Winter Outlook 2019 / 2020 Summer Review 2019

27 November 2019

entsoe

Contents

Index of Figures

Index of Tables

1 Executive Summary

Under normal conditions, the pan-European adequacy analysis indicates no risk for supply shortage during system-wide peak moments. Nevertheless, extreme cold spells, combined with low renewable generation and unplanned outages of generation and transmission, indicate a risk of supply shortages in Belgium and France in January 2020. Adequacy risk is observed when the daily average temperature in that region drops to -5°C, which is nearly 10°C lower than the normal January temperature and rather unlikely in the region.

Under these circumstances, both countries would heavily rely on imports. In some cases, they even may be looking for available out-of-market measures and regional cooperation to prevent the local demand-shedding. Such conditions would require system reliability to be tightly monitored closer to the operational timeframe with the support of Regional Security Coordinators (RSCs). This tight cooperation will be especially crucial should there be significant unplanned outages of generation or transmission combined with extreme cold weather conditions and low renewable energy generation.

Renewable generation capacity in 2019 increased at the same pace as in 2018 in Europe. As a result, higher renewable curtailment should be expected in periods with low demand and high renewable generation compared to winter 2018/2019. In addition, conventional generation continued to be decommissioned since 2018 but at a slower rate.

No significant events were recorded in summer 2019. Some heatwaves were recorded, but with no impact on electricity supply. Hydro reservoir levels remained stable over 2019 and were near average by the end of the summer season in most regions, except Italy, where reservoir levels settled slightly above historical minimum levels.

2 Introduction

2.1 Purpose of the Seasonal Outlooks

ENTSO-E and its member Transmission System Operators (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 occurred 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 using 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 25 November 2019 and 5 April 2020. The Summer Review examines the system adequacy issues registered between 27 May 2019 and 30 September 2019.

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 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 that the expansion of Renewable Energy Sources (RES) remained at the same level, whereas conventional generation capacity decreased less compared to last year.

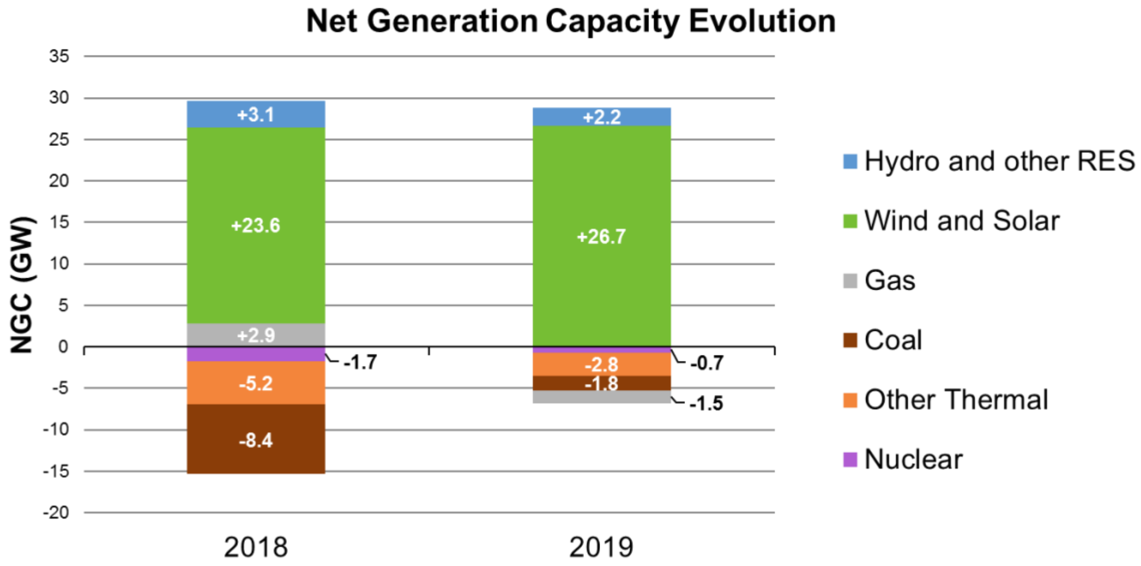


Figure 1: Evolution of NGC per technology.

In the map given in Figure 2, net generation capacities (NGCs) are displayed in absolute values (GW) for each study region. To ease comparison at the pan-European level, a ratio of NGC 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.

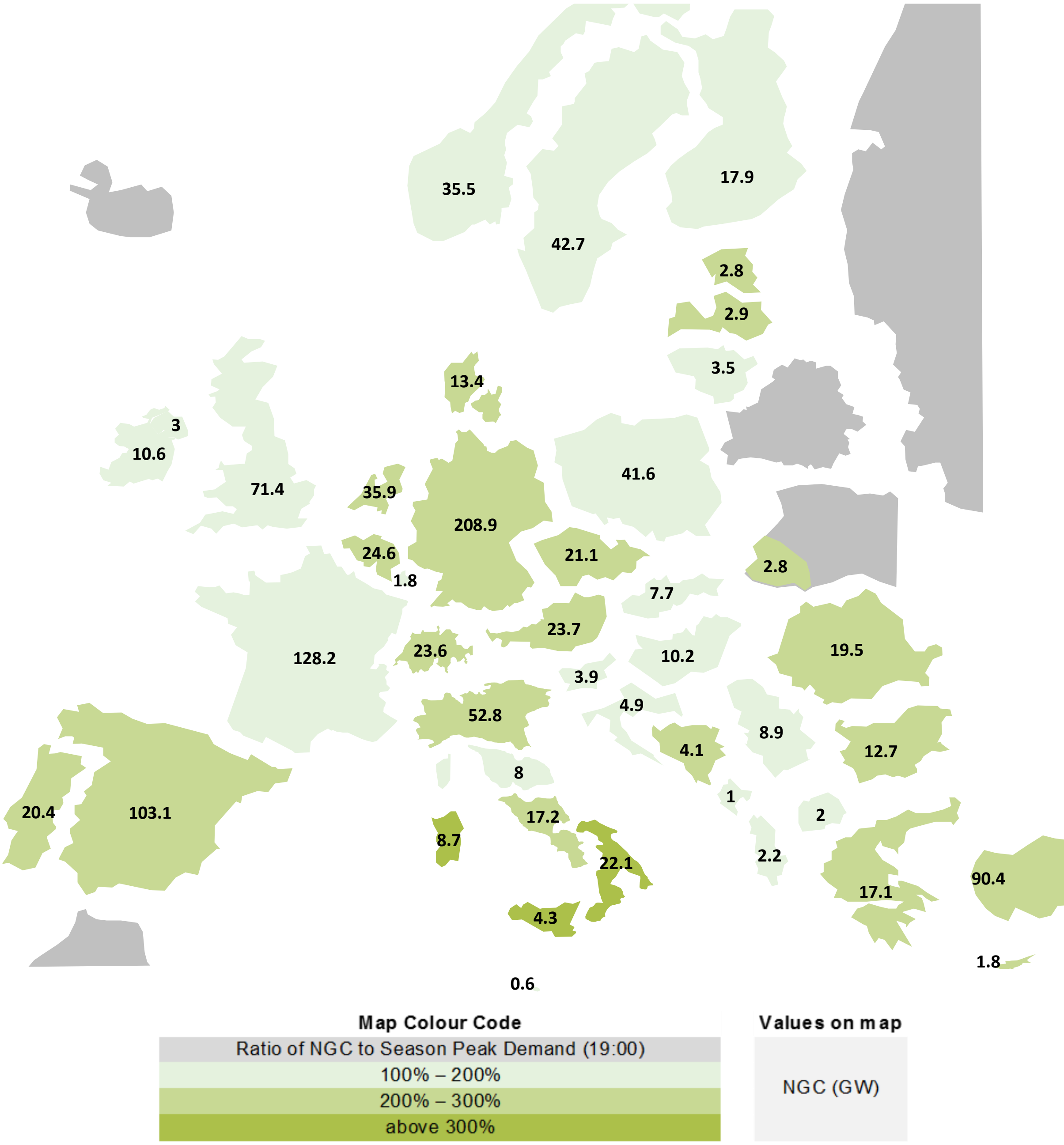


Figure 2: NGCs (in GW) and colour according to their ratio to expected national peak demand in the winter season.

