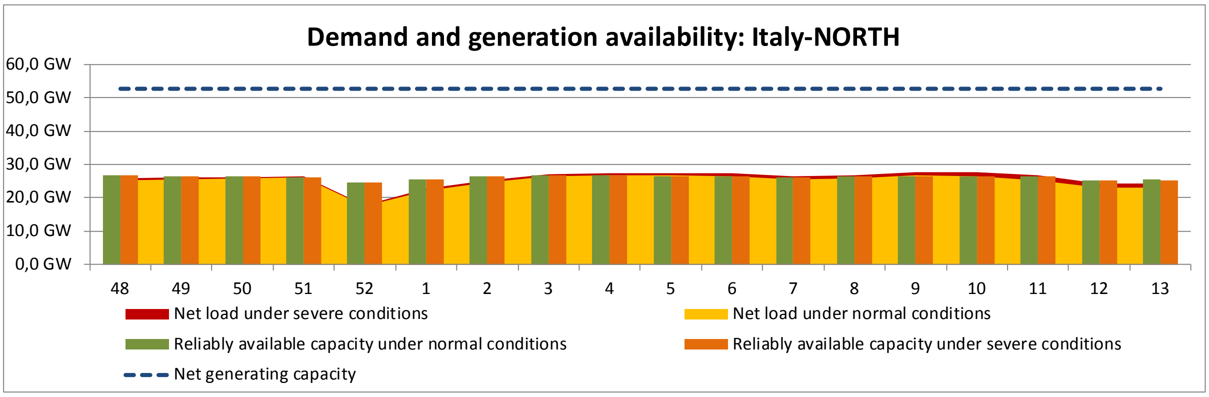
Under severe conditions, the situation for the winter 2018/2019 could lead to the need of imports for several weeks from December until end of February.

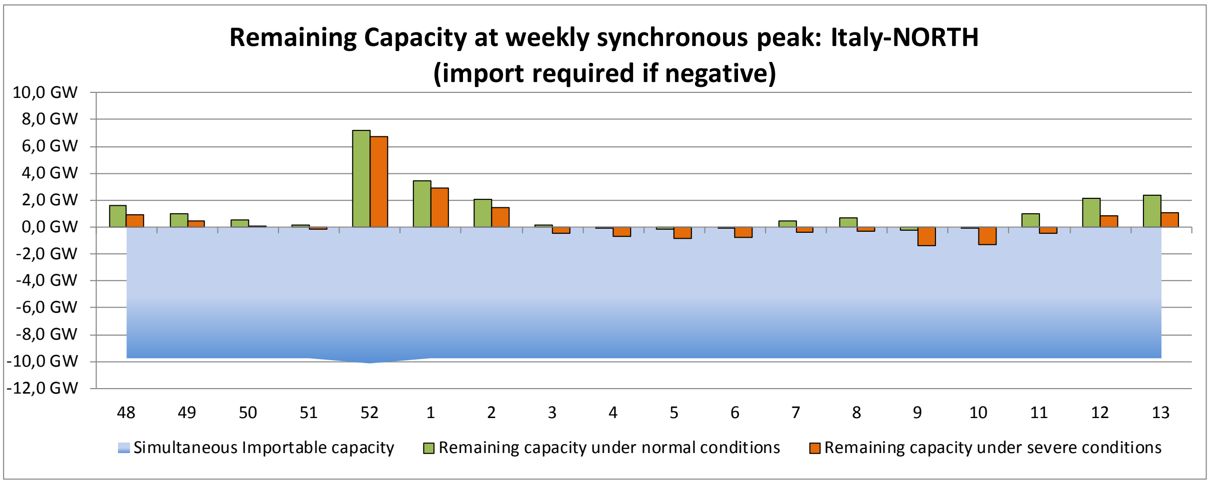
An appropriated planning (and coordination) of planned grid and generation outages has been performed, but in case of need, postponement and/or cancellation of maintenance could be needed.

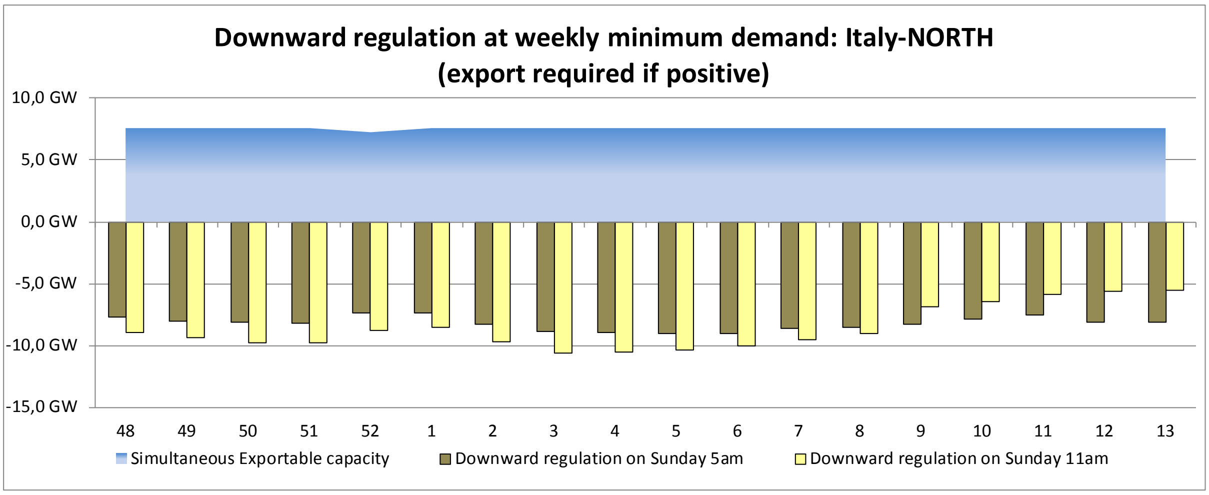
Improved regional coordination processes (including regional weekly adequacy assessment–SMTA project) will support the definition of proper and efficient counter–measures in the event the risk of incurring in critical situations is detected in the short-term.

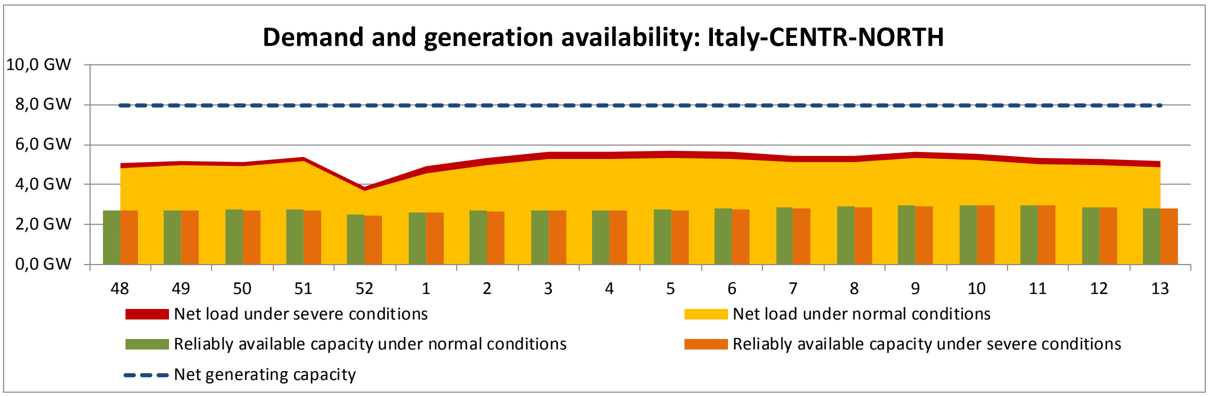
Most critical periods for downward regulation and counter-measures

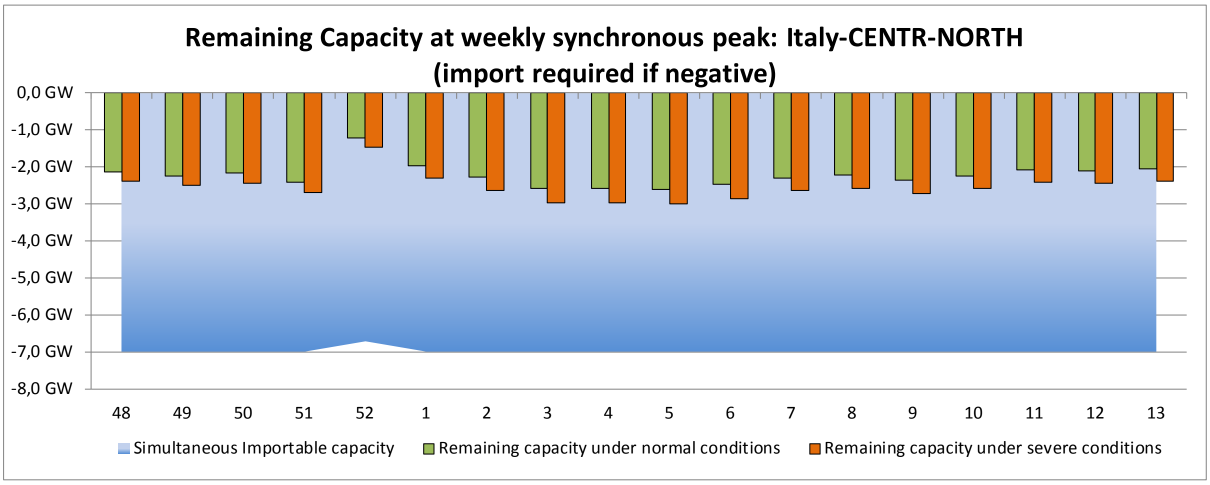
The worst week for downward regulation is expected to be the week of Christmas. To cope with this risk, the Terna prepared preliminary action and emergency plans and, in case of need, will adopt the appropriate counter–measures. To guarantee system security, Terna could adopt enhanced coordination with 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.

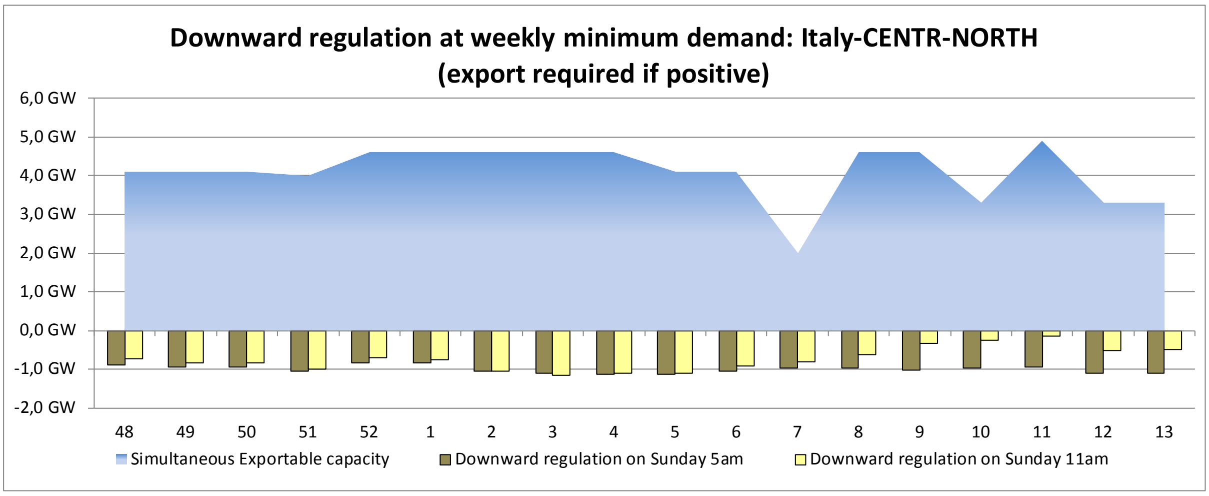


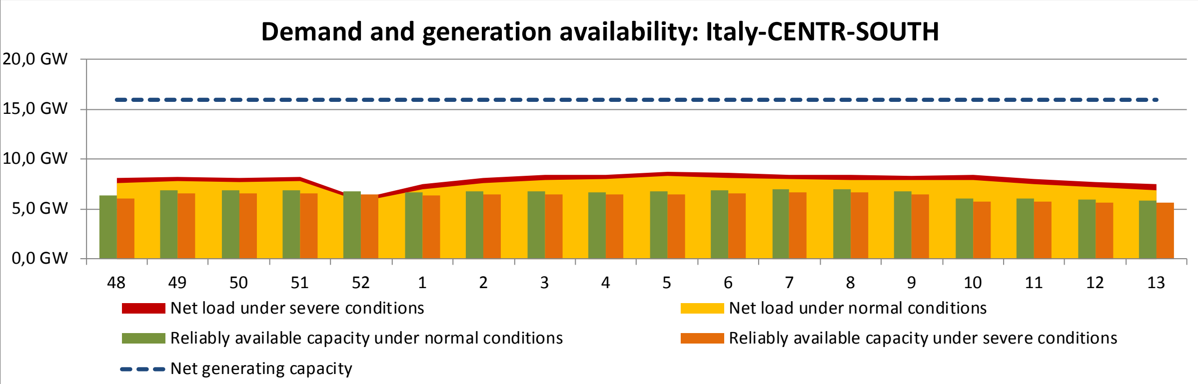


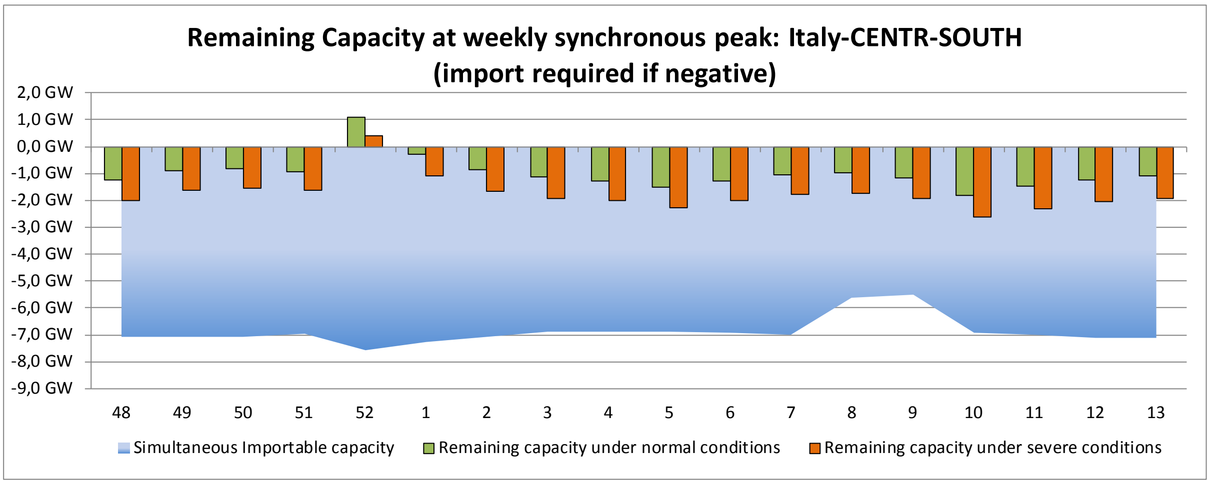


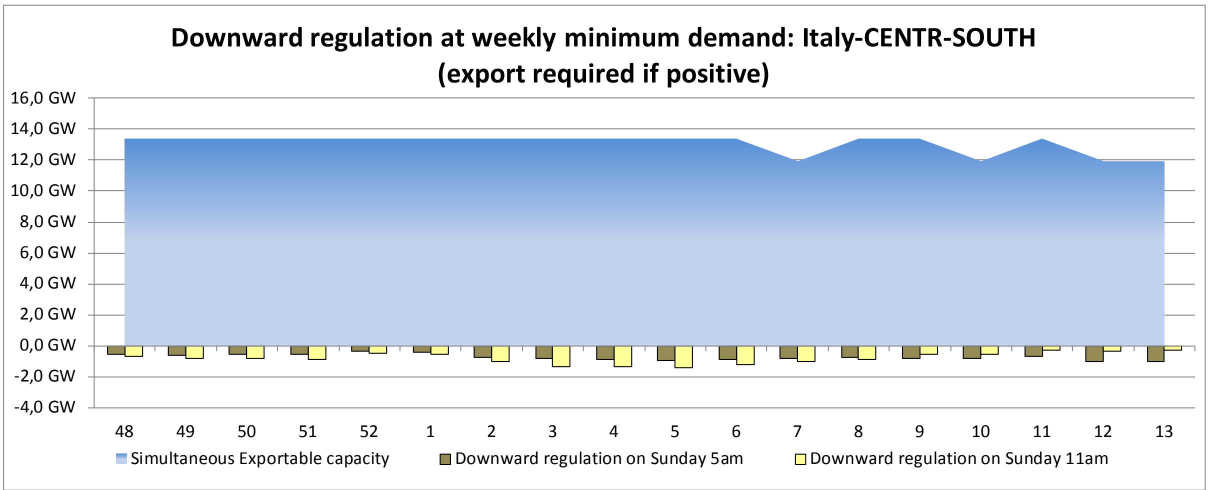

Demand and generation availability: Italy-CENTR-NORTH
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

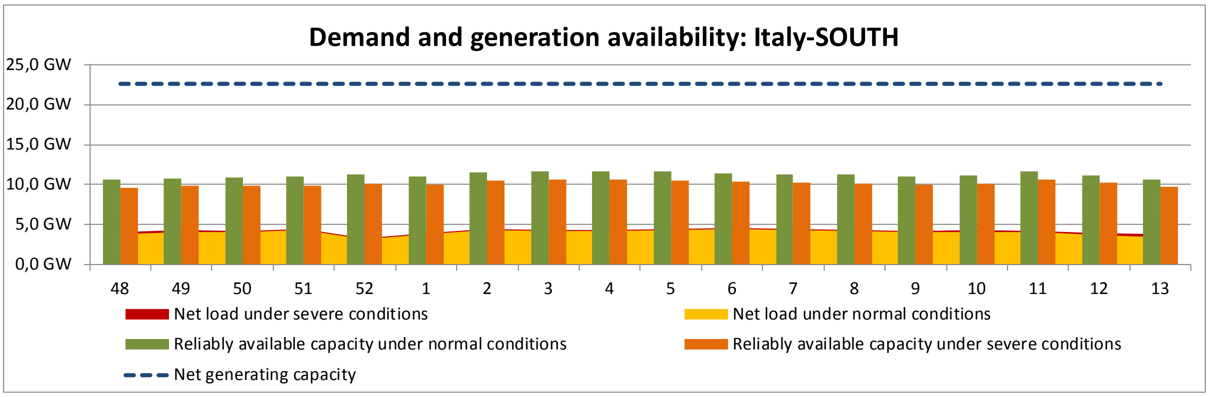

Remaining Capacity at weekly synchronous peak: Italy-CENTR-NORTH
(import required if negative)
0,0 GW
-1,0 GW
-2,0 GW
-3,0 GW
-4,0 GW
-5,0 GW
-6,0 GW
-7,0 GW
-8,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

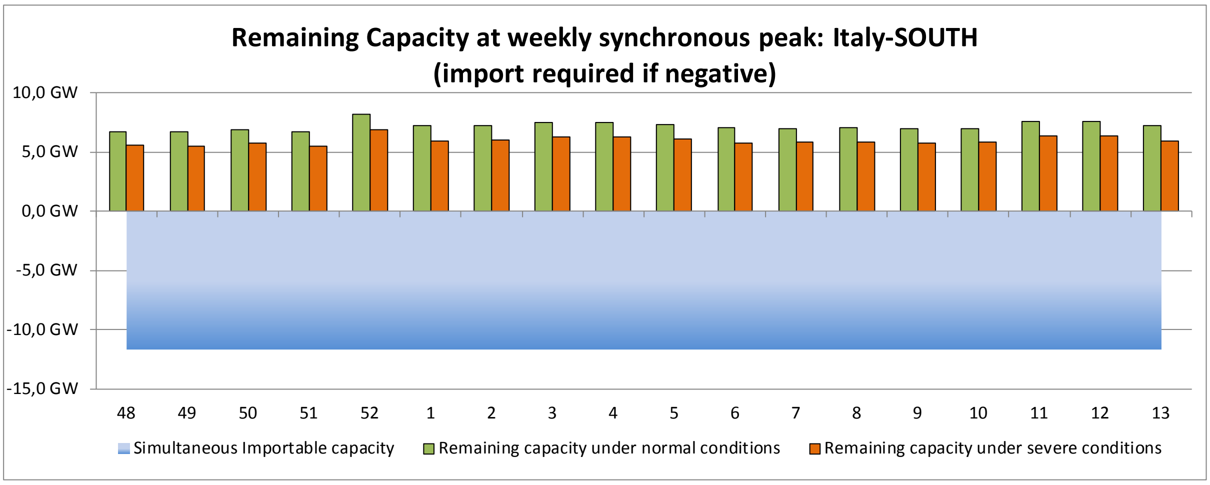

Downward regulation at weekly minimum demand: Italy-CENTR-NORTH
(export required if positive)
6,0 GW
5,0 GW
4,0 GW
3,0 GW
2,0 GW
1,0 GW
0,0 GW
-1,0 GW
-2,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