3 Winter Outlook 2019/2020 – 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

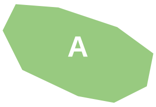
Results in figures displaying maps in Section 3 present reliably available generation capacity capability to supply peak demand in the coming season under study (normal or severe condition). If reliably available capacity (RAC) in the country is sufficient to supply expected demand throughout the whole 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.

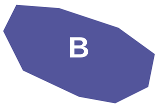
In addition, a simplified merit-order approach[4] is considered. Countries in specific weeks that do not require imports from an adequacy perspective, but could import from a market perspective, are coloured in light blue.

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

How to read the results



Country is capable of supplying demand throughout the season



Country needs imports at least 1 week in season to supply demand

Weekly results table

- National generation is sufficient to supply national demand
- National generation is sufficient to supply national demand, but cheaper generation is available abroad
- National generation is insufficient to supply national demand – need for imports
- National generation and imports are insufficient to supply national demand

Ratio of fill represents unsupplied demand by imports

Example

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

3.2 Adequacy Under Normal Conditions

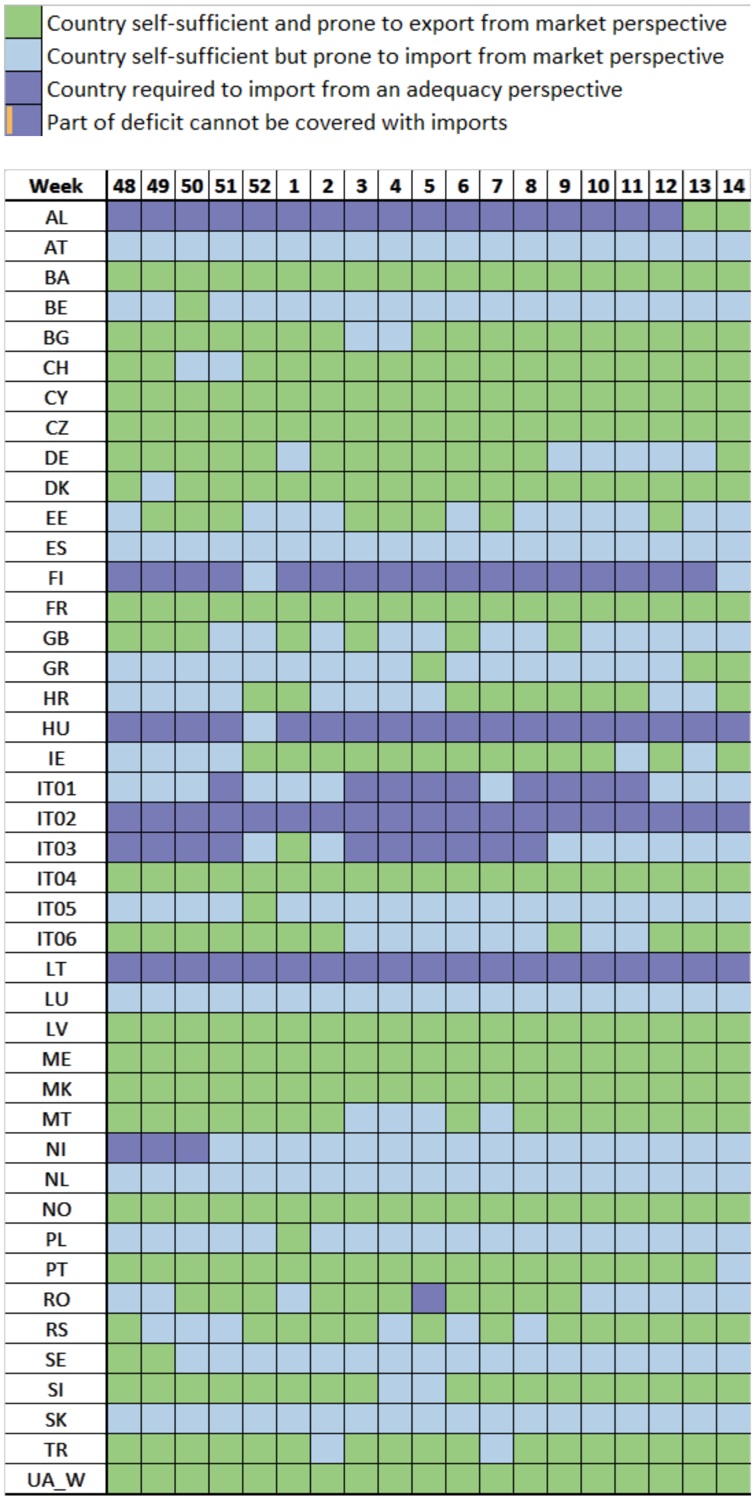
Under normal conditions, generation capacities and available market-based DSR are sufficient to supply demand in all of Europe throughout the winter season, with only some countries requiring an import contribution.

No need for energy import | Imports needed at least one week

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 Italy, Northern-Central Italy, Southern-Central Italy and Lithuania rely on imports this season. Northern Ireland (in weeks 48 to 50) and Romania (in week 5) would require imports in some specific weeks only and could be subject to adequacy issues under severe conditions at these weeks.

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—a 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 the 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.

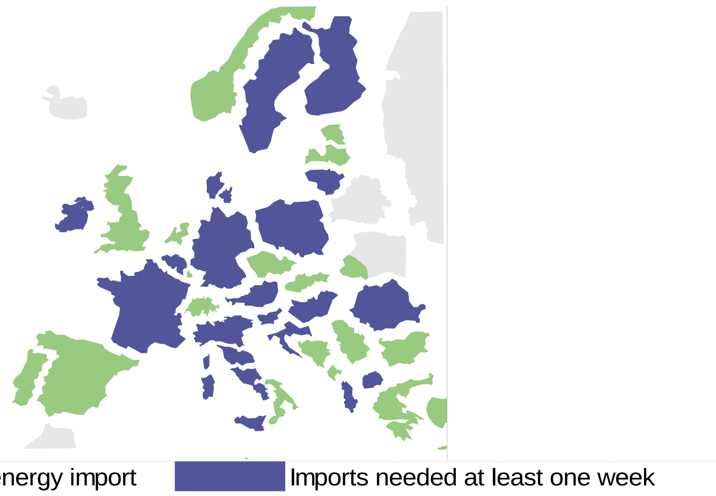


Figure 4: Adequacy under severe conditions.

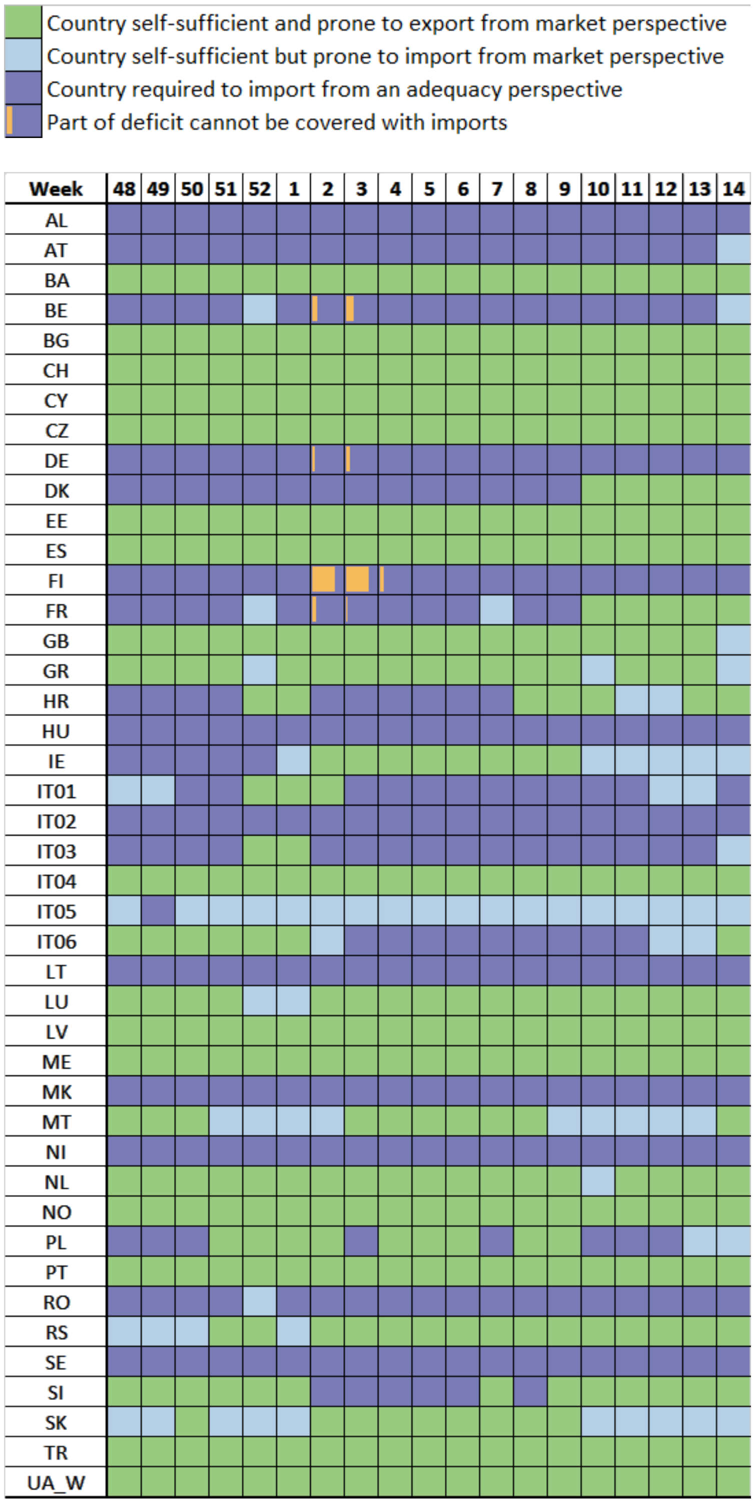
Results on a weekly basis presented in Table 2 indicate that Belgium, Germany, Finland, and France could face some adequacy issues at the beginning of 2020. This is a first-time when adequacy risk is identified in Germany under severe conditions ('deterministic stress test'). This is mainly explained by the decommissioning of nuclear, hard coal and lignite units (accounting for 3.3 GW) and increased system reserve need (around 1.1 GW) compared to winter 2018/2019. 0.8 GW of decommissioned capacity will serve as additional out-of-market measures to cope with adequacy risks. Nevertheless, this risk was not confirmed in probabilistic assessments (cf. Section 3.5).