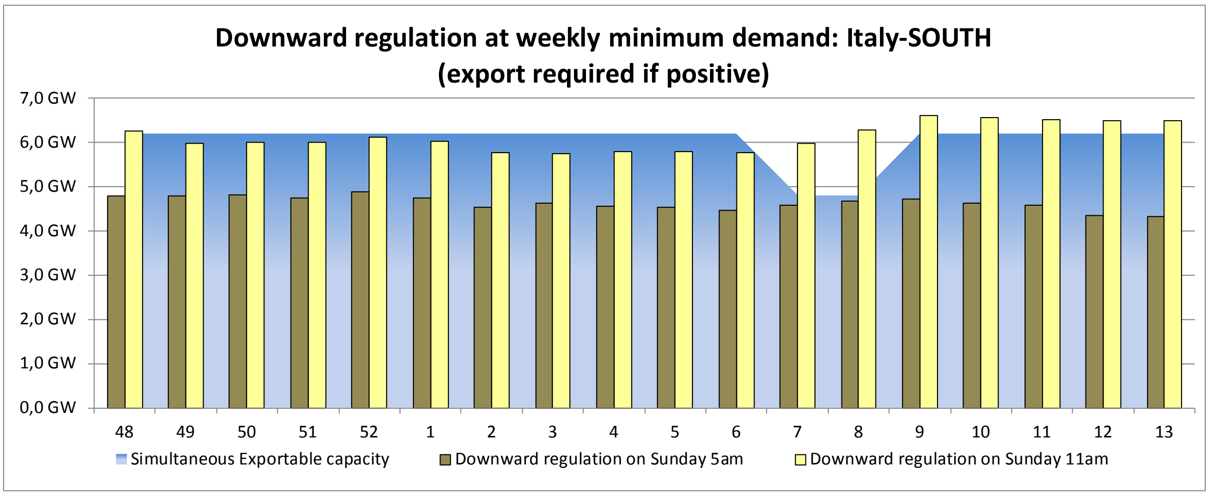

Demand and generation availability: Italy-CENTR-SOUTH
20,0 GW
15,0 GW
10,0 GW
5,0 GW
0,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

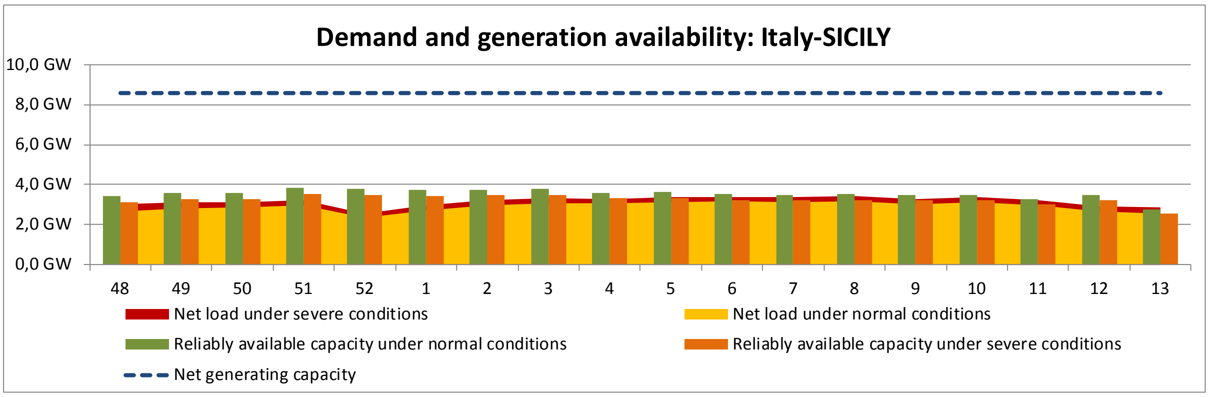

Remaining Capacity at weekly synchronous peak: Italy-CENTR-SOUTH
(import required if negative)
2,0 GW
1,0 GW
0,0 GW
-1,0 GW
-2,0 GW
-3,0 GW
-4,0 GW
-5,0 GW
-6,0 GW
-7,0 GW
-8,0 GW
-9,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

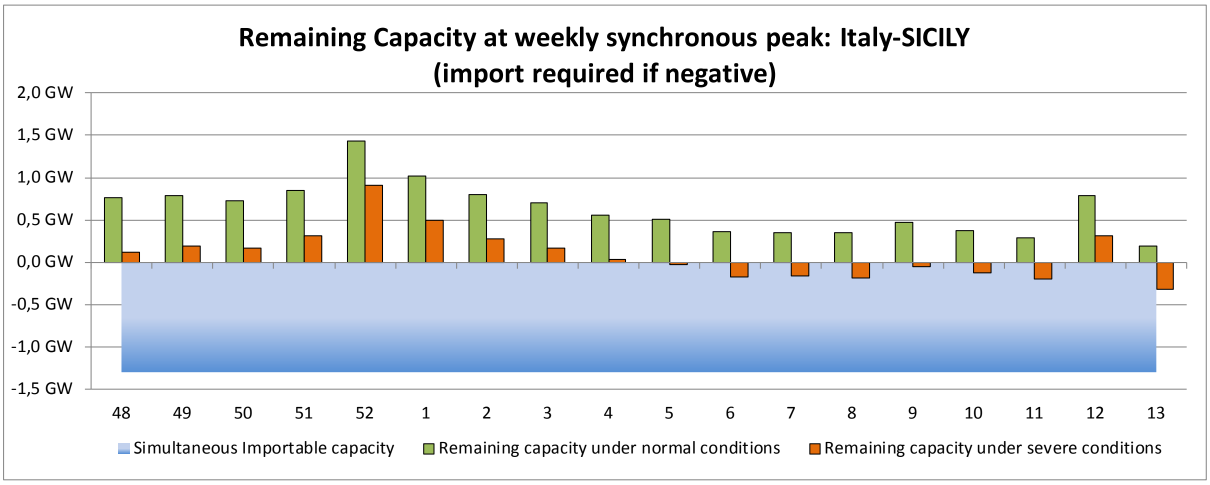

Downward regulation at weekly minimum demand: Italy-CENTR-SOUTH
(export required if positive)
16,0 GW
14,0 GW
12,0 GW
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
-2,0 GW
-4,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

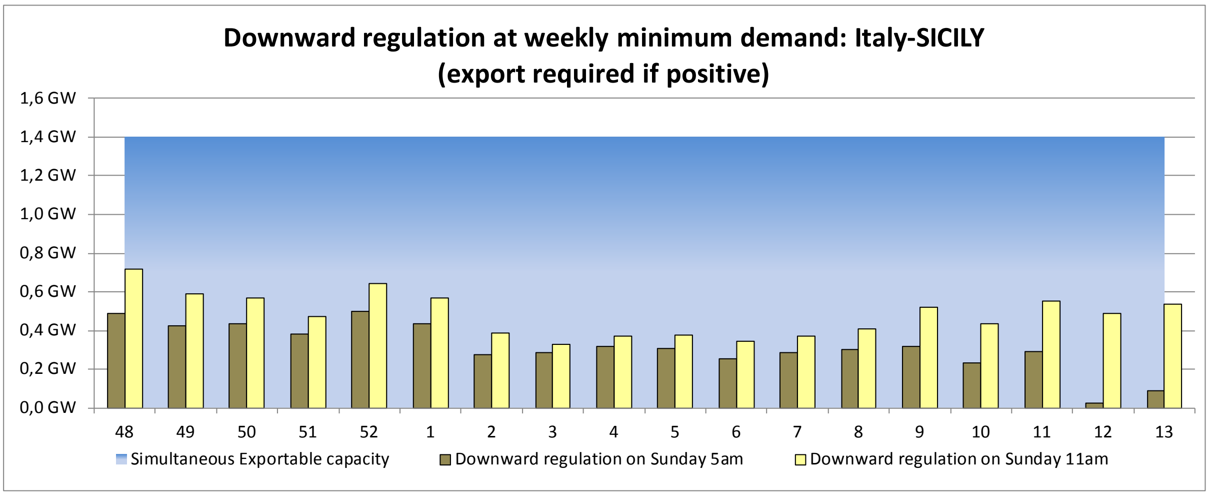

Demand and generation availability: Italy-SOUTH
25,0 GW
20,0 GW
15,0 GW
10,0 GW
5,0 GW
0,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

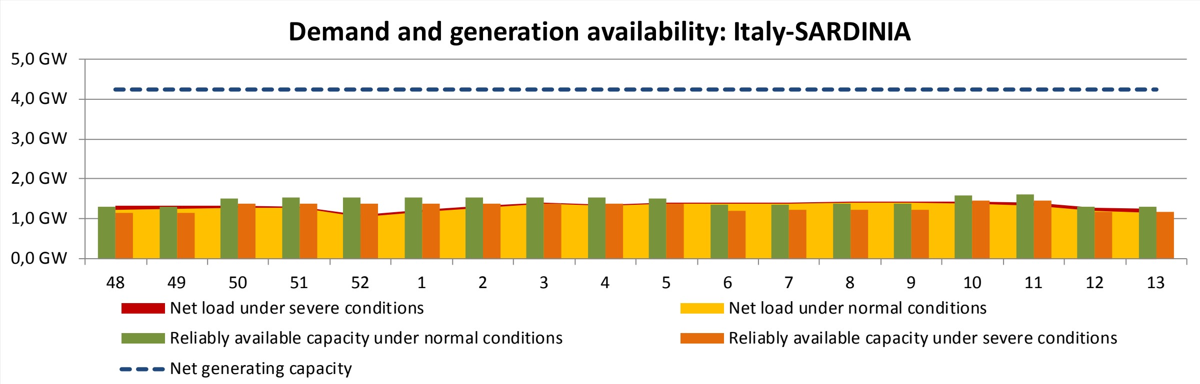

Remaining Capacity at weekly synchronous peak: Italy-SOUTH
(import required if negative)
10,0 GW
5,0 GW
0,0 GW
-5,0 GW
-10,0 GW
-15,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

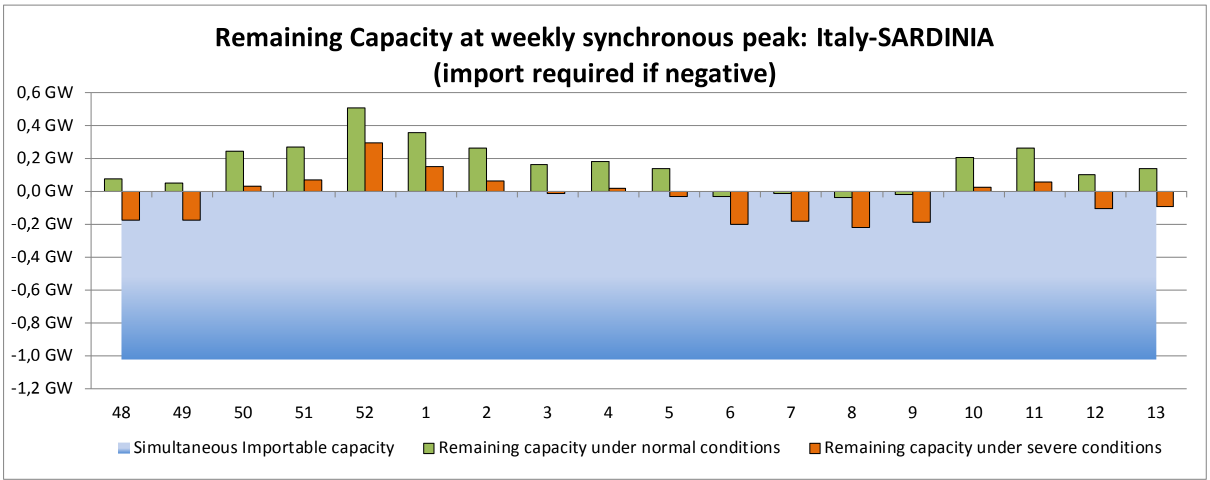

Downward regulation at weekly minimum demand: Italy-SOUTH
(export required if positive)
7,0 GW
6,0 GW
5,0 GW
4,0 GW
3,0 GW
2,0 GW
1,0 GW
0,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

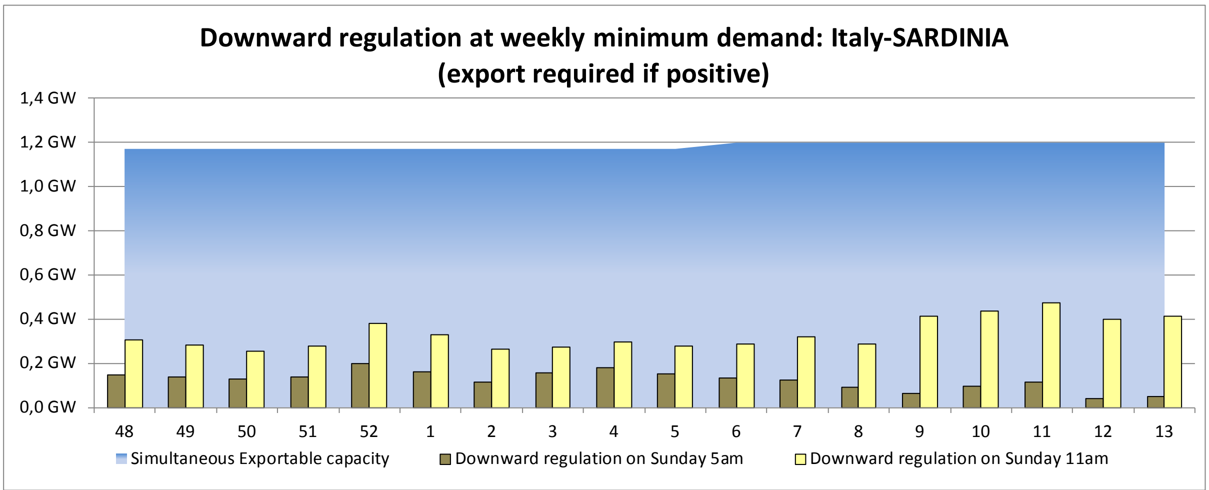

Demand and generation availability: Italy-SICILY
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity


Remaining Capacity at weekly synchronous peak: Italy-SICILY
(import required if negative)
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 Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions


Downward regulation at weekly minimum demand: Italy-SICILY
(export required if positive)
1,6 GW
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 2018

Summer 2018 recorded an electricity demand in line with the value of the same period of 2017 (about 0.6% year over year – preliminary data). The temperature profiles of both years are very similar; with the end of September being exception. Therefore, the sensitivity between temperature and demand did not impact the year over year variance.

The maximum peak demand in the summer was recorded on 1 August (about 57.6 GW – preliminary data). It was the hottest day, with the daily average temperature reaching about 29°C.

During the last summer, there were no significant events regarding the adequacy of the system. The margins have been positive and sufficient to ensure the necessary system security standards thanks to the countermeasures applied for the summer period (e.g. coordination of the unavailability of network elements).

During the summer 2018, the hydro reservoir levels in Italy have been higher compared to the 2017, when reservoir levels were close to the historical minimum.

Finally, there have not been any significant fires causing problems on the electrical system security during summer 2018.

Latvia: Winter Outlook 2018/2019

The actual load very much depends on weather conditions in area of Latvia and actual air temperature on a particular day and hour. The TSO is not expecting demand shedding in normal and severe conditions; therefore load must be covered during the whole winter period. The system service reserve is 100 MW in normal and severe conditions during whole year.

The total installed capacity for Latvian power system is around 2.9 GW for the whole winter period. The fossil power plants are around 1.03 GW, the hydro power plants (run of river) are around 1.6 GW and the rest of capacity is from other RES (wind, bio fuel and solar)– 0.27 GW. Other–non RES generation is from small CHP power plants distributed within the area of Latvia. For almost the whole winter period there is no scheduled maintenance and overhauls on gas power plants, therefore the full capacity of fossil fuels will be available in the whole winter period. In the beginning of 2019, a couple of units from HPPs on Daugava river are in maintenance (around 300 MW all observed time period). It is assumed that during the winter period, the available capacity of HPPs for normal conditions on Daugava river is around 500 MW (average historical production amount during winter period), but in severe conditions the amount is reduced to 400 MW due to the lower water inflow level. The full capacity of HPPs of Daugava river will be available from April till June when usually a flood season is going on and the water has to be utilized as much as possible.

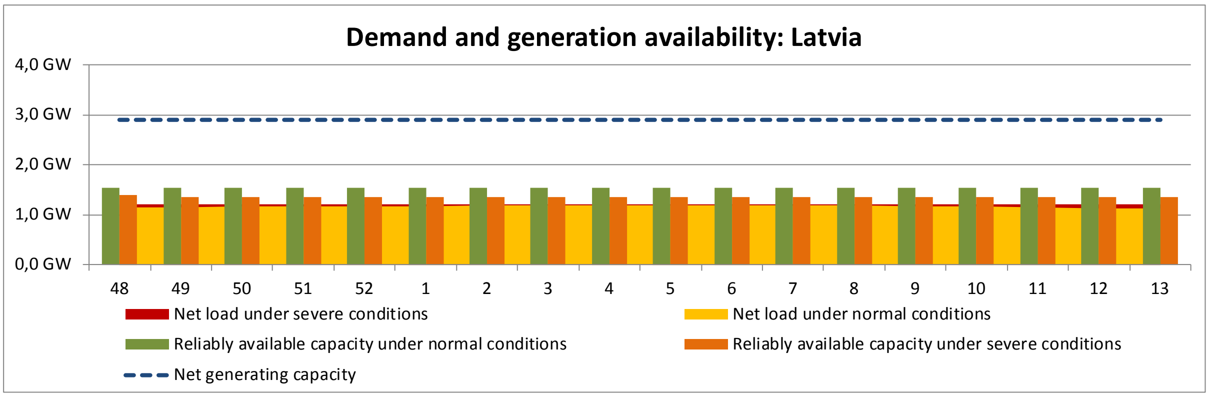
Most critical periods for maintaining adequacy margins and countermeasures

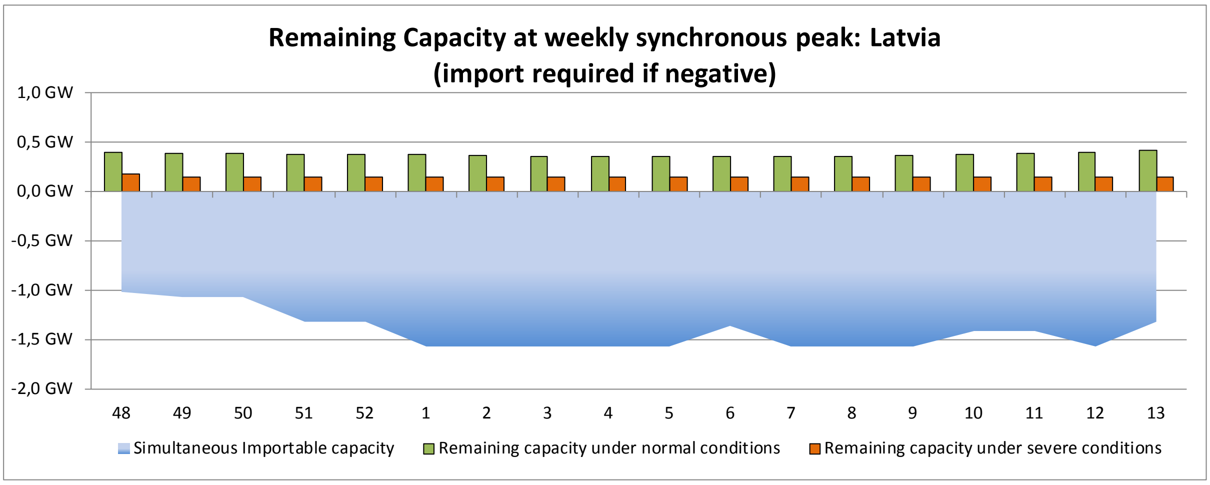
The peak demand under normal and severe conditions can be covered during the whole observed winter period without any restrictions.