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

Furthermore, 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).

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 in weeks 2–3.

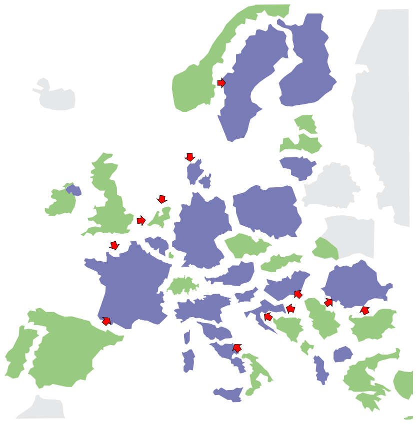


Figure 5 Regional isolation under severe conditions.

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 optimisation 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).

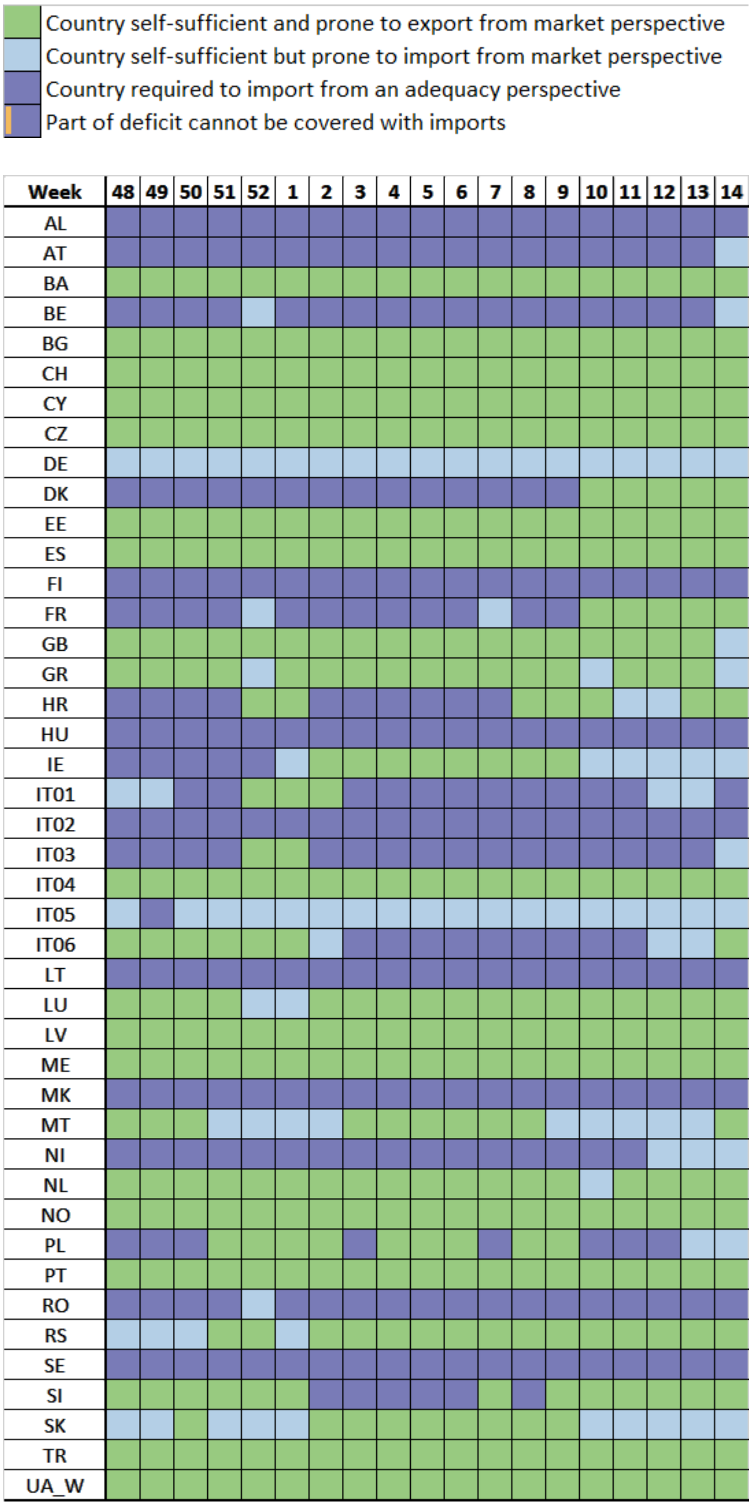
3.4 Sensitivity Analysis Under Severe Conditions Considering Existing Out-of-Market measures

The sensitivity analysis assessed whether available strategic reserves would be sufficient to solve adequacy issues in Europe under the severe conditions identified in Section 3.3. With 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 out-of-market measures are considered available and can be shared between countries. This assumption cannot always be made for the decisions that will be actually taken, 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 the contribution of out-of-market measures.

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 2020, as the risk is highest and covers the widest geographical region in Europe.

A pan-European analysis concludes there is approximately a 4% 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. Therefore, the global risk for the whole winter could be higher than the indicated 4%.

In Figure 6, the summary of probabilistic analysis for week 3 is presented. It validates risks in Belgium and France, but no risk is confirmed in Finland and Germany. This is explained because the probabilistic analysis uses historical correlated climatic variables that are not all simultaneously extreme. The deterministic simultaneous severe conditions (one-in twenty-year highest demand and lowest RES generation) in all countries could even be considered as a stress test.

These results indicate that Albania, Hungary, Lithuania, North Macedonia and Northern-Central Italy rely on imports in week 3, 2020. It is interesting to note that no risk is identified in Italy (Northern and Centre-Northern), even though the supply situation in these areas has not changed since winter 2018/2019, when risks were identified. This may suggest that the supply situation in winter 2019/2020 has improved in the neighbouring regions (in southern Italian regions and neighbouring countries in the north). Nevertheless, this also suggests that it is important to monitor the situation carefully, as Italy might experience adequacy issues if significant generation and/or transmission unplanned outages occur.