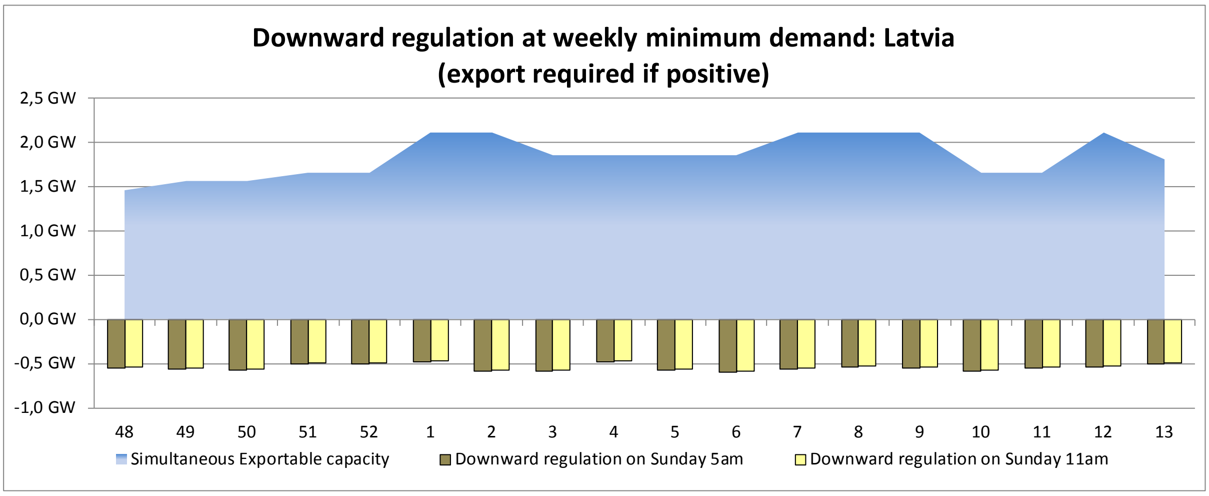
In general, the Latvian TSO doesn't see any problems in covering peak demand for the whole winter period despite the weather conditions. Also, no gas imports or any other fuel shortages in power plants are expected in Latvia.

Most critical periods for downward regulation and countermeasures

The amount of inflexible generation in Latvia isn't so significant; therefore, we don't see a problem with the operation of inflexible generation in night and day time minimum load hours. The inflexible generation is around 200 MW.







Latvia: Summer review 2018

No adequacy or downward regulation issues were identified during the past season.

This summer was very dry. The production of hydro generation was low, but anticipated as the average air temperature in Latvia during the summer was the highest in the last 20 years and consequently water flows in Daugava river were very low.

The Latvian power system relies on imports from neighbouring countries and gas CHPs.

The big, significant faults in the interconnectors were not observed.

Lithuania: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

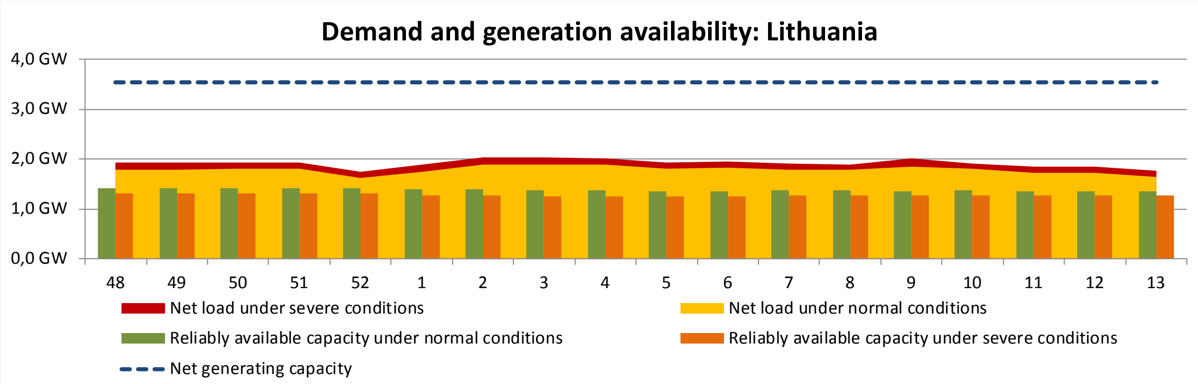
The demand estimation for normal conditions was based on the statistical data of the previous three years. However, during the winter season, consumption is highly dependent on actual weather conditions. Compared with a previous winter, total demand is expected to be around 2.7% higher, with a maximum (under normal conditions) of 2006 MWh in the middle of January.

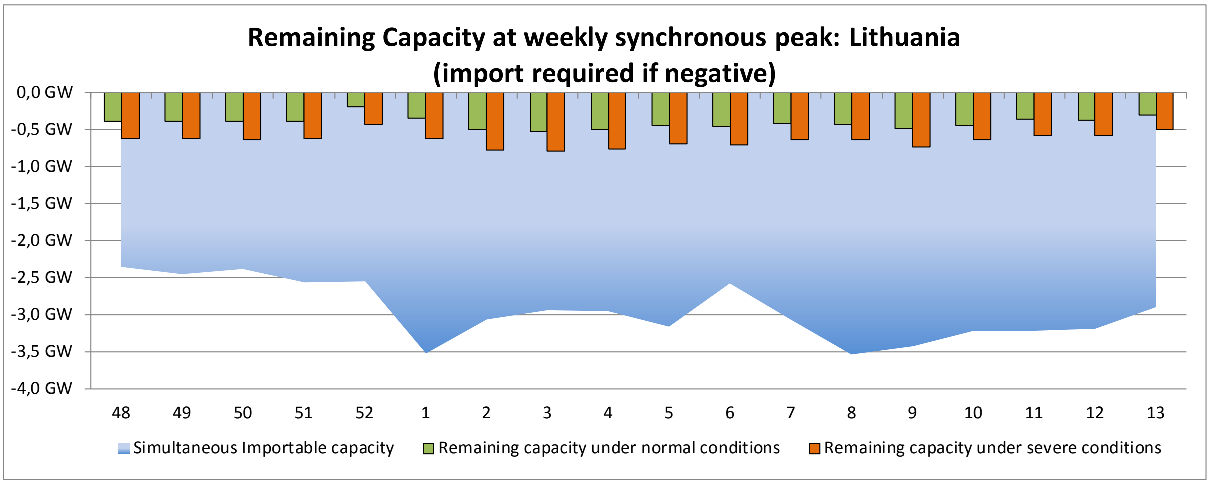
Since the last winter season, net generating capacity increased by 77 MW and is currently equal to 3533 MW. The total volume of frequency restoration reserves and replacement reserves will increase from 883 MW to 920 MW (26% of NGC) from 2019. For the upcoming winter season, the maintenance schedule will not be intensive; however, a large amount of capacity will not be usable due to the mothballing of one generation unit of the Elektrėnai Complex, Vilnius Combined Heat Power Plant and of one block of Kaunas Combined Heat and Power Plant that combine 662 MW (19% of NGC).

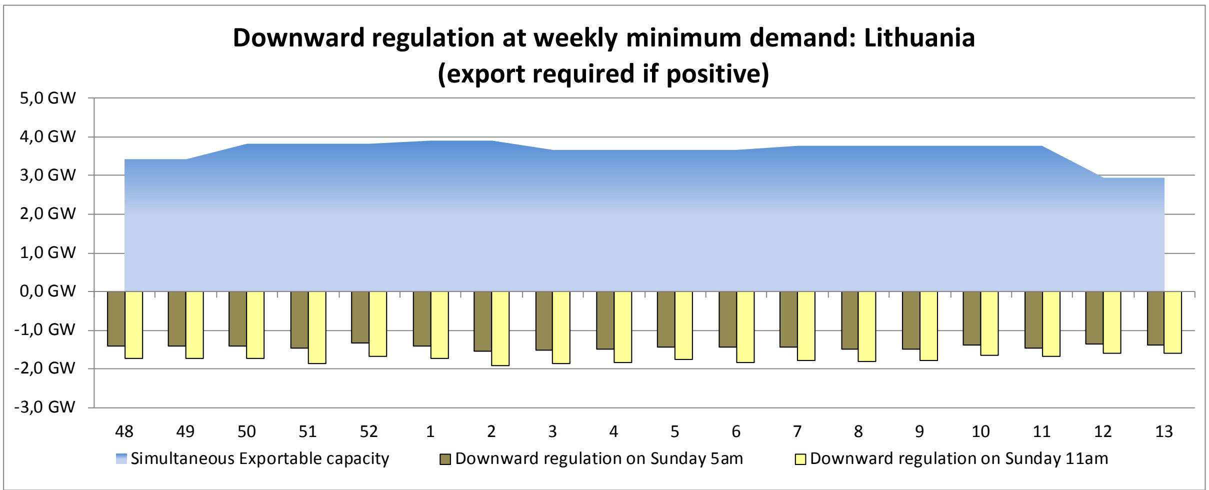
All import volume from third countries (Russia, Belarus) based on power flow calculations are allocated on Lithuania–Belarus interconnection and highly depends on Estonia–Latvia interconnection capacity. Highest restrictions of the import capacity from third countries are foreseen from week 13, due to maintenance activities on the Estonia–Latvia interconnection lines.

Due to limited generation capabilities in Kaliningrad region during peak demand hours, decreased import capacities are expected on the Lithuania–Russia cross–border interconnection. Highest import constraint is foreseen from week 50 until week 52 because of planned maintenance activities of the Kaliningrad Thermal Power Plant.

Average national margins of the Lithuanian power system during the upcoming winter season are forecasted to be negative, but cross border interconnection capacity is expected to be sufficient to maintain system adequacy.







Lithuania: Summer review 2018

Total national consumption in the summer of 2018 was 4.4% higher than in the previous summer. The maximum demand (1713 MW) was reached in the beginning of August, while the minimum demand (870 MW) was in the beginning of July.

The average summer balance portfolio consisted of 22% local generation and 78% imports from neighbouring countries. The largest proportion of imported electricity was from Russia (49%) and Sweden (33%).

In the summer of 2018, local generation was 22% (181 GWh) lower than in the previous summer. The highest impact for this change is different weather conditions. Due to lighter winds, wind generation was lower by 25% (71 GWh), while due to lower precipitation, renewable hydro generation was lower by 29% (24 GWh) and hydro pumped storage generation was lower by 37% (66 GWh). Generation of fossil fuel was 17% lower (29 GWh).

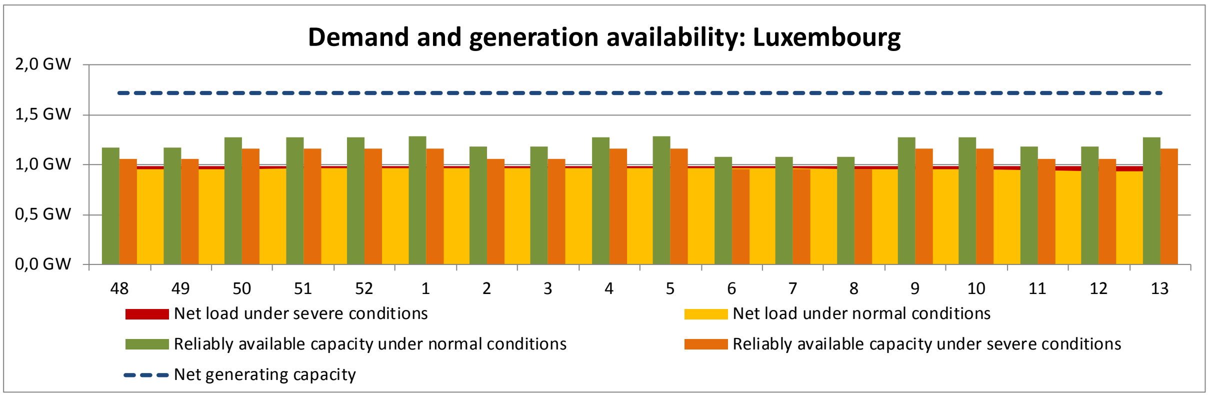
During summer period, import and export capacities of Lithuania power system had no significant deviations from yearly plans. In the beginning of the summer period during weeks 14-21, the import volume from the Kaliningrad region to the Lithuania power system was significantly decreased because of maintenance activities in Kaliningrad thermal power plant.

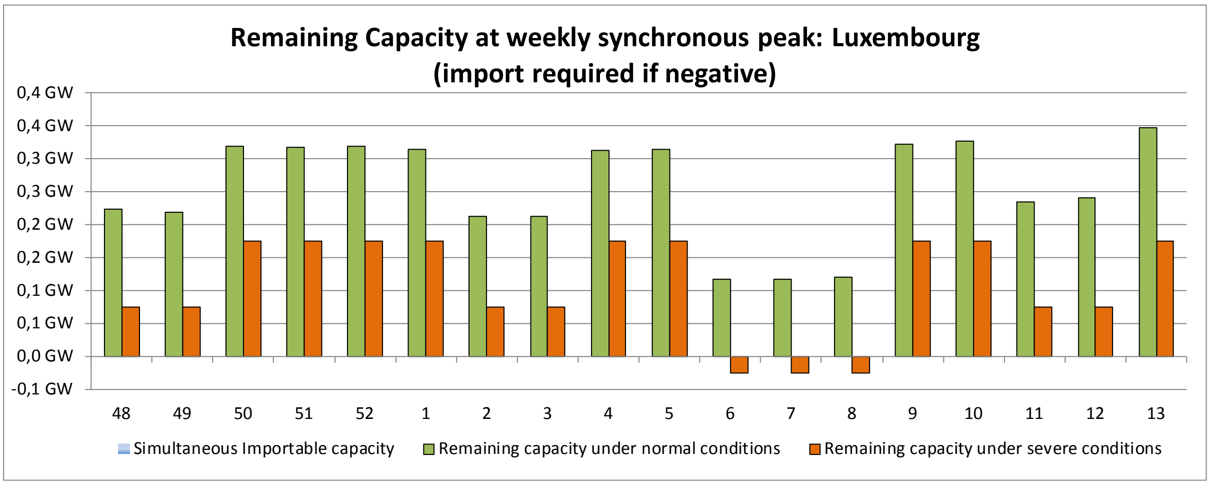
Capacities from third countries most of the time were limited due to congested Estonia–Latvia cross–border interconnection.

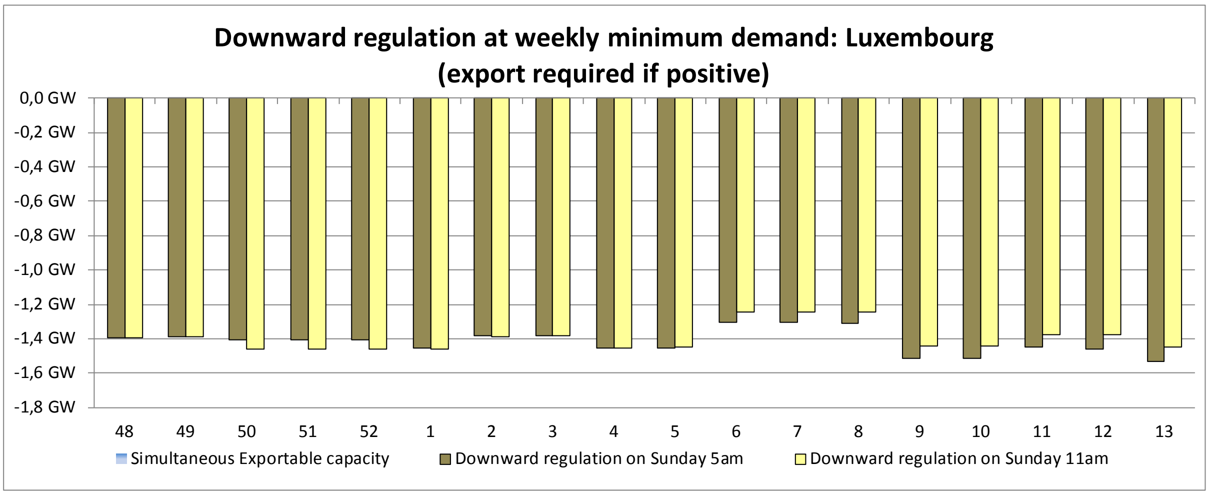
Luxembourg: Winter Outlook 2018/2019[20]

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







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

Luxembourg: Summer review 2018

No adequacy or downward regulation issues were identified during the past season.

Malta: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.

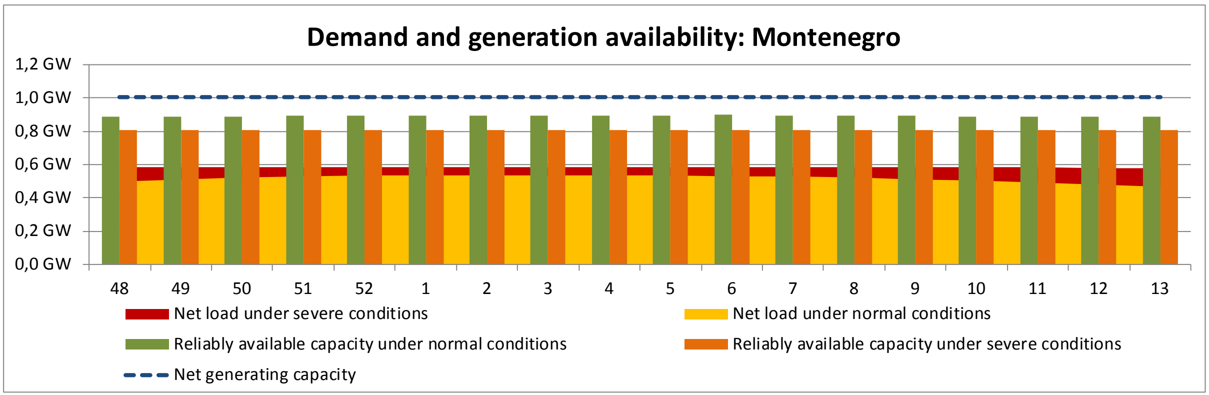
Malta: Summer review 2018

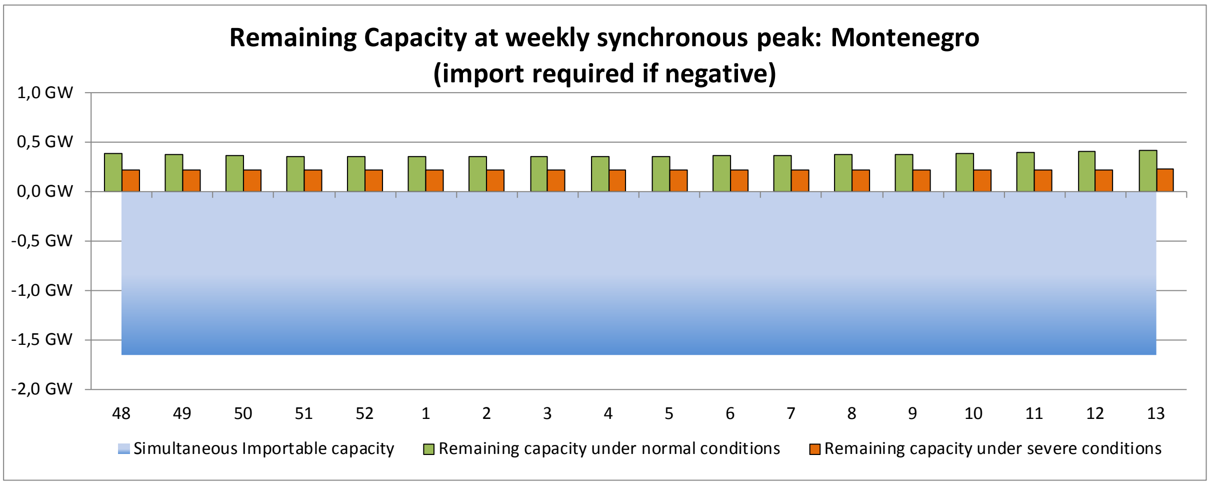
No adequacy or downward regulation issues were identified during the past season.