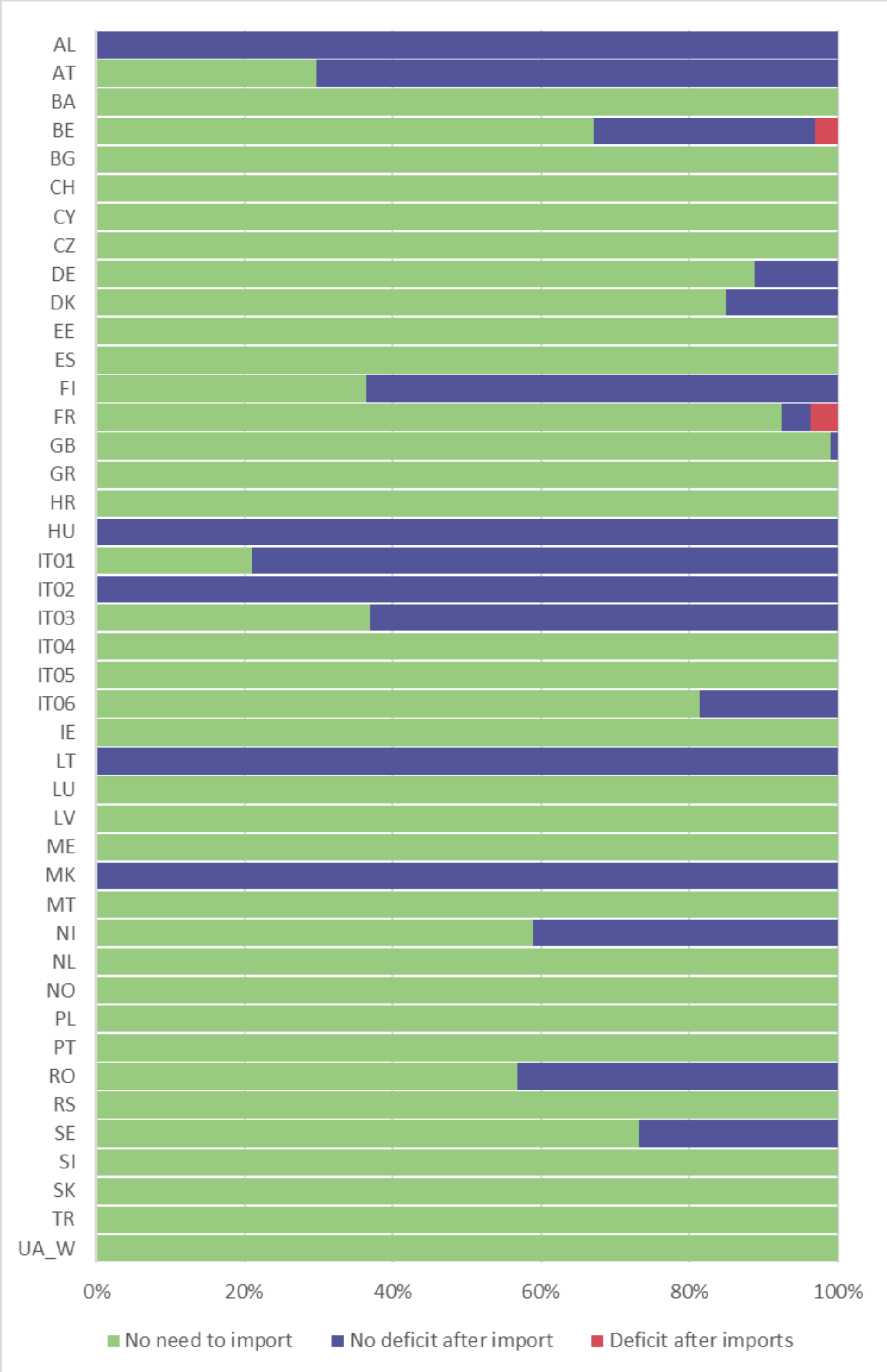


Figure 6: Probabilistic simulation results–week 3

Figure 7 and Figure 8 present a more detailed probabilistic analysis results of countries at risk. They suggest that risks exist when temperatures drop significantly in Belgium and France. Belgium would be exposed to risk, especially when a temperature drop coincides with low wind generation.

The probabilistic simulation results of Belgium, considering the most expected unplanned outages of generation and transmission, suggest inadequacy risk if the daily average temperature falls to -5°C and wind generation does not reach 30% of wind generation capacity.

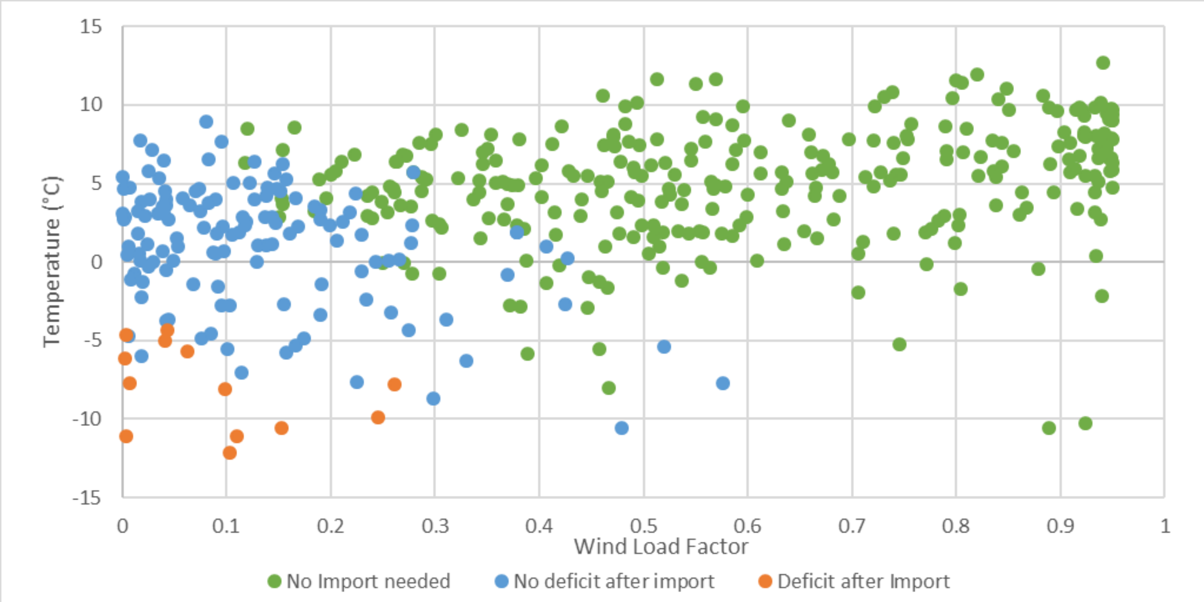


Figure 7: Probabilistic sensitivity analysis–week 3 in Belgium.

The 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 drops to -5°C, which is 10°C lower than the seasonal norm for January. These weather conditions are linked to historical extreme weather conditions, such as the cold spell in 1985. However, the RTE (French TSO) national study[6] 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).

[6] French generation adequacy reports

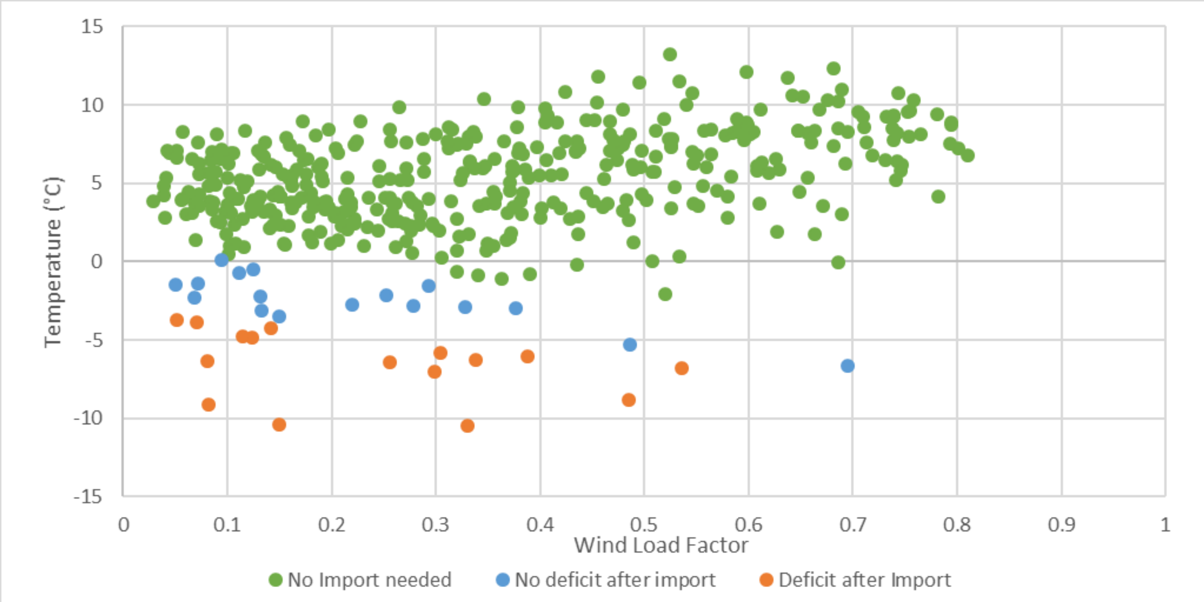


Figure 8: Probabilistic sensitivity analysis–week 3 in France.