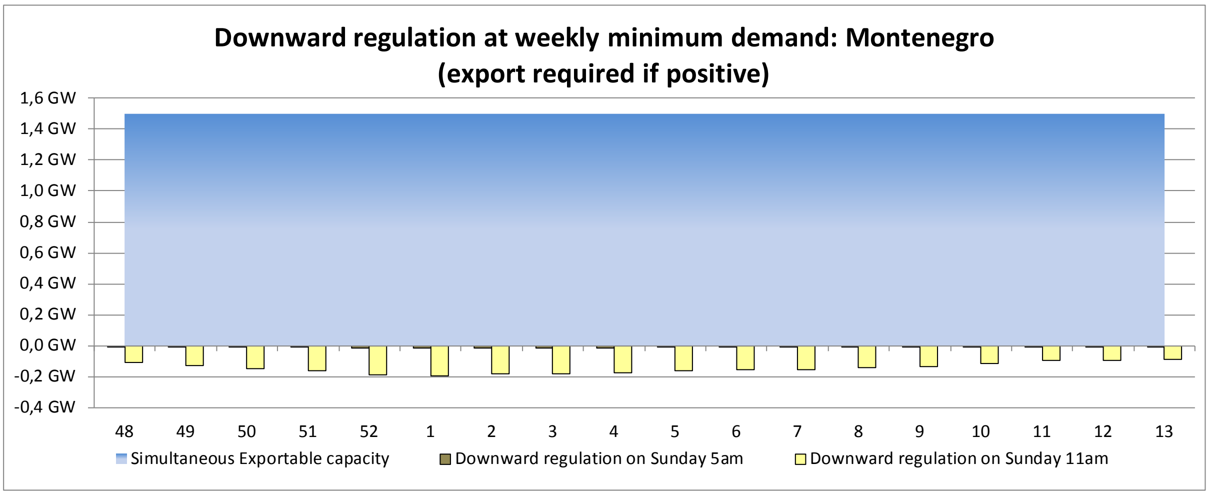
Montenegro: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.





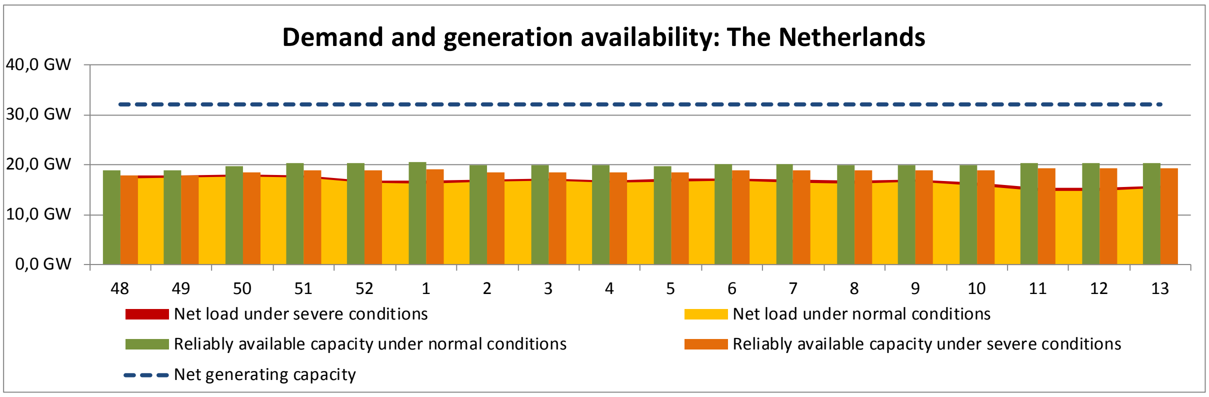


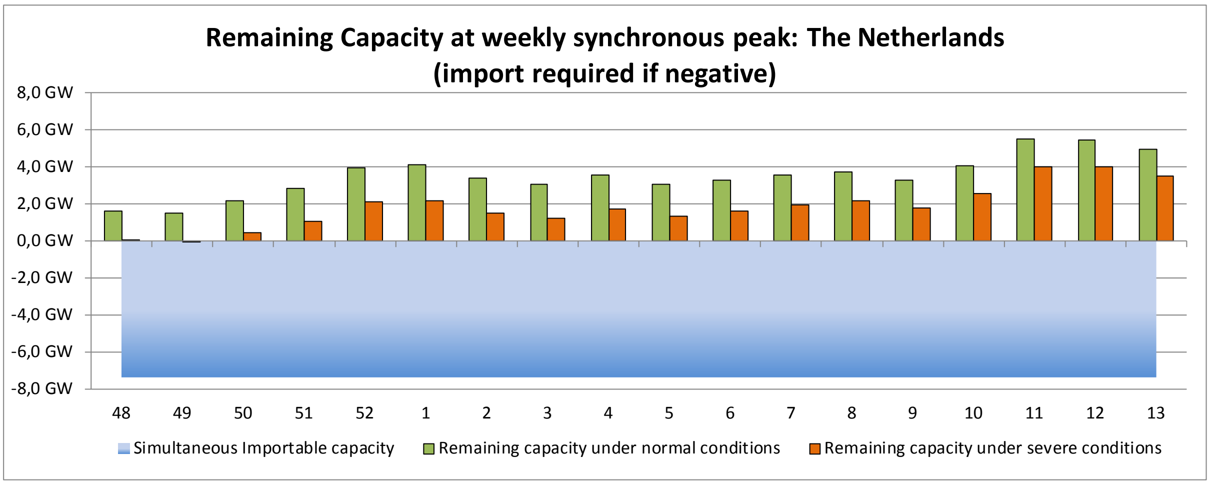
Montenegro: Summer review 2018

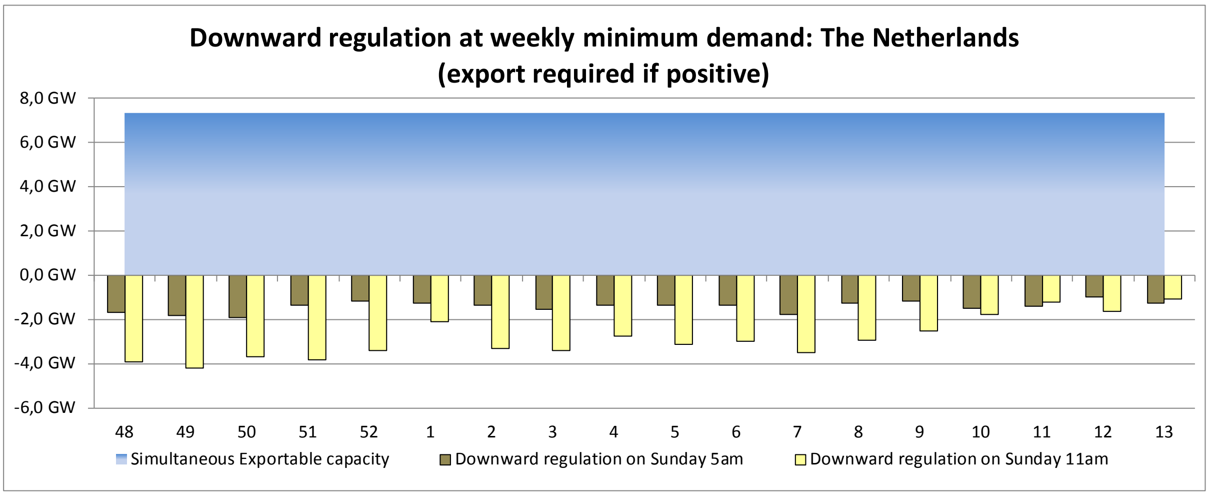
No adequacy or downward regulation issues were identified during the past season.

Netherlands: Winter Outlook 2018/2019

Chapter 3.3 "Adequacy under severe conditions" reports that imports are needed in the Netherlands for at least one week (NL is blue in figure 4) The reported import dependency is very small (53.7 MW in week 49) and is caused by the fact that almost 2 GW generating capacity is in maintenance. The planned unavailability data for NL was derived from ENTSO-E's Transparency Platform. Generation companies reported 5 gas fired units with a total unavailability of 1950 MW for week 49. However we do not expect adequacy issues in the Netherlands; in case of severe conditions e.g. a cold spell, it is very likely that at least some of the reported winter maintenance will be cancelled.







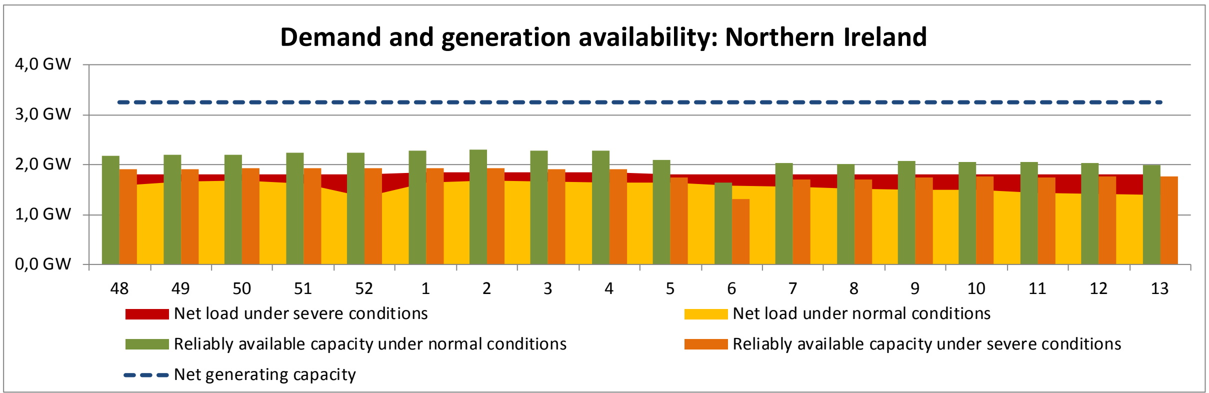
Netherlands: Summer review 2018

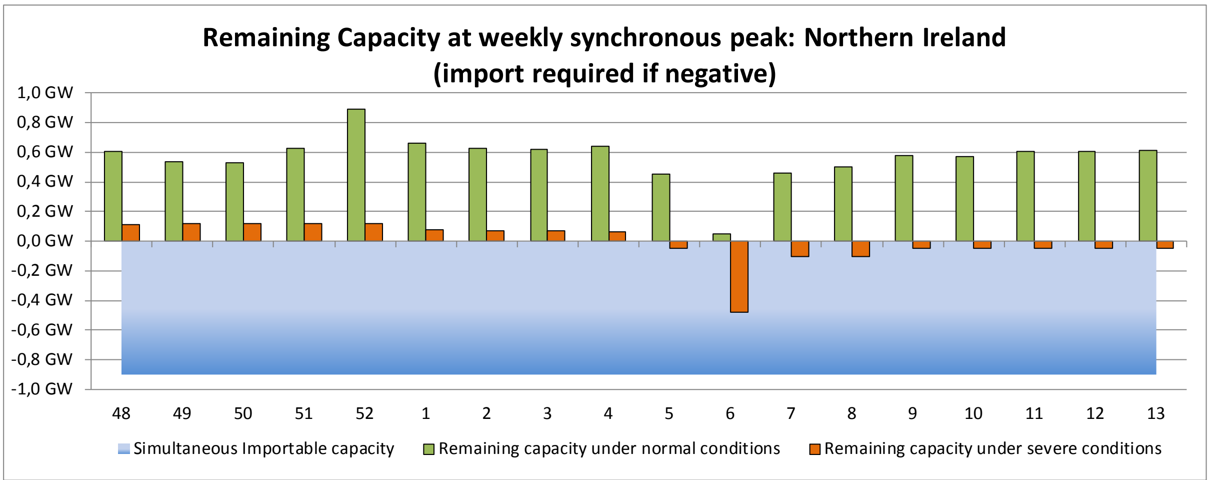
No adequacy or downward regulation issues were identified during the past season.

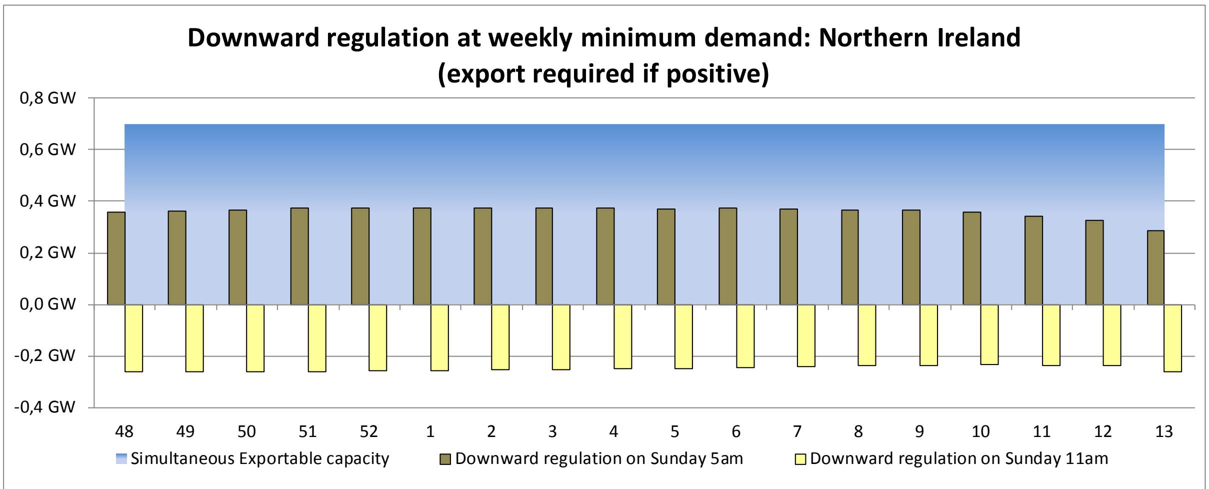
Northern Ireland: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







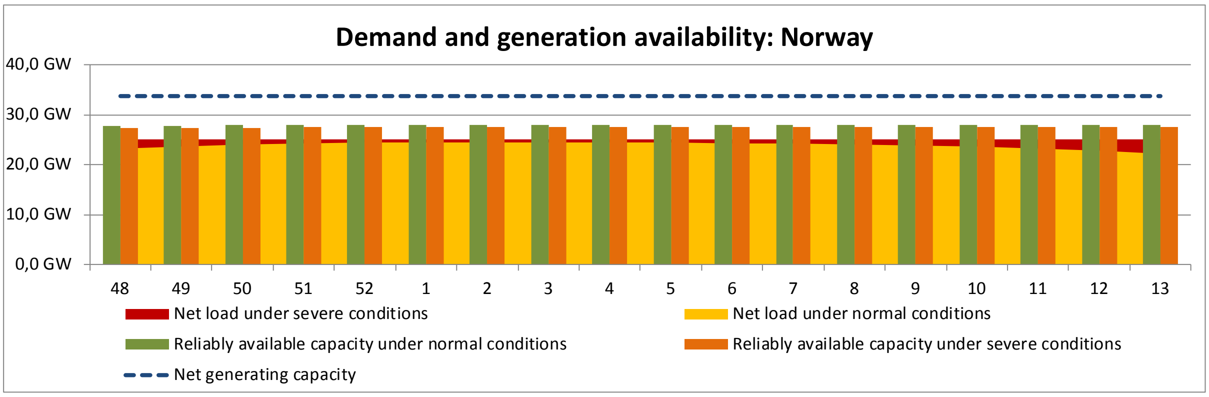
Northern Ireland: Summer review 2018

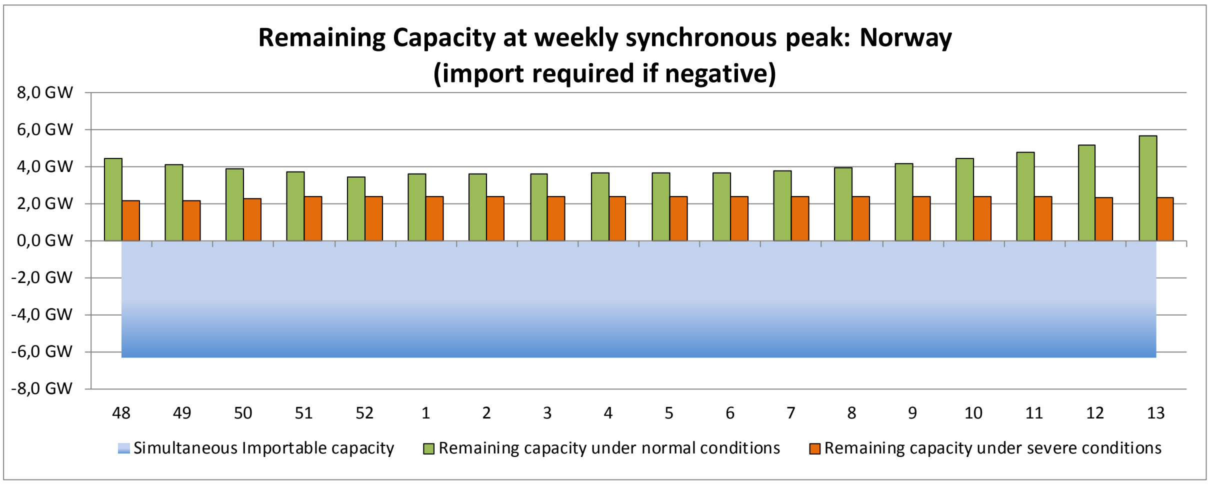
No adequacy or downward regulation issues were identified during the past season.

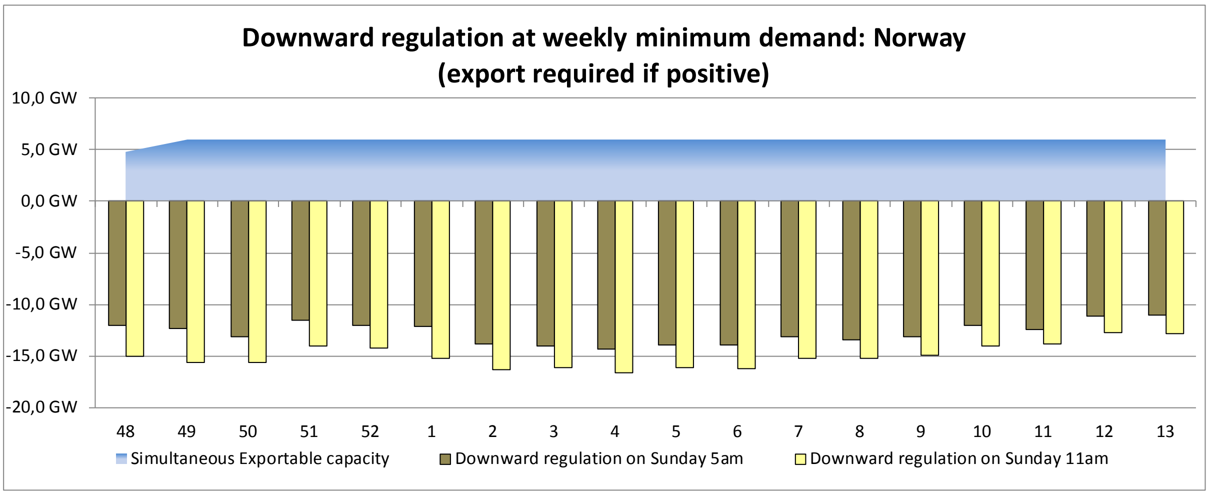
Norway: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







Norway: Summer review 2018

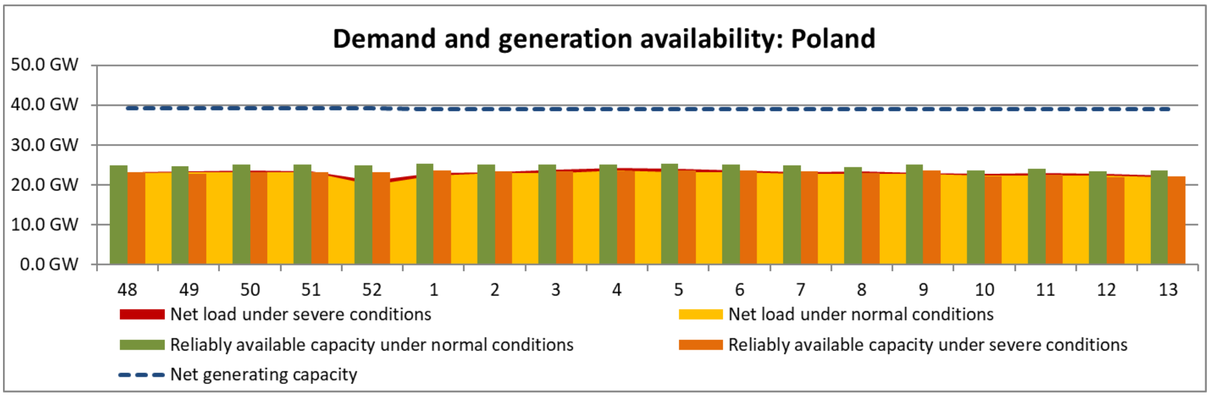
No adequacy or downward regulation issues were identified during the past season.