4 Winter Outlook 2019/2020 – 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 the 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 to be a representation of forecasted winter curtailment. They only indicate 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 the power system and also indicates business opportunities for emerging technologies such as batteries.

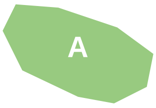
4.1 How to Read the Results

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.

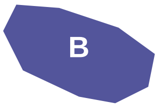
How to read the results

Weekly results table



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

Demand is sufficient to absorb Inflexible and variable generation



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

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

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

Ratio of fill represents ratio of excess power to be curtailed

Example

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

4.2 Daytime Downward Regulation

The results displayed in Figure 9 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, weeks 13–14 in 2020 when it is 11:00 CEST.

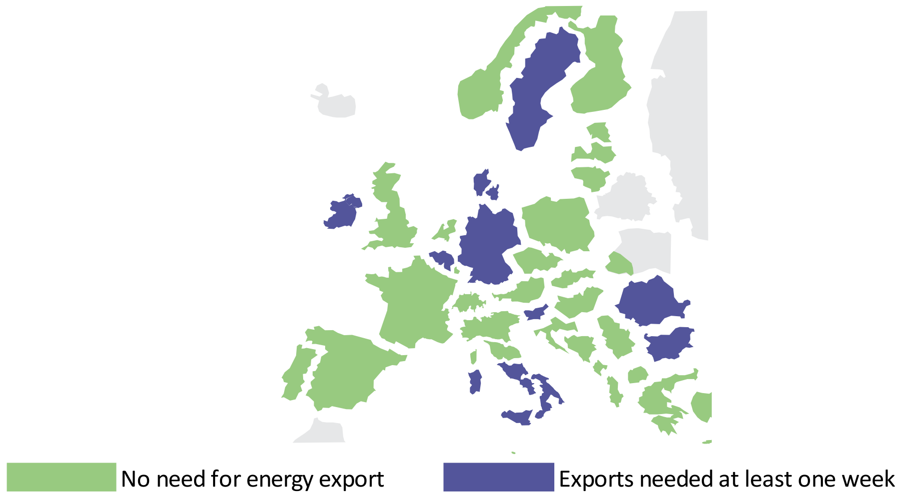
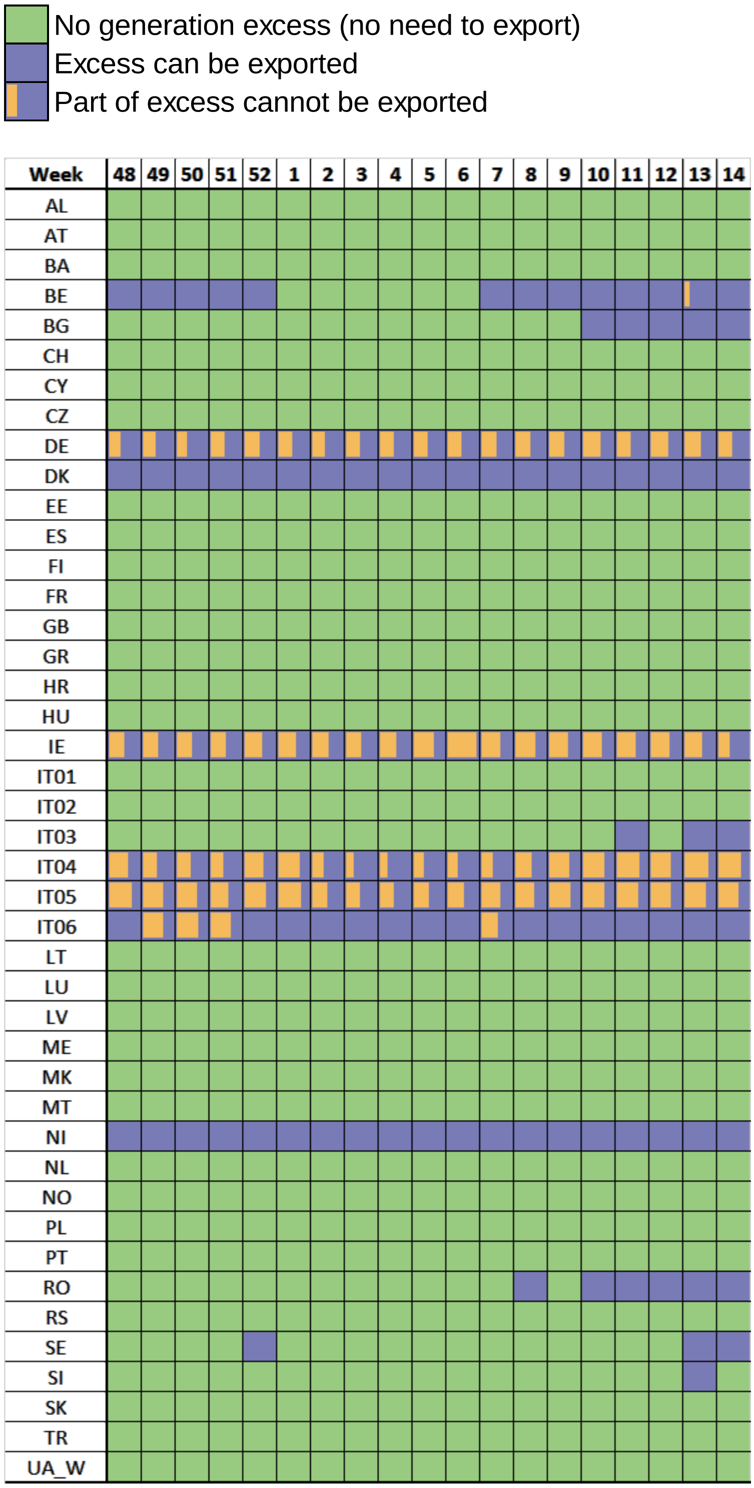


Figure 9: Daytime national downward regulation adequacy.

The weekly results in Table 4 indicate that the curtailment of excess wind and PV may be necessary in some countries to ensure system stability. Higher rates of curtailment are observed in some countries compared to the results of the Winter Outlook 2018/2019. 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 10 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 Great Britain, Montenegro, North Macedonia and Poland.

The night-time downward regulation adequacy corresponds to Sunday early morning (5:00 CET for the study period but 5:00 CEST for weeks 13–14 in 2020). Curtailment mostly relates to wind generation as no PV generation is expected at that time.

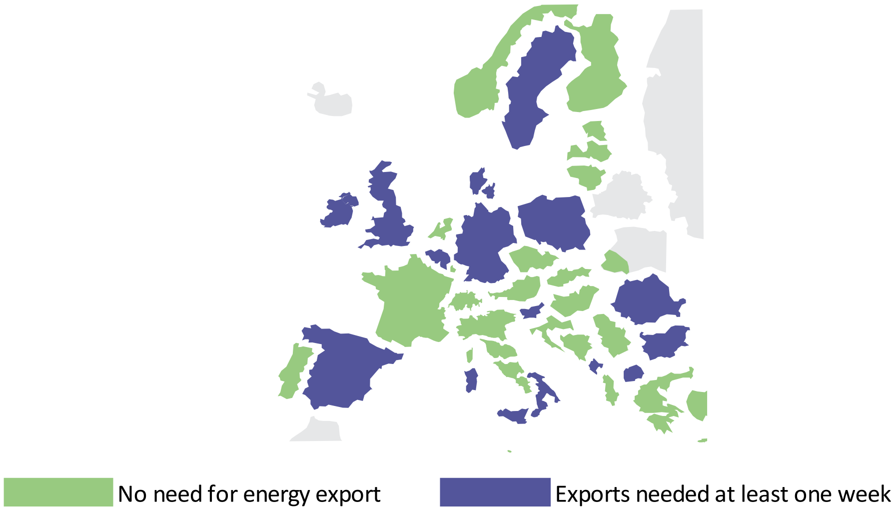
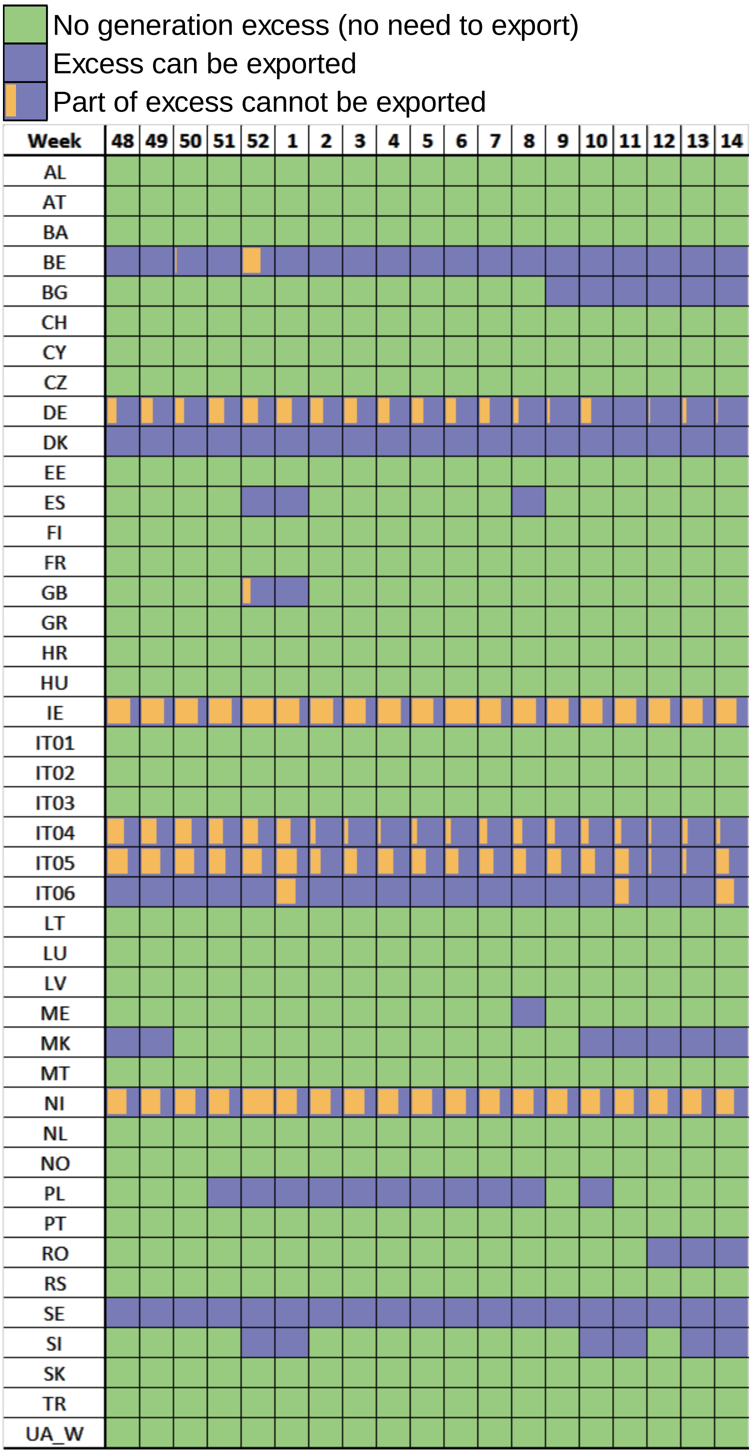


Figure 10: Night-time national downward regulation adequacy.

The weekly results in Table 5 are in line with the 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.

Table 5: Night-time downward regulation adequacy.



See Section 4.1 for details on how to read the results

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 September were around historical averages, with Italy being the exception whereby reservoir levels settled slightly above historical minimum levels. The reservoir levels in France and Austria recorded sharp increases at the beginning of summer 2019, but elsewhere reservoir levels remained stable around average throughout 2019.

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 above the historical minimum levels. Reservoir level trajectory in 2019 is very similar to the trajectory recorded in 2018—only a slight delay to reservoir level recovery was recorded in April and May, which was compensated for later. By July, reservoir levels reached levels recorded in 2018.

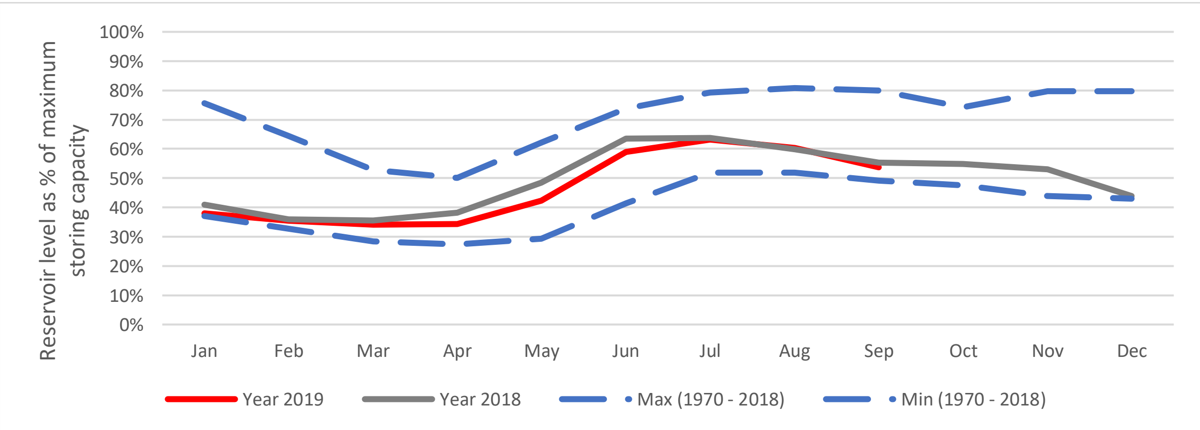


Figure 11: Reservoir levels in Italy.[7]

In France, the reservoir levels settled at average levels in the second half of 2019. At the beginning of 2019, reservoir levels were below the historical average and by summer had dropped below historical minimum levels. Nevertheless, water accumulation in reservoirs

[7] *Based on data published by Terna*

were recorded in summer and in August reservoir levels settled at the historical average level.

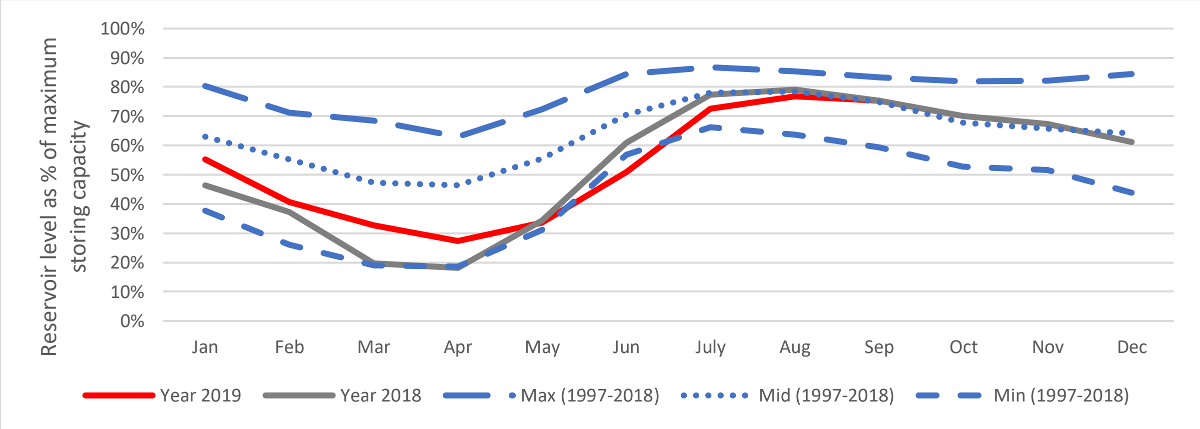


Figure 12: Reservoir levels in France.[8]

Hydro reservoirs levels in Spain have been slightly below the average levels since the beginning of 2019.