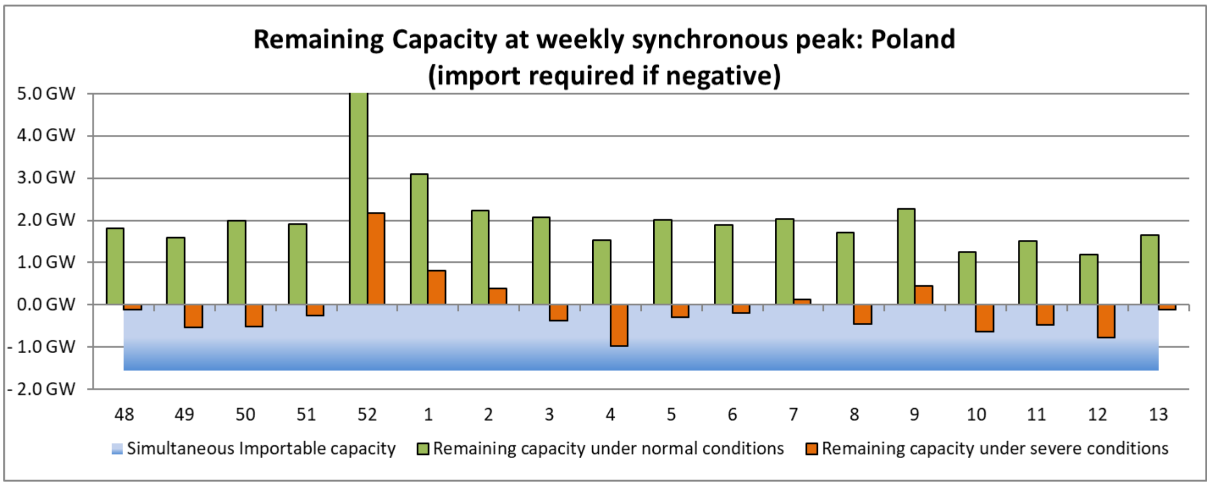
Poland: Winter Outlook 2018/2019

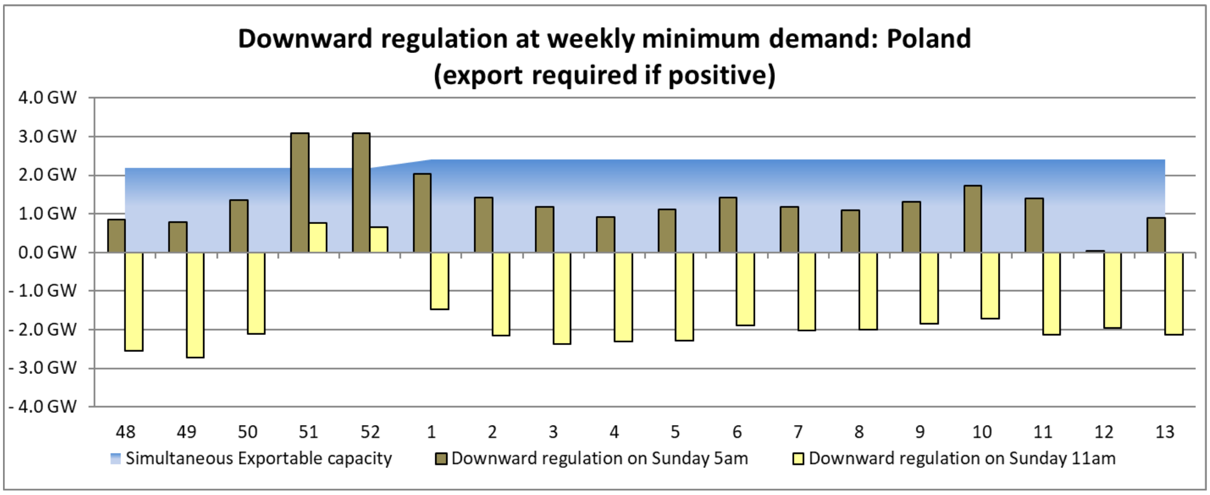
Potential critical periods and foreseen countermeasures

UPWARD REGULATION

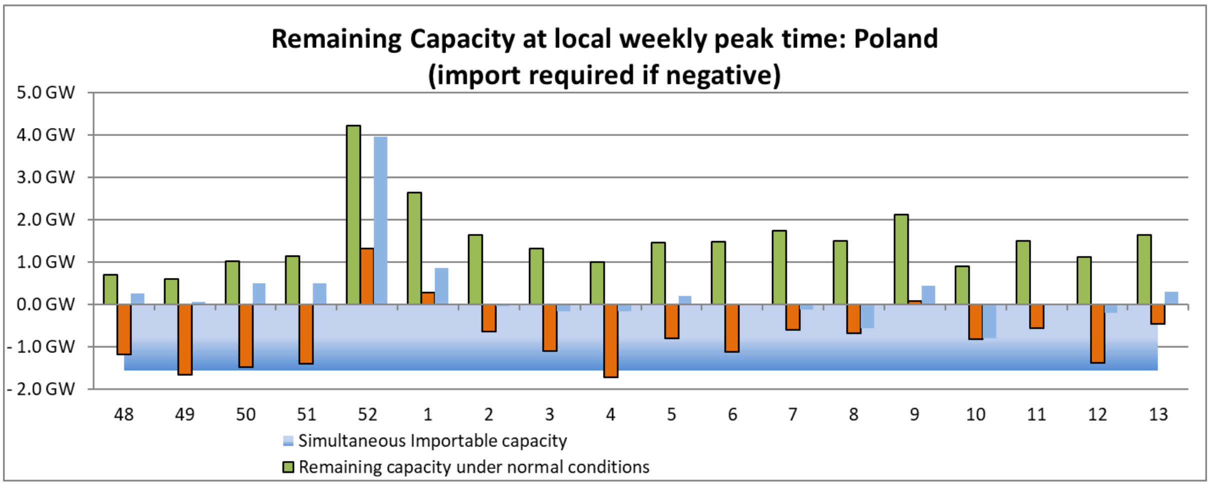
During severe conditions, at reference synchronous peak, the adequacy forecast for the coming winter looks a bit worse than in the previous Winter Outlook. This is mainly due to a failure in one of the biggest gas units in Poland (c.a. 450 MW) in September. It is assumed that this unit will not be available for the coming winter.







Moreover, values of weekly local peak demand forecast (unrestricted reference point in time) increased compared with last winter after implementation of new forecasting methodology. Considering the lower generation availability and the demand forecast based on new methodology, import needs in some weeks may exceed the available import capacity.



Under severe conditions for both reference and local peak demand time, the import via interconnections would be a key issue. Pan-European simulations have shown that generation resources might not be sufficient in all reference points to cover the import needs of the Polish power system.

In such situations, PSE has contracted at least 510 MW of DSR for the coming winter, which may be activated in case of inadequacy. Nevertheless, the mentioned DSR potential was not considered in the Winter Outlook 2018/2019 study as this DSR is procured to be used as a remedial measure and is out-of-market.

Poland: Summer review 2018

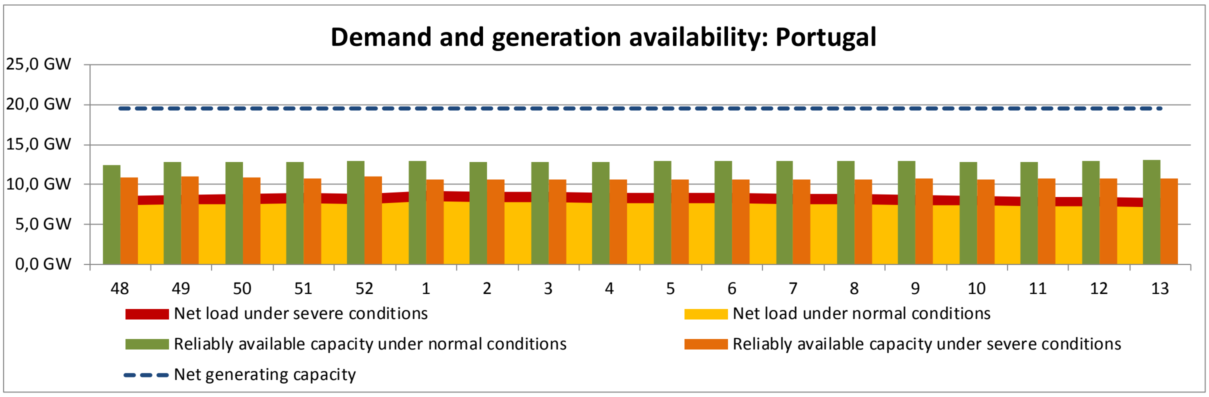
There were no adequacy issues noticed last summer, however at the turn of July and August a heat wave caused significant limitations in a power plant located in the central part of Poland. Power output in this power plant had to be reduced due to the high temperature of the cooling water. Due to these limitations, fulfilling N-1 criteria in the closest area was an issue in the short–term forecast. PSE signed the yellow light in the European Awareness System (EAS) and initiated available operational measures to successfully manage the situation.

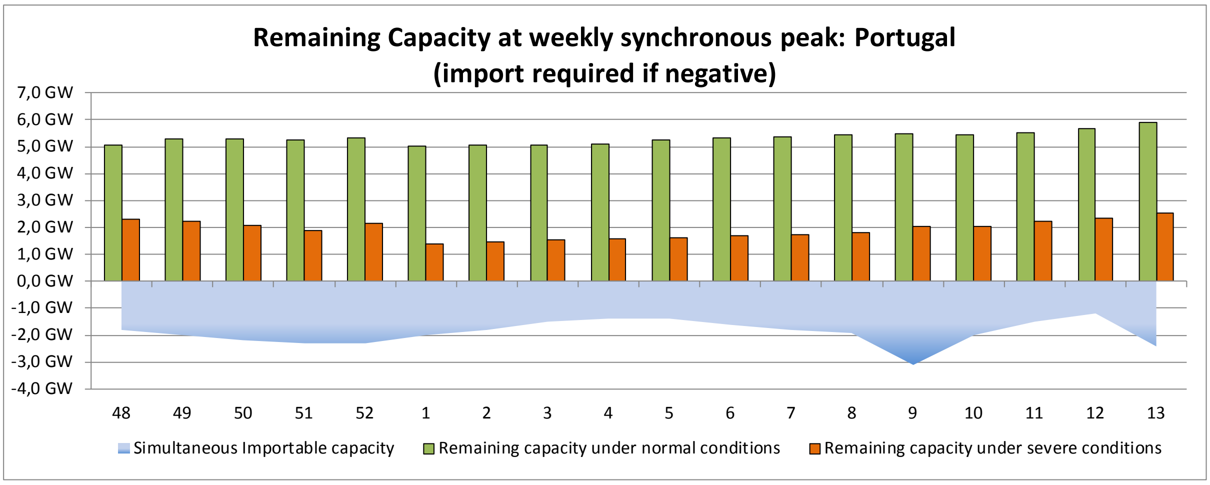
Summer 2018 was another one in a row to hit summer’s peak demand record, however annual peak still takes place in winter season. The peak demand was registered on 2 August 2018 at 13:15. It amounted to circa 22.1 GW.

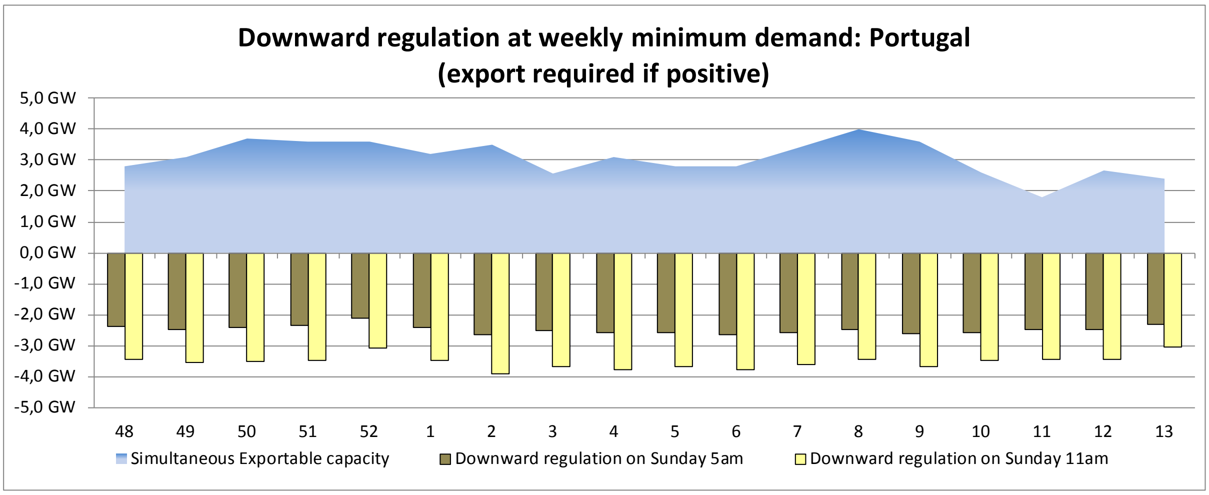
Portugal: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







Portugal: Summer review 2018

During the summer season, the demand for electric energy was once more strongly influenced by temperatures significantly above the normal values, registering an increase of 2.5% in August and 4.2% in September. These values decrease to -0.7% and 1.5% respectively when corrected for the temperature effect and number of working days.

As a result of the above average rainfall, which was registered in the period from March to July, and the significant inflows from the Spanish reservoirs, the conditions were very favourable for hydro generation during the summer season, despite the very reduced precipitation.

On the other hand, wind power generation was poor, registering a particularly low value in September, a month that is statistically the lowest of the year, with the wind production index standing at 0.61 (39% lower than the average value). This is the lowest wind production index since the beginning of records (2001).

As a whole, during the summer season renewable generation was at the lowest level of the year, supplying on average 36% of the national consumption and export balance.

The interconnection balance remained exporter, with an equivalent weight of 8% of national demand.

Romania: Winter Outlook 2018/2019

The early weather forecast for the coming winter 2018–2019 indicates a mild winter for the Romania region. In the event of normal conditions, the balance forecast does not indicate any problems which could affect the Romanian Power System adequacy during the coming winter 2018–2019.

Potential critical periods and foreseen countermeasures

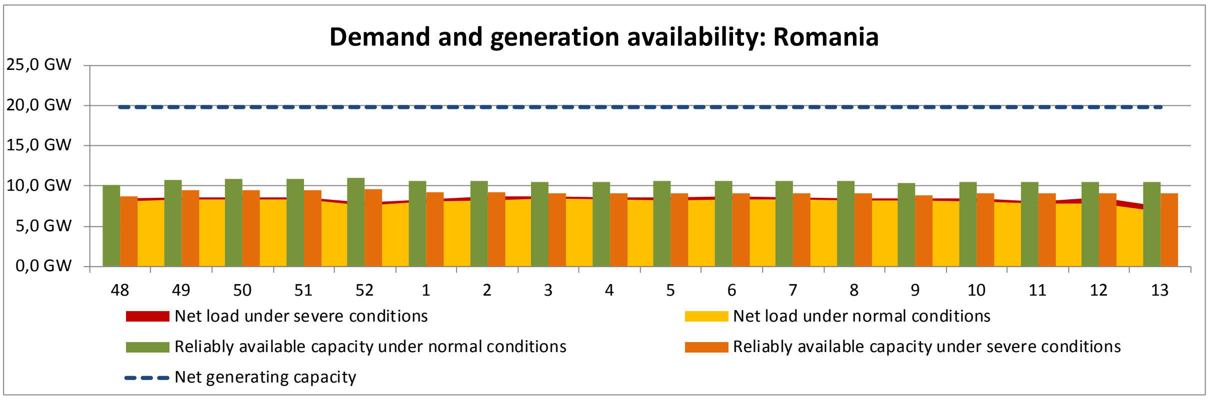
In the event of severe conditions due to the extreme weather conditions with very low temperatures values and no wind generation, potential critical periods may occur (weeks 2–week 6 and week 9).

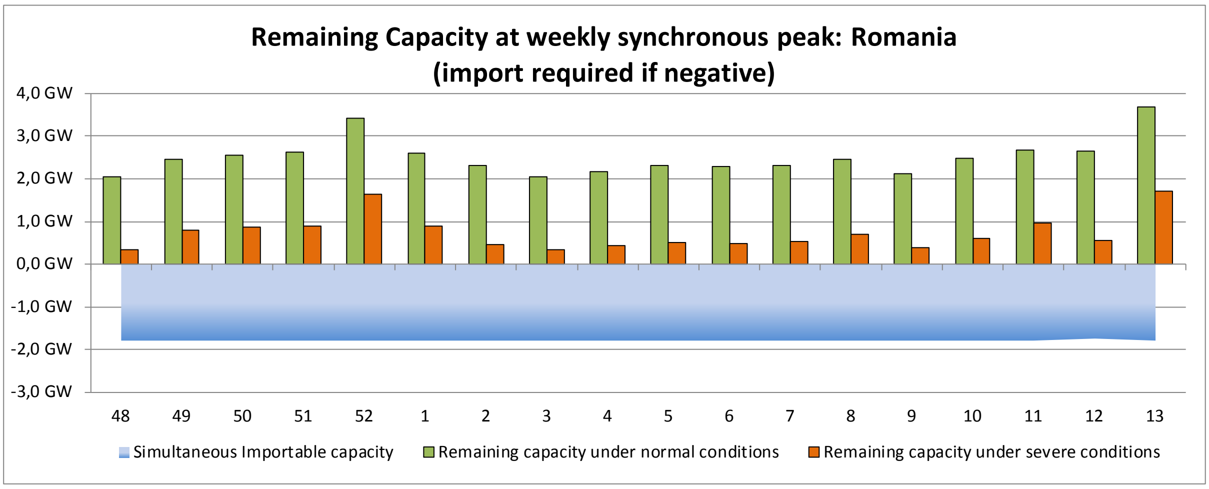
During these potential critical periods with temperatures values below -15°C and no wind generation, the remaining capacity could be at the lowest. It would be between 300 MW and 500 MW, during the high peak time.

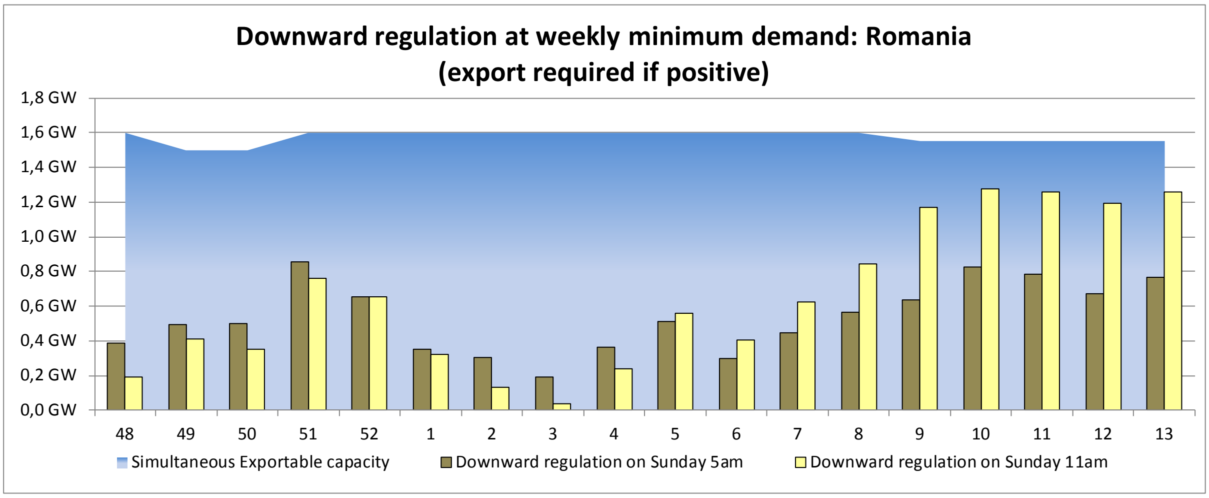
In the event of a gas crisis, certain thermal power plants can be switched from gas fired operation to oil fired operation. In this way, a possible gas crisis will not endanger the system adequacy during the coming winter.

Most critical periods for downward regulation and countermeasures

In the event of positive downward regulation during the minimum demand on 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 net positions are 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 2018

No adequacy or downward regulation issues were identified during the past season.