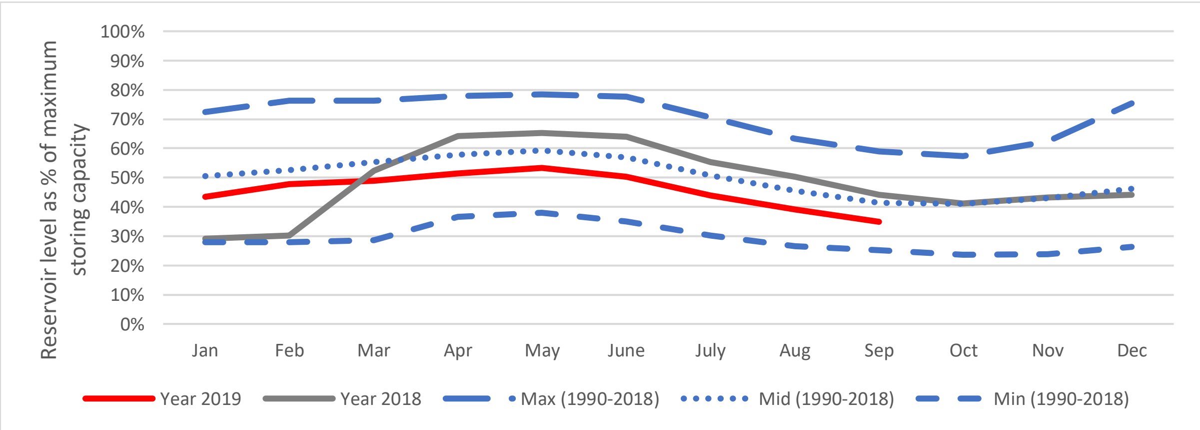


Figure 13: Reservoir levels in Spain.[9]

Reservoir levels in Switzerland settled above average. In general, reservoir levels were above average almost throughout 2019, with the exception being May and June when levels dropped to average. Nevertheless, reservoirs recovered above average levels in July and since then they have not dropped to average levels.

8 *Procured based on data published by* *RTE*

9 *Based on data published by* *REE*

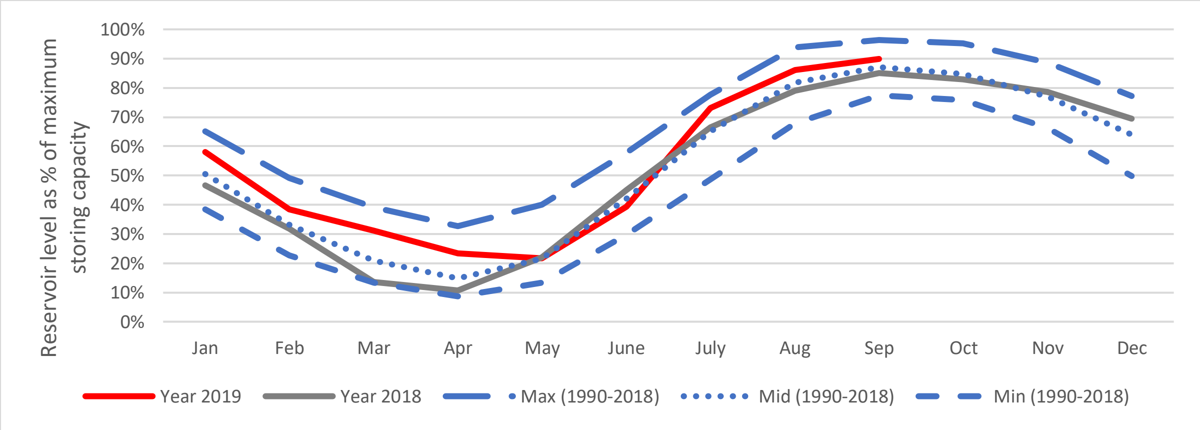


Figure 14: Reservoir levels in Switzerland.[10]

In January, Austria's reservoirs levels were in between the historical minimum and maximum levels and just above the levels recorded in 2018. Reservoirs were just in between the historical minimum and maximum throughout 2019, with the exception being the May–July period, when a sharp hydro reservoir increase was recorded and reservoirs stayed close to historical maximum levels.

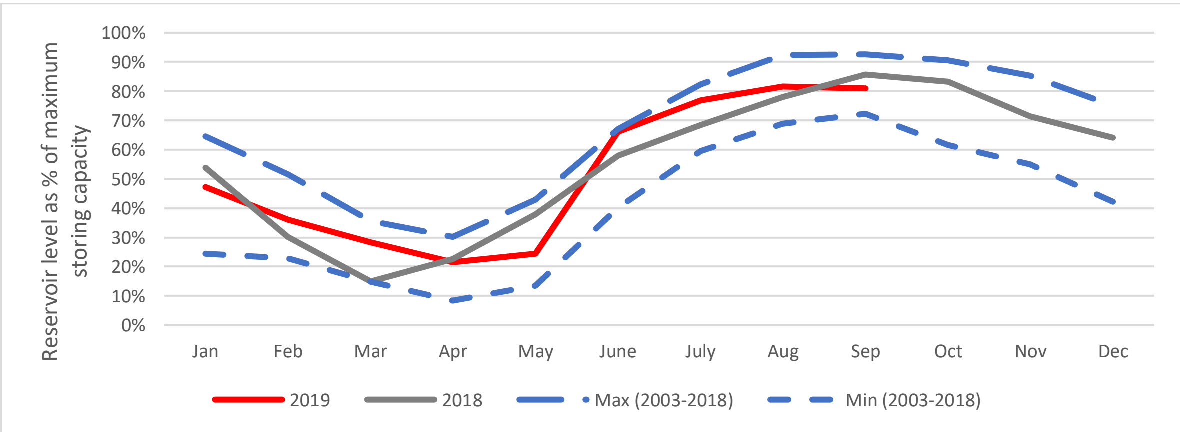


Figure 15: Reservoir levels in Austria.[11]

Hydro reservoir levels in Norway have remained around historical average levels throughout 2019. The reservoir levels did not drop as they did in 2018.

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

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

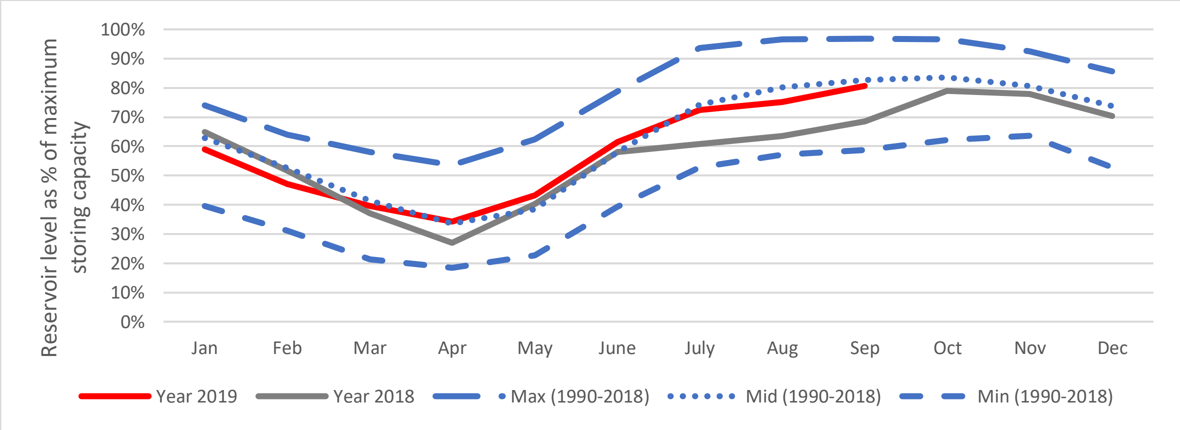


Figure 16: Reservoir levels in Norway.[12]

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

6 Implementation of Risk-Preparedness Regulation: electricity crisis scenarios and future adequacy assessments

6.1 Background

The Risk Preparedness Regulation (RPR) 2019/941 of 5 June 2019 on risk-preparedness in the electricity sector (repealing Directive 2005/89/EC) was developed to set out a common framework of rules on how to prevent, prepare for and manage electricity crises.

ENTSO-E has recently developed two methodologies to address and prepare the framework of risk preparedness, both shared for public consultation during summer 2019. Both methodologies shall be submitted in January 2020 for ACER's review and approval.