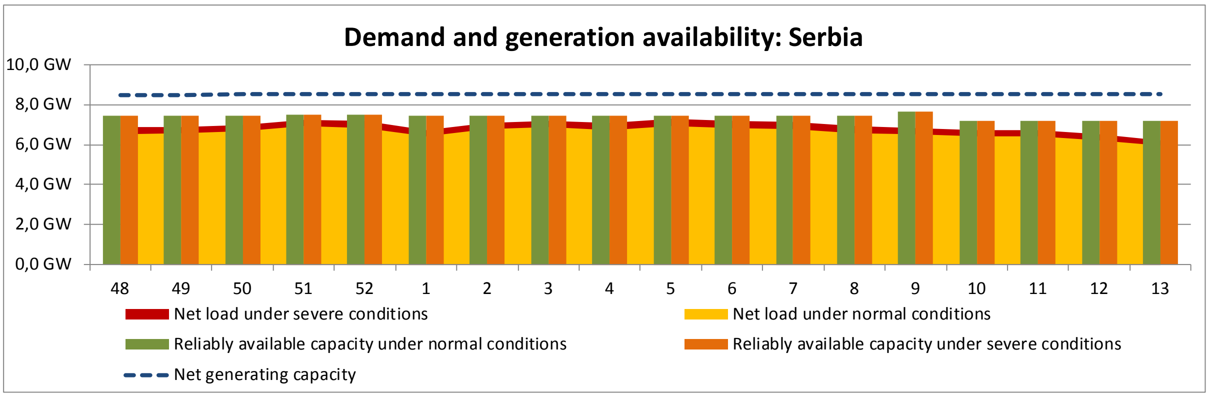
Serbia: Winter Outlook 2018/2019

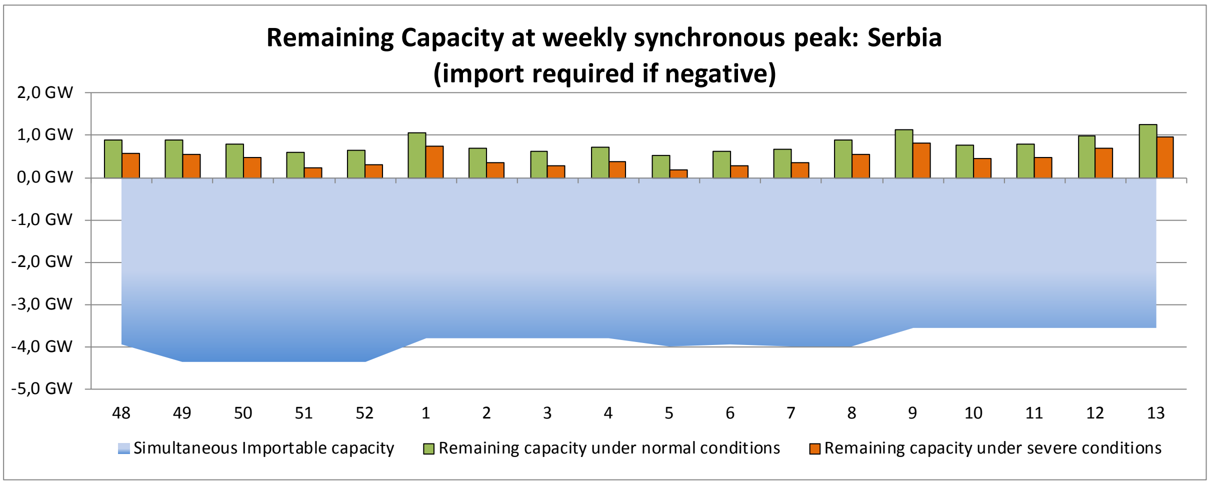
For the upcoming winter, Serbia does not expect problems to cover demand. Moreover, some energy exports are expected under normal weather conditions during February and March.

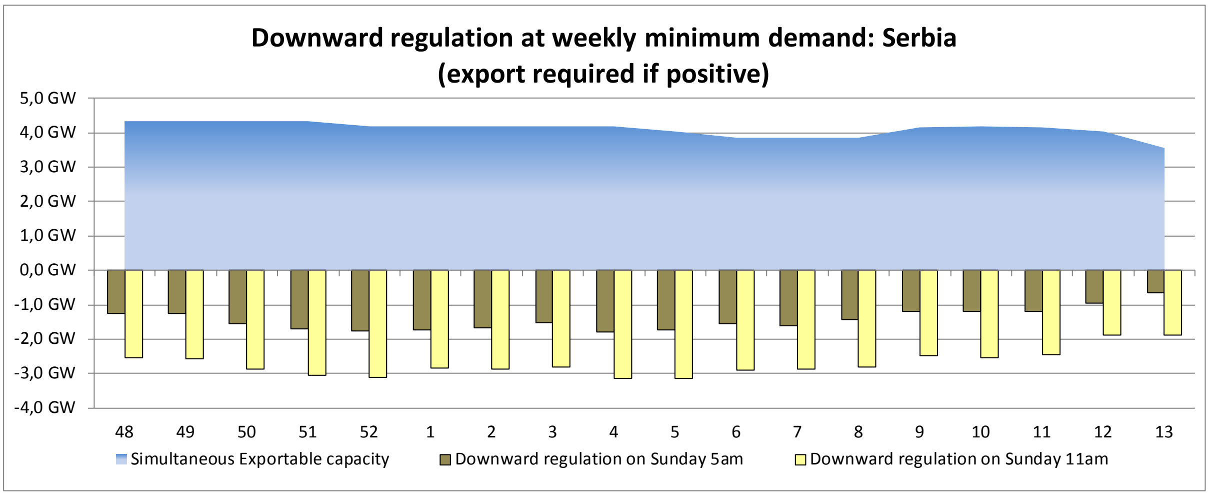
The maintenance of power plants and transmission network are planned to be completed before the significant increase of demand. Only the major overhauls of the two hydro generators are planned, but missing power of 200 MW does not significantly affect the adequacy.

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

Problems to cover demand might occur at extremely high peak demand under severe weather conditions, especially in January. Then energy imports would be required.







Serbia: Summer review 2018

The last summer passed without major problems. During June and July, temperatures were normal and some energy exports were realized.

In August, higher temperature periods and high levels of maintenance caused the lack of energy and occasional needs for energy imports. Furthermore, the import of energy mainly continued during September, due to the higher rates of forced outages of production units.

Problems from the last winter that related to the lack of energy in the sub–area KOSTT which operates within the EMS control area continued throughout the last summer. By mid–July, this energy imbalance caused the synchronous time delay of over 60 seconds, when Regional Group Continental Europe (RGCE) took measures and returned the deviation to the permitted limits that have not been violated until now.

Slovakia: Winter Outlook 2018/2019

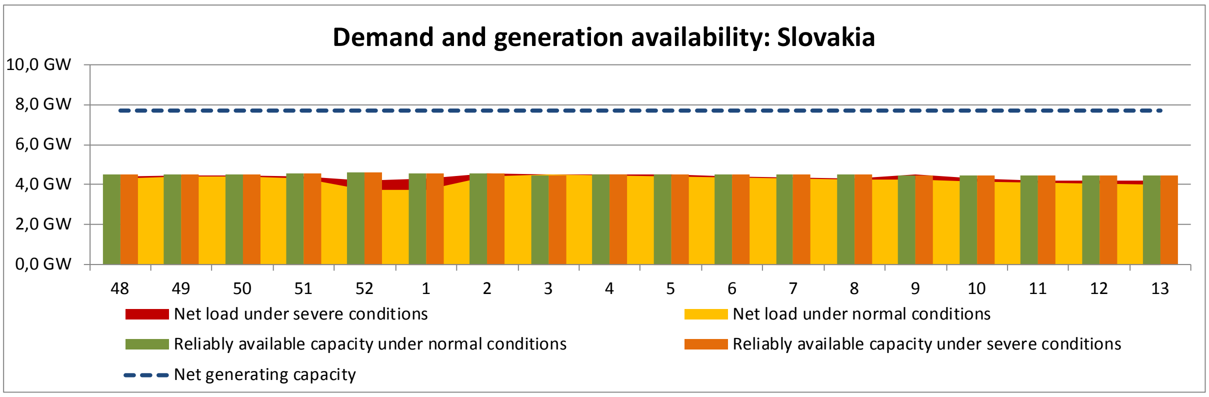
Potential critical periods and foreseen countermeasures

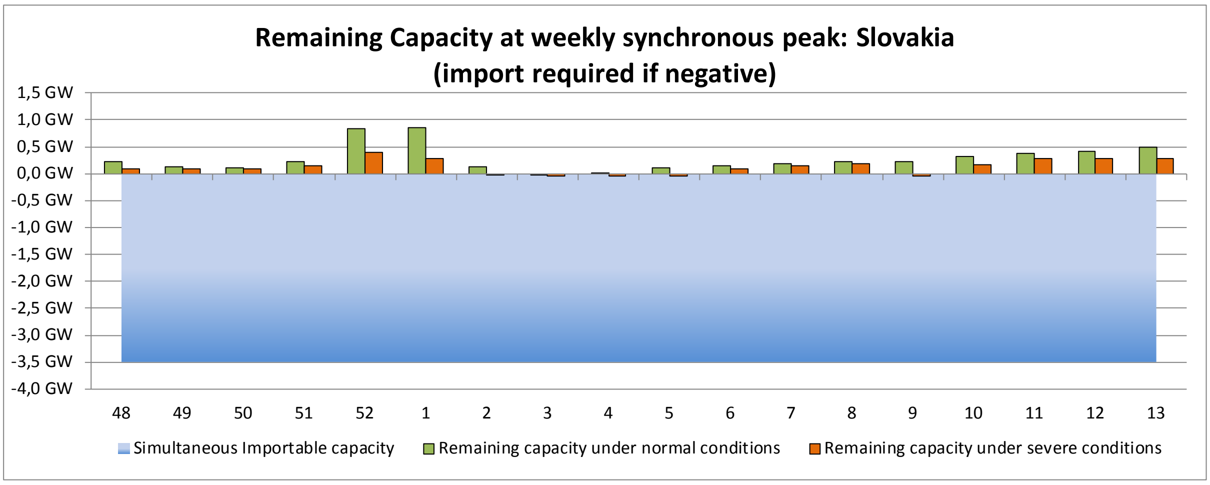
In winter 2018/2019, the expected generation capacity of Slovakia will be sufficient in most weeks, besides two weeks in January under the normal conditions scenario. In the severe conditions scenario, the situation is a little worse, in four weeks of January and one week at the end of February the lack of capacities is foreseen if peak load exceeds 4 500 MW. Cross–border capacities for electricity import are still sufficient

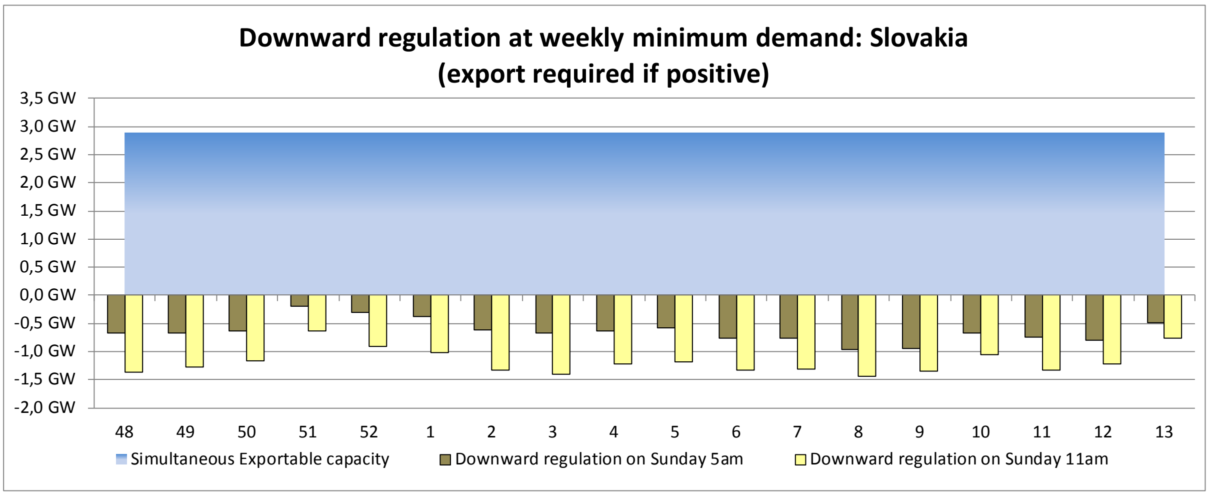
During winter 2018/2019, the expected maximum weekly peak load under severe conditions is foreseen as 4 550 MW in January. The real peak demand in the last but one winter 2016/2017 that was in January very cold, was at this level (4 550 MW).

In both scenarios, combined-cycle natural gas power plant Malženice (419.6 MW) is not considered in operation during this winter period. The maintenance schedule of the generation units is usually set to minimum.

No adequacy or downward regulation issues are expected for the coming season.







Slovakia: Summer review 2018

No adequacy or downward regulation issues were identified during the past season.

The following comment covers the summer period from June till September 2018. The weather of summer 2018 can be characterised as very dry with extreme high air temperatures. In some summer days (in July and August) measured maximum daily temperatures reached 35°C in some parts of Slovakia, and daily averages were over 25°C. The average temperature of this summer was 19.9°C (in summer 2017 it was 19.1 °C). July and August 2018 were slightly warmer than in 2017 (+0.5 and +0.7°C); the average temperature in September 2018 was much higher than in 2017 (+2.0 °C).

The maximum summer load was 3 878 MW on 27 August and it was 30 MW higher than in summer 2017. Maximum weekly loads were higher from the middle of May until almost the end of June by 4% (150 MW), from July until the middle of August by 1.8% (65 MW) and in September lower by 1.3% (48 MW). All these values are average differences between 2018 and 2017.

Production of electricity in Slovakia during the summer period was lower (index 93.6%). The warm and dry weather impacted mainly on the production of hydro power plants (81.1%) due to dry climate conditions. Production of nuclear power plants was lower (92.5%) due to the maintenance of nuclear units in July and September. On the other side, fossil power plants increased their production (index 106.4%) because of higher production from hard coal (142.3%) and natural gas (121.9%). In September especially, the production of fossil fuels was higher (123.7%) because of economically profitable production as a replacement of lost hydro and nuclear production. The production from lignite was much lower (65.5%) this summer due to the maintenance of two 110 MW units of power plant Nováky.

On 10 July, the combined–cycle natural gas power plant Malženice (capacity 419.6 MW) started test operation and later passed to short commercial production. The power plant had been out of operation since 1 May 2013. Besides the production of electricity during working days of this summer, the benefit of the power plant was ancillary services provision. From the 1 October, the power plant is out of operation again.

The electricity consumption was slightly higher compared with the previous summer (index 100.5 %). There was an increase of consumption in June (102.3%), July (100.8%) and in August (100.5%); a contrariwise decrease of consumption was in September (98.5%).

The electricity was imported in all summer months into the power system of Slovakia. In summer 2018, the share of import in the electricity consumption of Slovakia increased to 14.2% compared with 7.8% in summer 2017 because the hydro, nuclear and lignite power plants production was lower than the previous summer. The total import was 1 371 GWh (in summer 2017 it was 753 GWh). Cross border capacities were sufficient to ensure such a level of import. There were no remedial actions to solve the overloading of transmission lines. The amount of transmitted electricity was much lower than in the previous summer (a decrease from 90.1% to 95.2%), with the exception of August (101%).

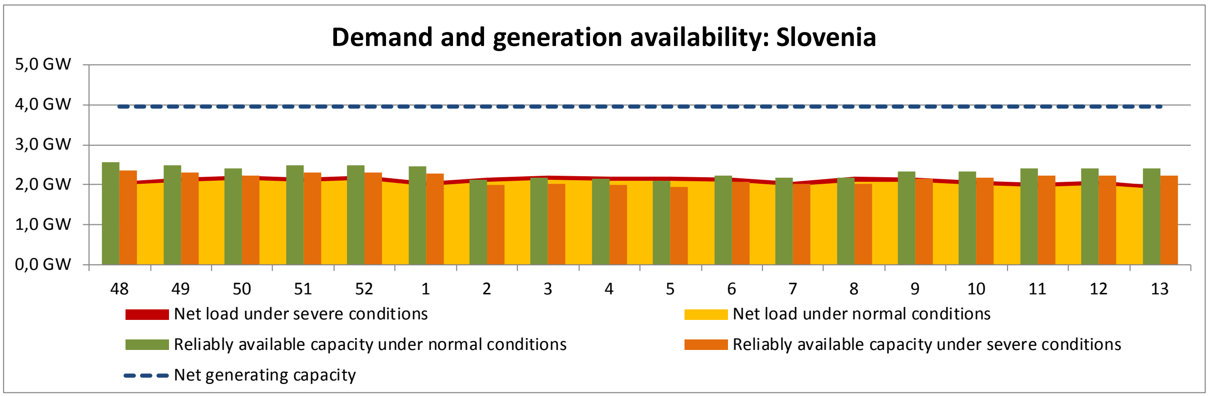
There were three forced outages of nuclear units (500 MW) this summer. The first outage was in June and it took 2.5 hours. The second outage in August took 9 hours; the nuclear unit was shut down due to the urgent repair of the line connecting the unit to the system. The last outage in September took 11 days. A significant scheduled outage of pumping power plant (734 MW) that took 1.5 days took place in July. In addition to the aforementioned forced outages, there were also short period outages of smaller units (about 100 MW) that took from several hours to several days. The scheduled maintenance of nuclear power units lasted 28 days more than in summer 2017.

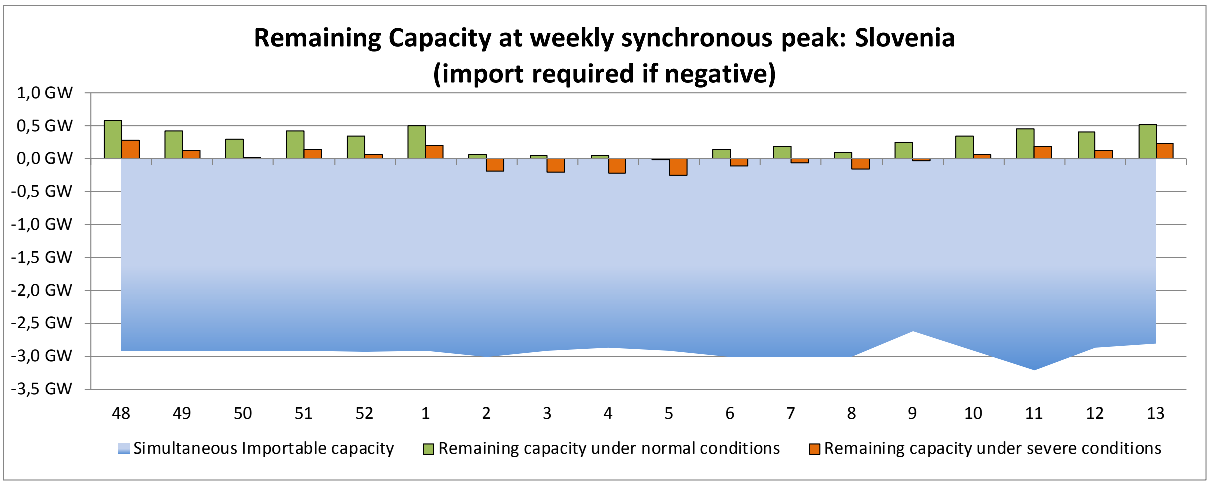
There were no significant outages of transmission system devices this summer.

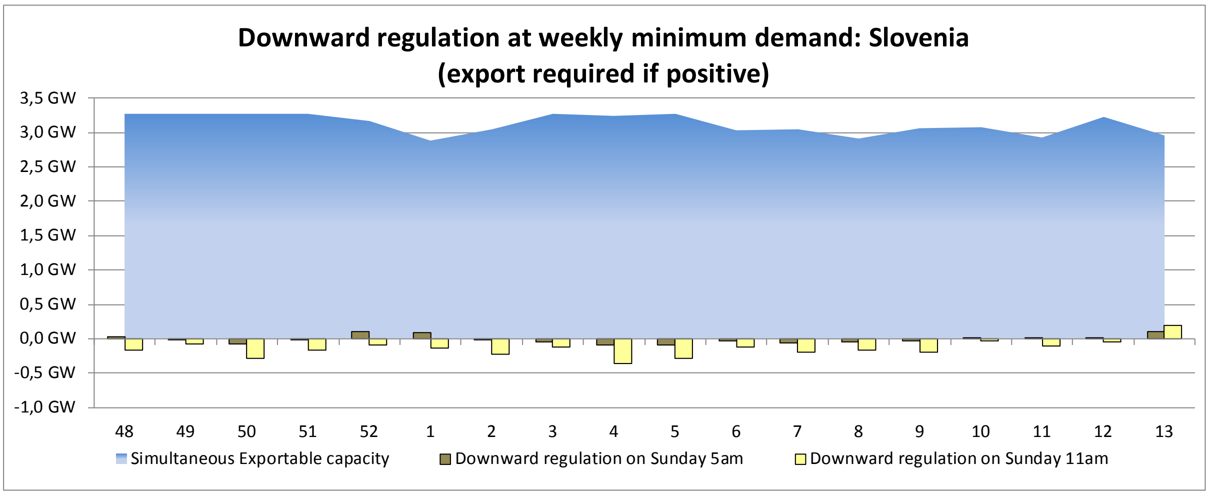
Slovenia: Winter Outlook 2018/2019

No adequacy issues are expected for the upcoming winter in Slovenia. However, in the event that severe conditions appear in January or in February, Slovenia might face a negative remaining capacity and require an import of maximum 250 MW.

During the whole observed period, the only pumping hydro power plant in Slovenia of nominal power 180 MW will be under maintenance and an export of maximum 100 MW will potentially be required during the low consumption periods in the last and the first week of the year.







Slovenia: Summer review 2018

Slovenia did not experience any adequacy related issues this summer, considering that the last few years temperatures were above average and the amount of precipitation was relatively high as well.

In July, a 248 MW unit was stopped in the Thermal power plant Sostanj. Another unit in the same power plant in August was reconnected to the grid again after having lost its energy licence three years ago.

Spain: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

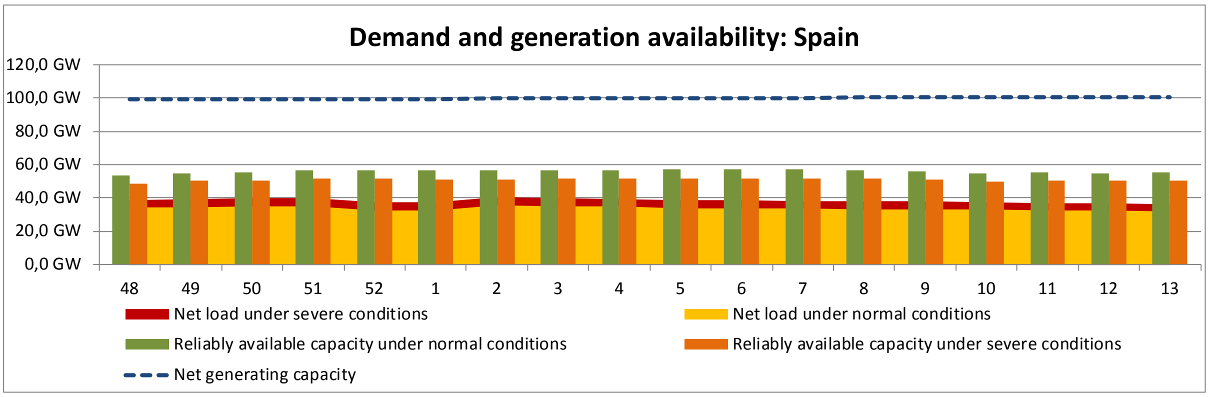
There is no adequacy risk detected in the Spanish peninsular system for the upcoming winter. Good generation–demand adequacy can be expected regardless of imports from neighbouring countries. Furthermore, capacity margins for Spain are higher in the reference synchronous time point (19:00 CET), as in Spain, local peak winter demand usually takes place around 20:00–21:00 CET.

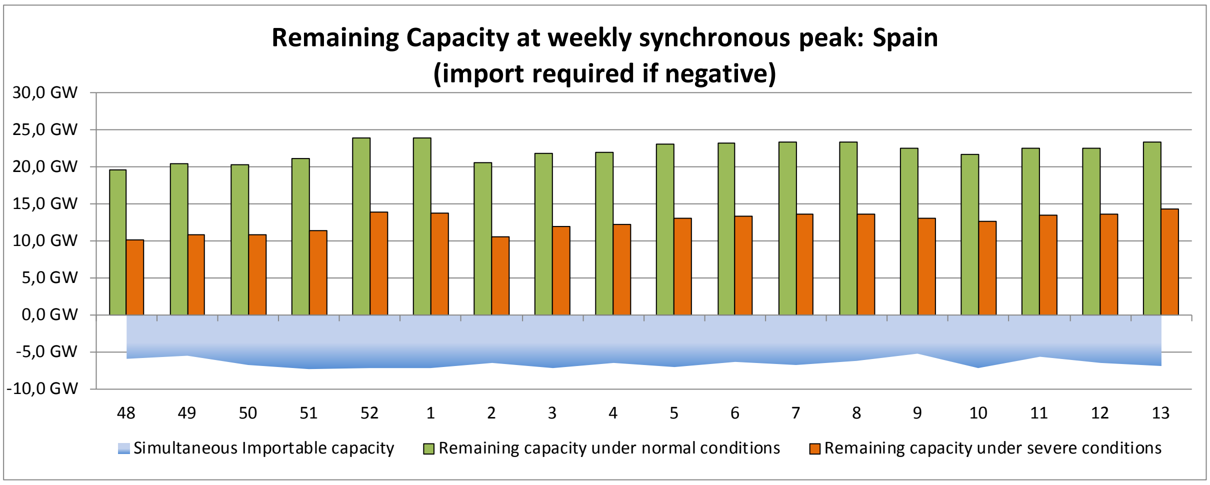
Although there are no adequacy risks identified, the factors which could reduce the remaining capacity during the next winter in the Spanish system would be the sensitivity of the demand to temperature under extreme weather conditions, persisting drought conditions, and gas availability to combined cycle thermal plants during situations of low RES.

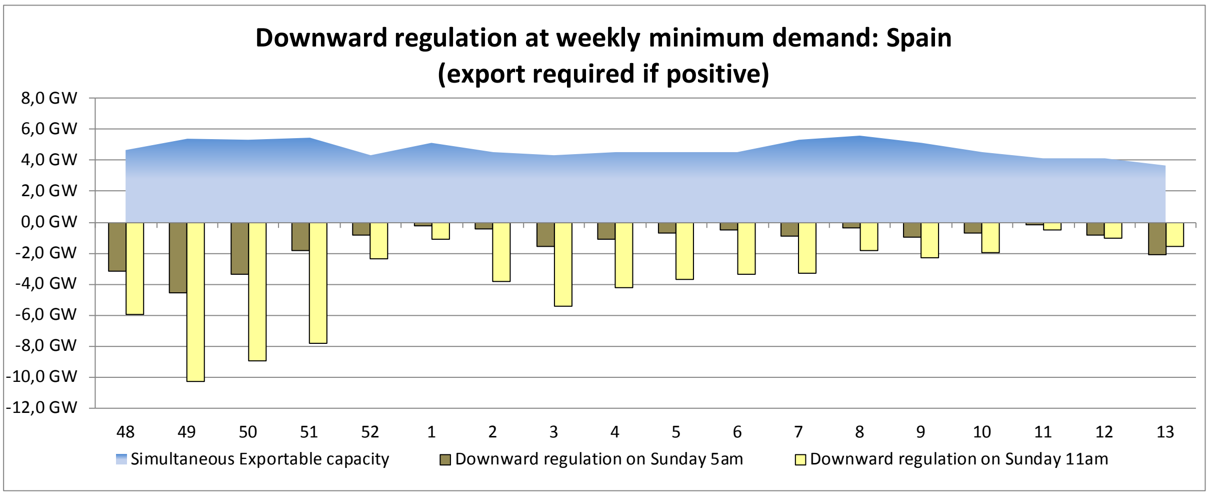
No downward regulation issues are forecasted in the quantitative analysis, but with higher RES levels there might be periods with lower margins (mainly at 5:00, during Christmas period and at the beginning of spring due to the low demand). Furthermore, the risk of RES spilling is low, because part of the RES participates in balancing markets.

The export capacity of interconnectors is a key factor in order to avoid the spilling of renewable energy, mainly wind power. Another point worthy of mention is the importance of energy storage–mainly pump storage plants–in order to properly manage the excess of inflexible power.

Hydro reservoirs levels are currently near to the historical average values, after sharply increasing in the first half of the year (reservoir levels were very low in the beginning of the year).







Spain: Summer review 2018

No adequacy or downward regulation issues were identified during the past season.

Sweden: Winter Outlook 2018/2019

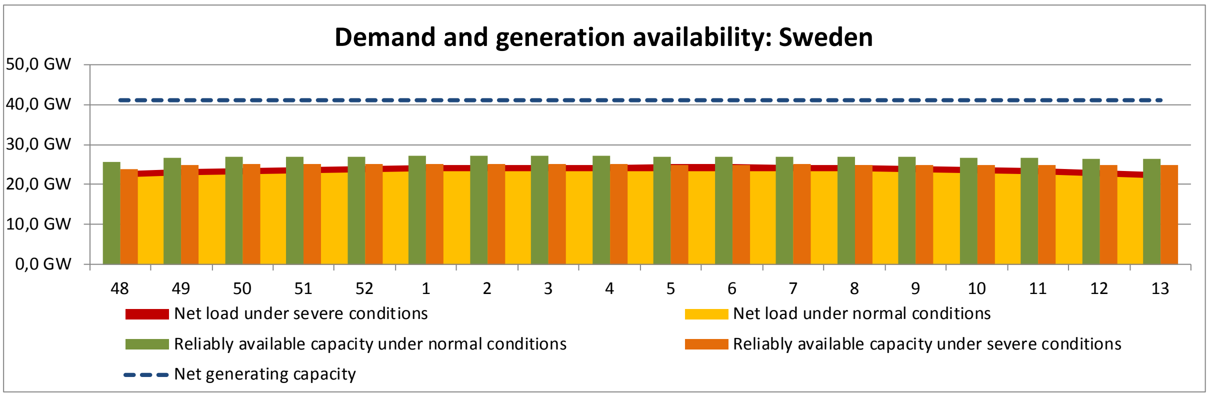
Potential critical periods and foreseen countermeasures

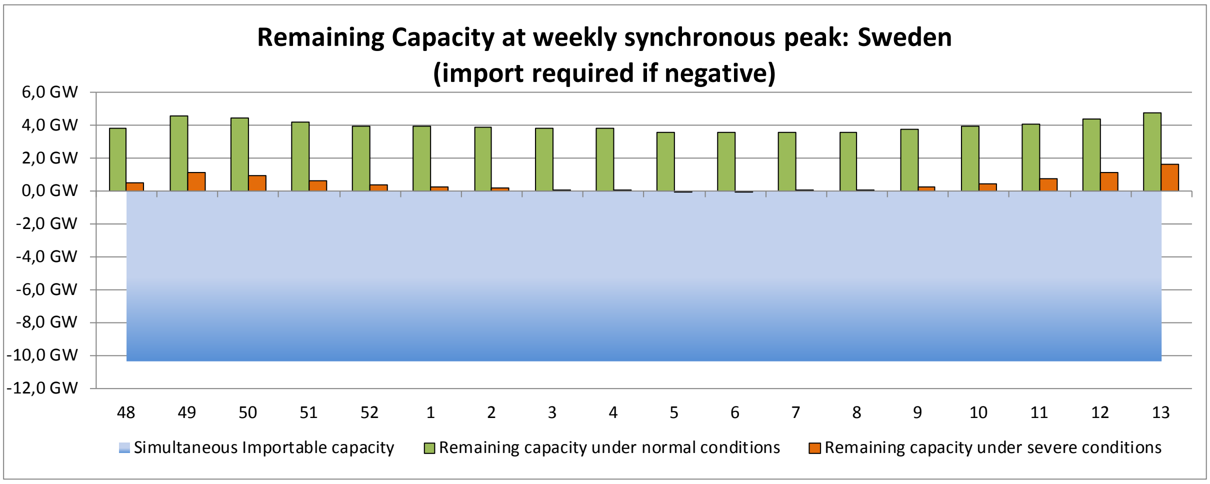
The winter period is the most critical period for maintaining adequacy in Sweden since electricity consumption is strongly dependent on outdoor temperatures. At severe conditions, interconnections are expected to play a role in maintaining adequacy during peak demand (which for Sweden typically occurs during a different hour than the reference point in time).

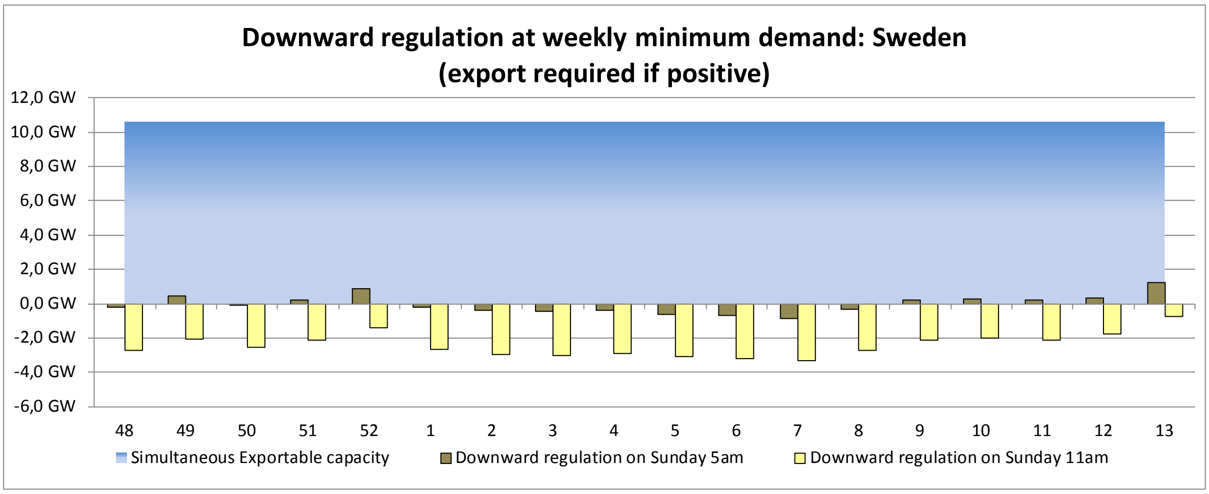
The domestic power balance is positive according to the data and method used in this report. However, there is still a risk that adequacy margins are overestimated, since internal congestions are not accounted for in the analysis. According to a report by the Swedish TSO Svenska kraftnät that uses another method, the domestic power balance is expected to be negative even for normal conditions (during the worst periods of the winter).

To secure adequacy at peak demand time, Svenska kraftnät contracts a 'peak load reserve'. For the winter 2018/2019 the 'peak load reserve' is 767 MW, of which 562 MW is production capacity and 205 MW is demand reduction.

No critical periods for downward regulation are foreseen in Sweden during the winter. The winter outlook chart suggests week 52 and week 13 might be problematic, however, downward regulation is generally not a problem during the Swedish winter due to good export possibilities.







Sweden: Summer review 2018

During the summer, low levels of system inertia occurred and, as foreseen in the Summer Outlook report 2018, new countermeasures were activated. Due to the low levels of system inertia, the output power of the largest production unit in the Nordic synchronous system was reduced on three occasions.

For a few hours in May, there was a critical downward regulation situation due to strong spring flow, higher wind power production than forecasted and reduced transmission capacity on interconnectors. All commercial bids for downward regulation at the regulating power market were cleared, which resulted in very high negative downward regulation prices during these hours (-1000 EUR/MWh). Special regulation of a nuclear power production unit was ordered to handle the situation.

Summer 2018 was extremely hot with long periods of drought in most of the country and in July extensive fires occurred in the central part of Sweden. In total, the fires covered an area of 25,000 hectares. For the emergency services to be able to extinguish the fires, several internal transmission connections were taken out of operation. This resulted in a more sensitive power system, with decreased margins to handle any further outage (n-1 security), although security of supply was still considered good. To handle the challenges, transmission limits were set with greater margins. The power system was significantly affected by reduced transmission capacity for these reasons. In addition, high temperatures cause limited transmission capacity for thermal reasons. On most lines, the limits were decreased by 30–40 percent, while transmission capacity between bidding zone SE 2–SE 3 was reduced to half due to the fires and high temperatures. Most of the planned maintenance work on the high voltage power grid was cancelled due to the serious risk of fire or negative impact on transmission capacity.

At the end of July, a nuclear power production unit was taken out of operation because the seawater used to cool systems and components in the process, exceeded the maximum temperature limit. As a preventive adequacy measure, the activation time of Swedish wintertime 'peak load reserve' power plant was reduced. During this period, Sweden’s ability to support neighboring countries was severely limited. This shows that high ambient temperatures increase the risk of upward adequacy problems.

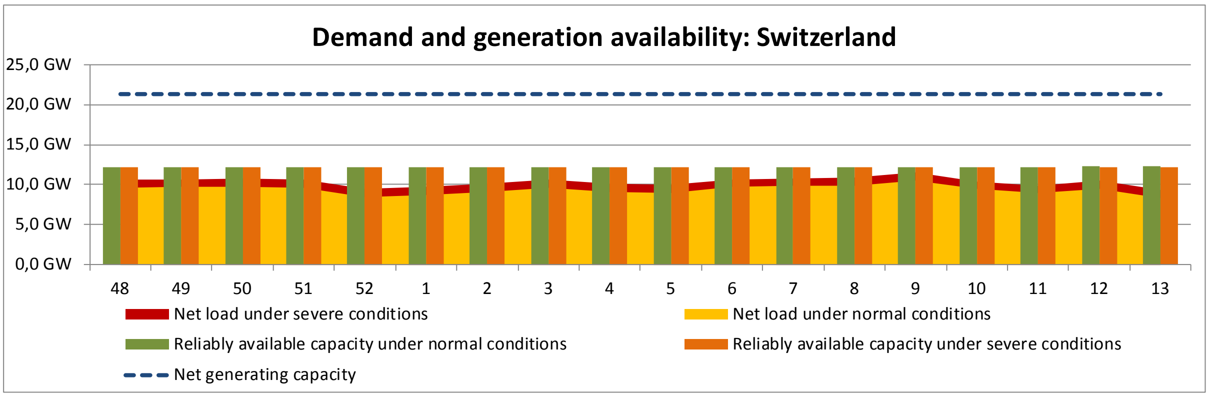
Switzerland: Winter Outlook 2018/2019

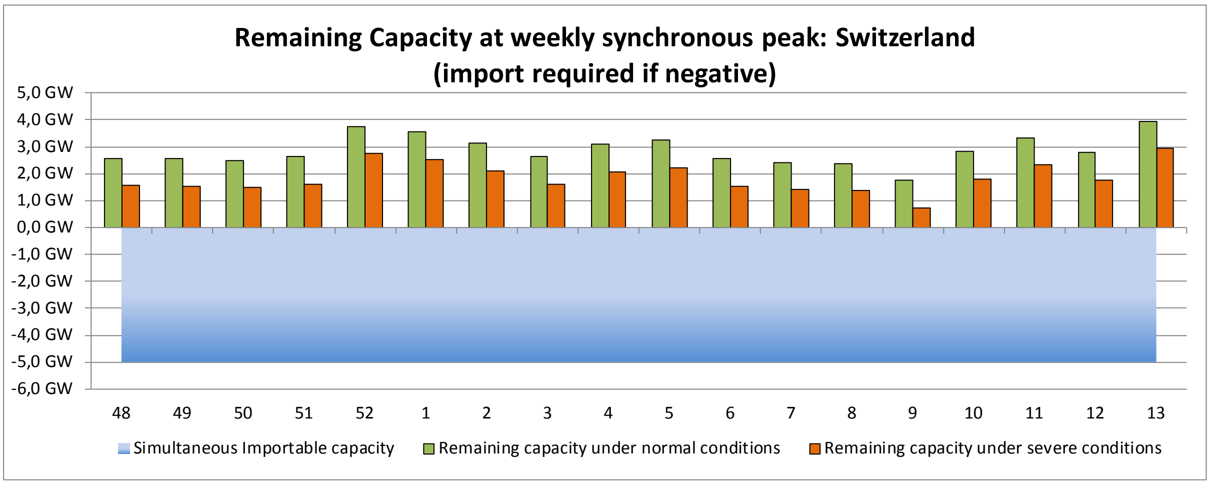
Potential critical periods and foreseen countermeasures

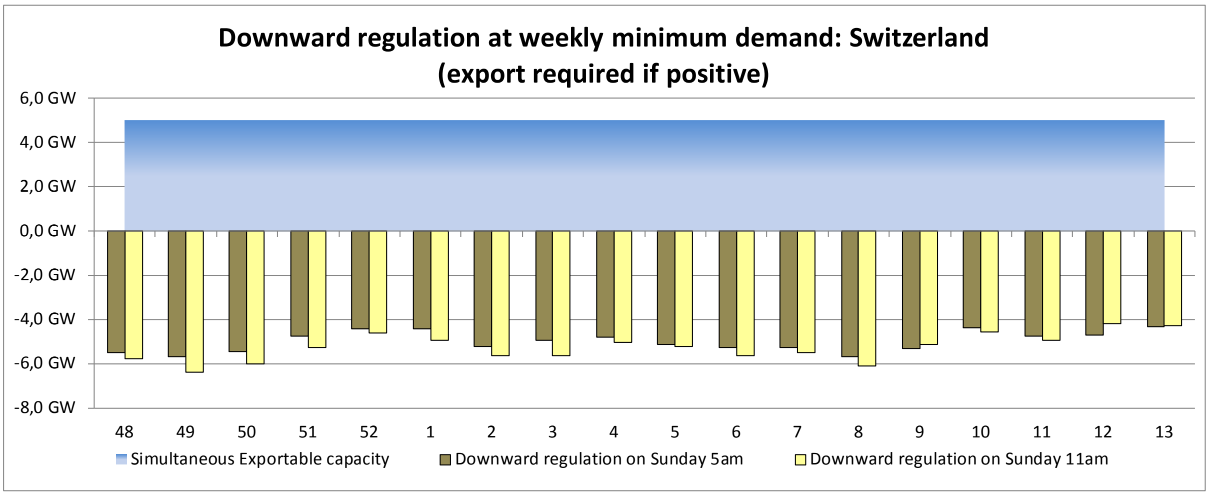
Using the current adequacy methodology, no adequacy or downward regulation issues are expected for the coming season. Deterministic capacity–based assessments cannot reveal potential problems faced by hydro–dominant countries like Switzerland. In particular, for Switzerland it is very important to also consider energy constraints. A potential winter deficit in Switzerland 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 which might occur.

In other words, even if the currently used methodology concludes that no problems are expected in Switzerland, specific problems might still arise (cf. situation of the winter 2015/2016 and Cold Spell January 2017).







Switzerland: Summer review 2018

No adequacy or downward regulation issues were identified during the past season.

General comments on past summer conditions

- Switzerland experienced its third hottest summer since the measurements, which began in 1864;
- The precipitations equalled 71% of the norm between 1981 and 2010;

- The sunshine was above the seasonal norms.

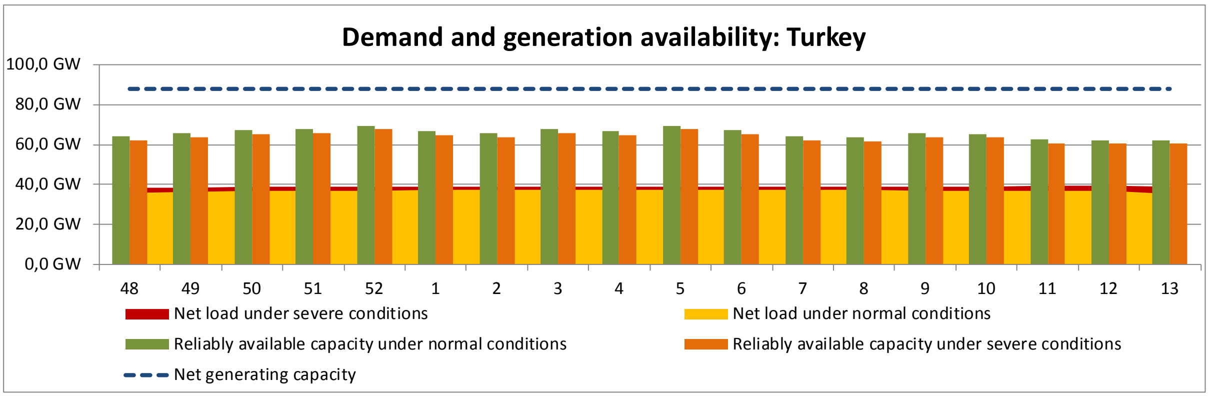
Specific events and unexpected situations that occurred during the past summer

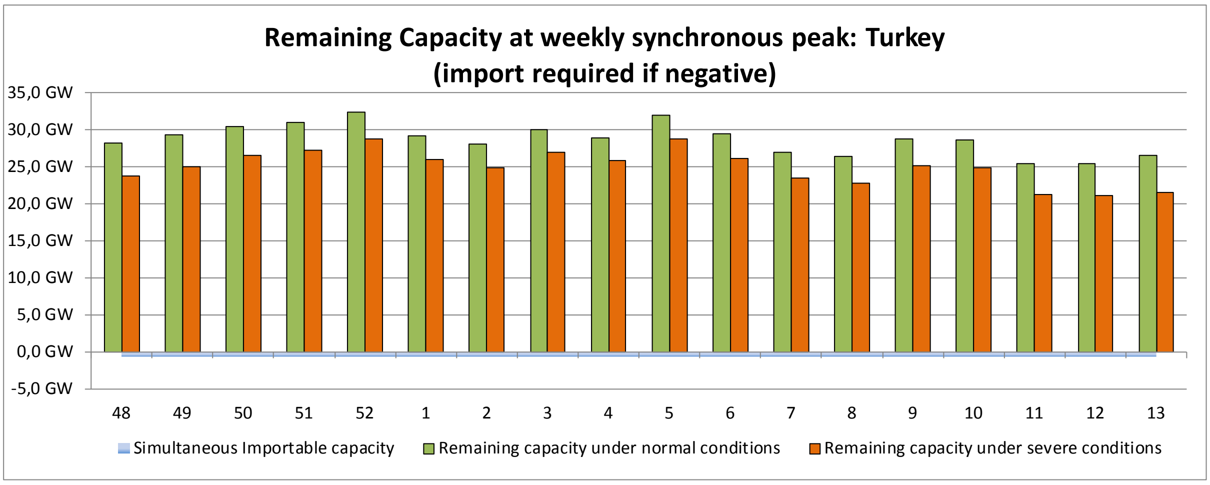
- During off–peak periods, in order to mitigate high voltages, the available compensation measures were often used;
- In order to ensure the grid security, besides topological measures, a high level of national and international redispatch as well as the postponement of some planned works were necessary;
- Furthermore, in June 2018, the Laufenburg grid control centre was successfully moved to Aarau.

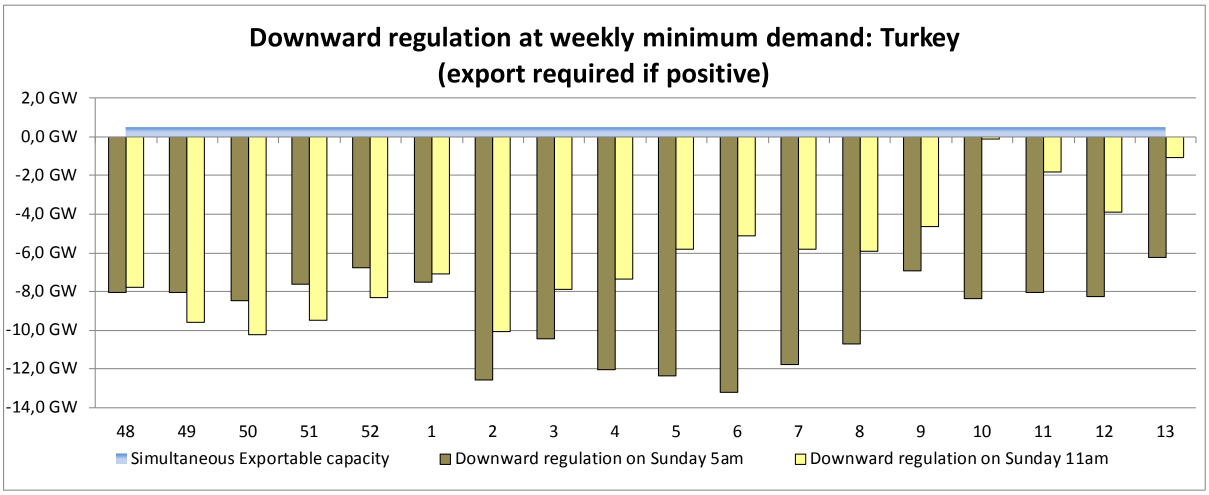
Turkey: Winter Outlook 2018/2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season.







Turkey: Summer review 2018

No adequacy or downward regulation issues were identified during past season.

Appendix 2: Methodology

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.*[21]

Despite its limitations, current Seasonal Outlook methodology indicates the most critical periods within the coming season and provides strong support for system operation planning coordination on a Pan-European level. Efforts are continuously being invested to come with advanced methodology to overcome limitations, thus providing additional realistic insight on possible European system operational states during each country's most critical moments. For this purpose, ENTSO-E is currently developing a full probabilistic methodology with hourly calculations at the Pan-European level.

1. Upward Adequacy and Downward Regulation Definitions

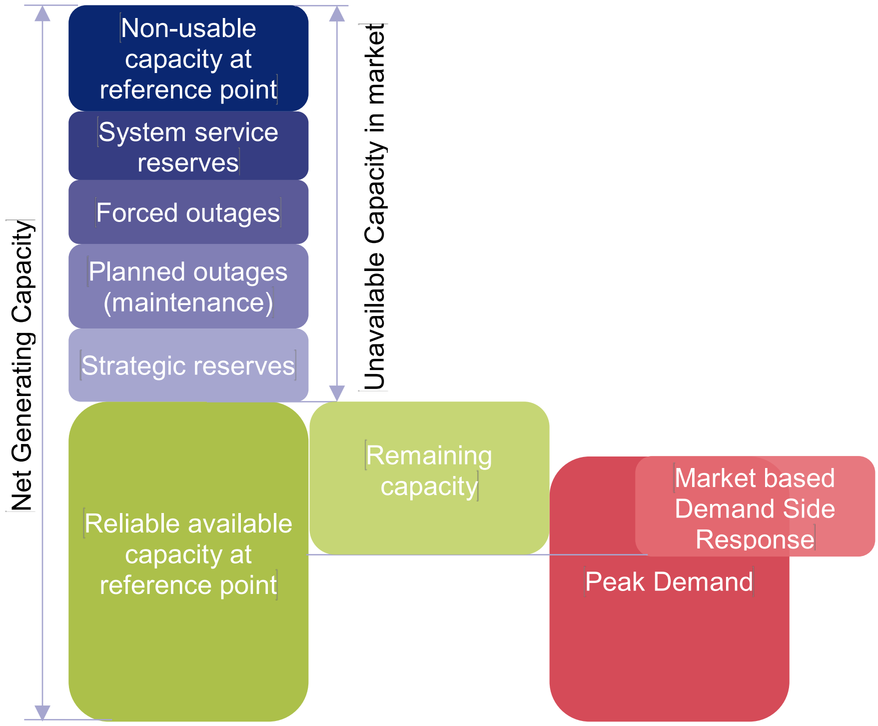
The **upward adequacy analysis** consists of identifying the ability of generation to meet the demand by calculating the 'remaining capacity' (RC) under either normal conditions or severe conditions.

- '**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 in less than 1 in 20 years.

The analysis is the same under normal or severe conditions, and is schematically depicted in the figure below:[22]

[21] *ENTSO-E Target Methodology for Adequacy Assessment*

[22] *Definitions may be found in Glossary given in Appendix 5:*



Upward adequacy methodology.

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

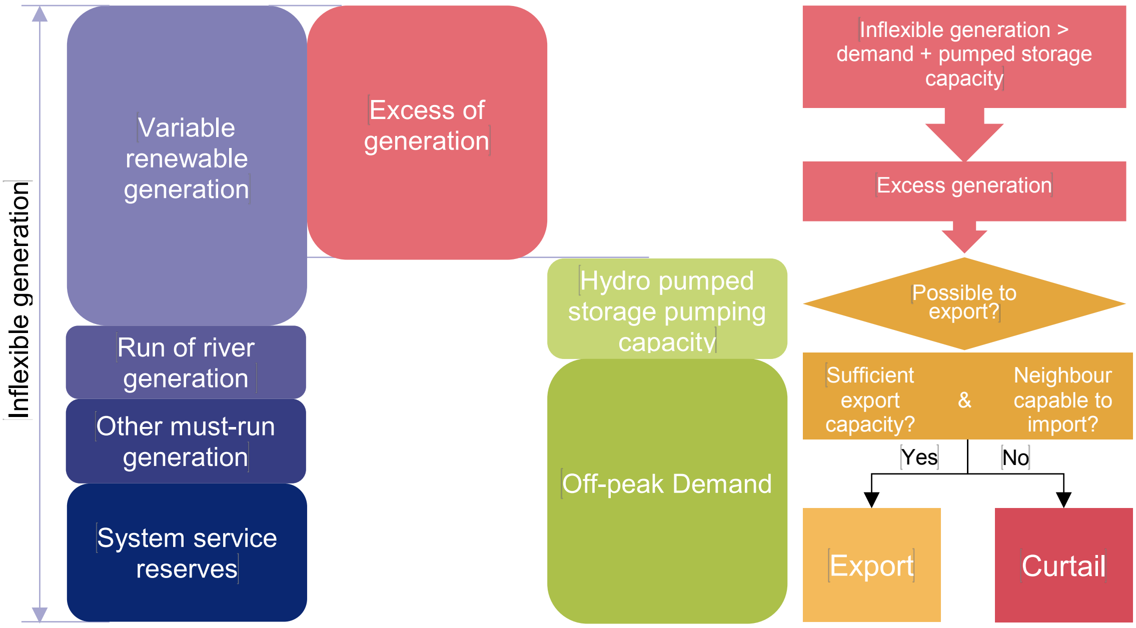
One synchronous point in time is collected for all countries to allow for a meaningful pan–European upward adequacy analysis when determining the feasibility of cross–border flows. The most representative synchronous point in time for the upward adequacy analysis is Wednesday 19:00 CET during wintertime and 19:00 CEST during summertime. At this time, the highest European residual load 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 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 the 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 countries' needs. There should be no problems with this approach, either for normal or 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, such as 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,
10. Market–based demand side management, and
11. Strategic reserves

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[23] is used to run numerous simulations. The following high–level methodology is applied to build each one of those simulations:

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

- 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 Modelling

3.1 Climate database

To improve data quality and pan–European consistency, ENTSO–E invested in a pan-–European Climate Database (PECD) that covers 34 years of historical data (1982–2015). The PECD consists of reanalysed hourly weather data and load factors of variable generation (namely, wind and solar). PECD data sets are prepared by external experts using best practice in industry, thus ensuring a representative estimation of demand, variable generation and other climate-dependent variables. 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 demand sensitivity to temperature in each country is calculated based on the PECD.

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

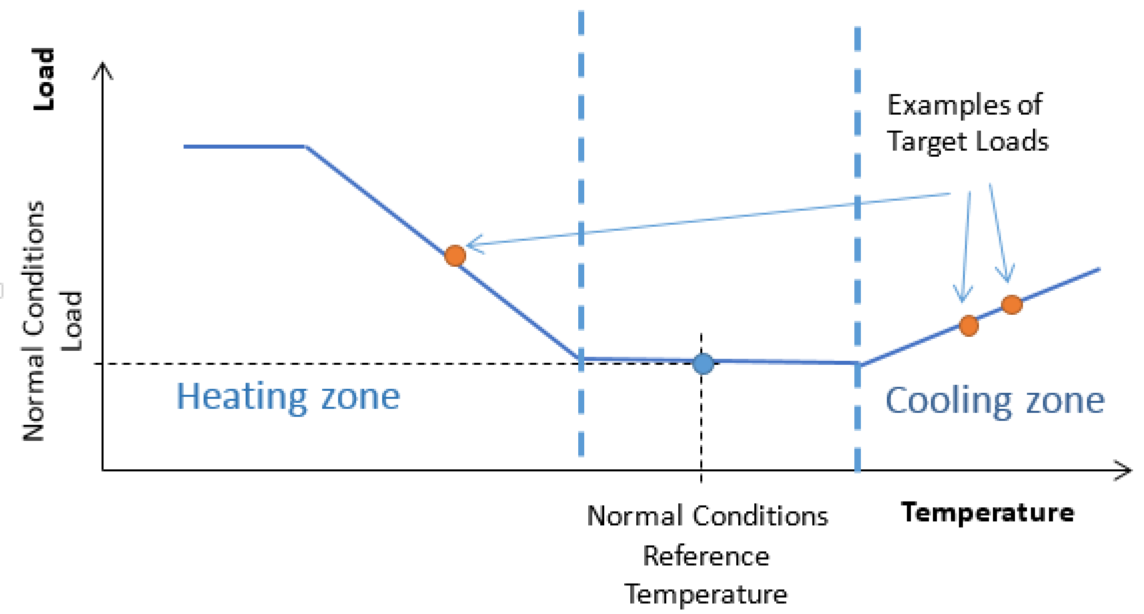
Regarding the downward adequacy analysis, the same approach is used, but using the 95th percentile value (that is exceeded only by 5% of records in collection).

3.2 Demand

The submitted per country demand 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 of how these coefficients were determined can be found in Appendix 3:.

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).

ENTSO–E is currently developing an enhanced demand modelling tool that will consider with high accuracy the influence of, e.g., temperature or bank holidays using a mathematical Single Decomposition approach.

3.3 Net Transfer Capacities

The import/export net transfer 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 Improvements

In the constant improvement process, the following key enhancements are planned for future Seasonal Outlooks:

- Investigate how to implement full probabilistic hourly calculations based on the Mid-Term Adequacy Forecast (MAF) experience[24], 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) shall also be considered. ENTSO–E will, in a stepwise approach, build consistent databases at hourly resolution and run tests in market modelling tools, The goal is to get the probabilistic methodology operational by 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.

24 MAF reports

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.[25]

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:[26]

$\boldsymbol{NMAT}_{ij}$, *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, ...)

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[25] *City Population is the source for city populations*

[26] *Climatology database of the World Meteorological Organization (WMO) is the source of average temperatures*

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,..)

$\mathbf{ND_{imonth}}$– 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

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

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

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

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

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

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

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

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}), in this way creating a resulting time series for working days only;
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** (**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.

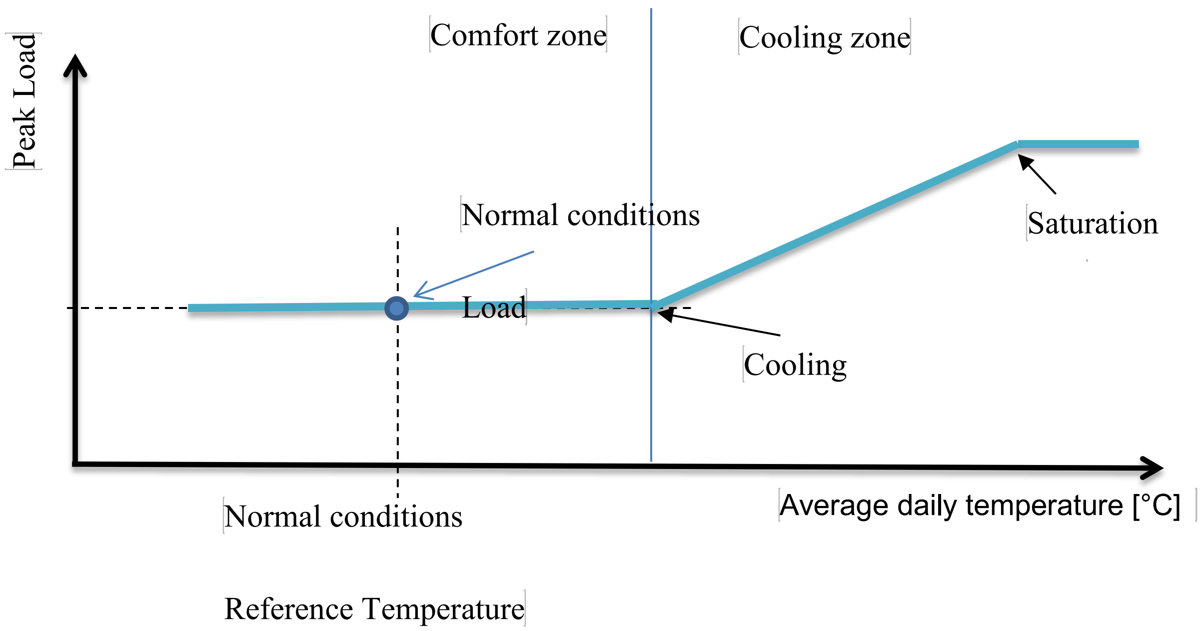
5. Model the relation between the peak load and the daily average temperature in the range **T_{start} – T_{satur}** by simple linear regression:

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

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;* - *sensitivity to decommissioning of generation* - *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 maintaining upward adequacy, countermeasures adopted and expected role of interconnectors.
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);* 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);* - *etc.*

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*** - ***voltage issues (only if relevant):*** *please list voltage regulation issues you had (e.g. too low voltage at peak or too high at off–peak times)*

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's 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.

Demand (or Load): Load or demand 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; and 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.

Residual Load (RL): is total demand subtracted by wind and PV generation at given reference point.

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).