1. The **methodology for identifying regional electricity crisis scenarios** is defined in Article 5 of the RPR: 'The proposed methodology shall identify electricity crisis scenarios in relation to system adequacy, system security and fuel security on the basis of at least the following risks: (a) rare and extreme natural hazards; (b) accidental hazards going beyond the N-1 security criterion and exceptional contingencies; (c) consequential hazards including the consequences of malicious attacks and of fuel shortages. 3. The proposed methodology shall include at least the following elements: (a) a consideration of all relevant national and regional circumstances, including any subgroups; (b) interaction and correlation of risks across borders; (c) simulations of simultaneous electricity crisis scenarios; (d) ranking of risks according to their impact and probability; (e) principles on how to handle sensitive information in a manner that ensures transparency towards the public. 4. When considering the risks of disruption of gas supply in the context of identifying the risks pursuant to point (c) of paragraph 2 of this Article, the ENTSO for Electricity shall use the natural gas supply and infrastructure disruption scenarios developed by ENTSOG pursuant to Article 7 of Regulation (EU) 2017/1938.'
2. The **methodology for short-term and seasonal adequacy assessments** is defined in Article 8 of the RPR, which shall cover at least the following: (a) the uncertainty of inputs such as the probability of a transmission capacity outage, the probability of an unplanned outage of power plants, severe weather conditions, variable demand, in particular peaks depending on weather conditions, and variability of production of energy from renewable sources; (b) the probability of the occurrence of an electricity crisis; (c) the probability of the occurrence of a simultaneous electricity crisis.

6.2 Impact for future Seasonal Outlooks reports

The RPR will lead to the following evolutions for future Seasonal Outlooks:

- The Seasonal Outlook assessments shall become fully probabilistic (e.g. using the Monte Carlo approach);
- Seasonal Outlooks shall point out the probability of an electricity crisis (by extension of the current assessment) and shall be based on realistic scenarios and latest assumptions;
- Coordinated methodology development with the week-ahead adequacy shall allow for increased consistency, and close the gap between seasonal to short-term adequacy.

The crisis scenarios identification is out of the scope of seasonal outlooks and refers to an extreme situation with very low probability and high impact. In particular, gas disruption analyses will be considered as a crisis scenario and will be maintained within the crisis scenario framework. Still, we can confirm, as stated in previous winter outlook, that current gas and electricity networks are considered robust to any gas transit disruption.

7 Summer 2019 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 2019 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[13] above-average temperatures, both throughout Europe and globally, with temperature records being broken in multiple countries. The period June–August became the fourth warmest summer since at least 1979, with temperatures averaging 1.1°C above the 1981–2010 norm. A lower-than-average precipitation was recorded in Austria and France.

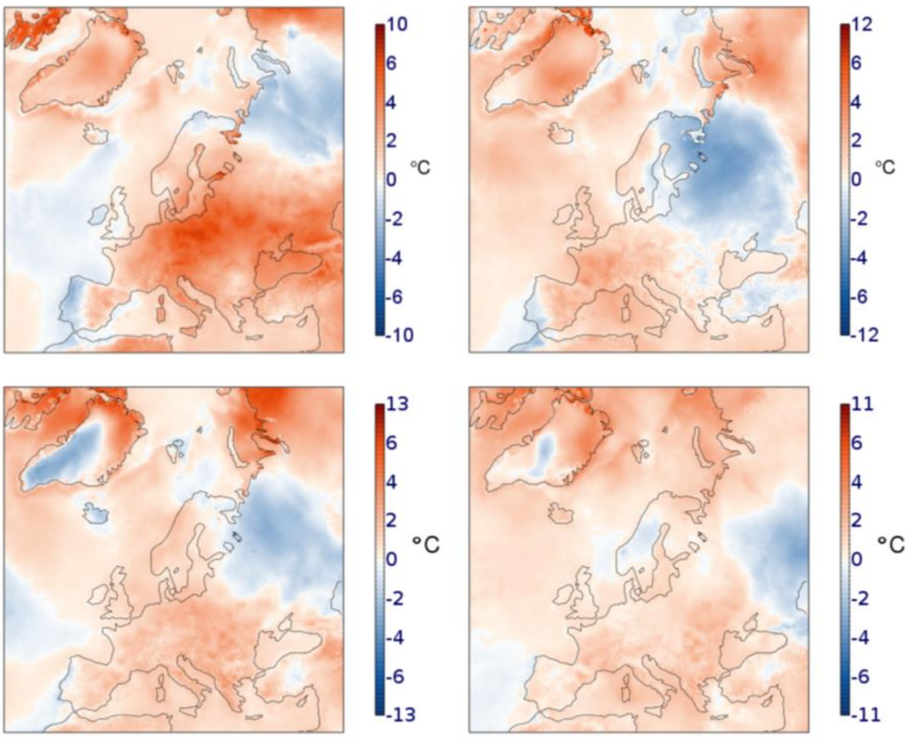


Figure 17: Surface air temperature anomaly for June–September 2019 relative to the June–September average for the period 1981–2010.[13]

[13] *Copernicus Climate Change Service–June top left figure; July top right; August bottom left; and September bottom right figure*

In 2019, the warmest June ever has been recorded, both in Europe and globally. Temperatures were warmer than average throughout the whole month in Central and Eastern Europe, whereas Western and Central Europe experienced a short heatwave in the last week of June.

A short and intense heatwave caused temperatures in July to be above average in Western Europe, whereas temperatures in Eastern Europe remained below average overall. All in all, temperatures for Europe as a whole were situated just above the 1981–2010 average.

Except for western Portugal and the northeast of Europe, the average European temperature in August was above the 1981–2010 average.

Globally, September 2019 became the warmest September on record, together with September 2016. Temperatures were above average in most of the European continent, particularly in the south and south-east. Temperatures in Norway, Sweden and the far east of the continent were lower than average.

7.2 Specific Events and Unexpected Situations During the Past Summer

Several events were recorded in summer 2019:

- Three days with large system imbalances were recorded in Germany in June. To mitigate imbalances, TSO activated all Interruptible Loads and system reserves and activated emergency power in Germany and at neighbouring TSOs. On one occasion, the extraordinary procedure within the ENTSO-E (‘50/100 mHz procedure’) was activated to control the imbalance.
- In August, some consumers lost electricity supply in Great Britain when the protection system disconnected the gas power plant and wind farm when lightning hit the power system. Furthermore, this incident had a prolonged impact on rail commuters in the London area.
- Some occasions with high RES generation and low demand were recorded in Belgium and France. As a result, nuclear generation was modulated in Belgium and France. Modulation was performed as a reaction to market signals as well as on the few occasions of a TSO request to ensure system operation security.

Appendices

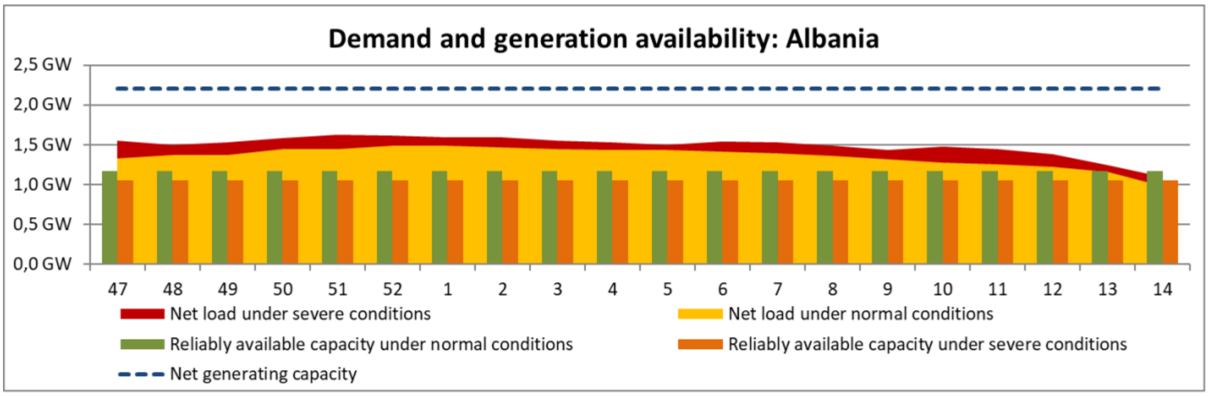
Appendix 1: Individual Country Comments on the Winter Outlook and Summer Reviews

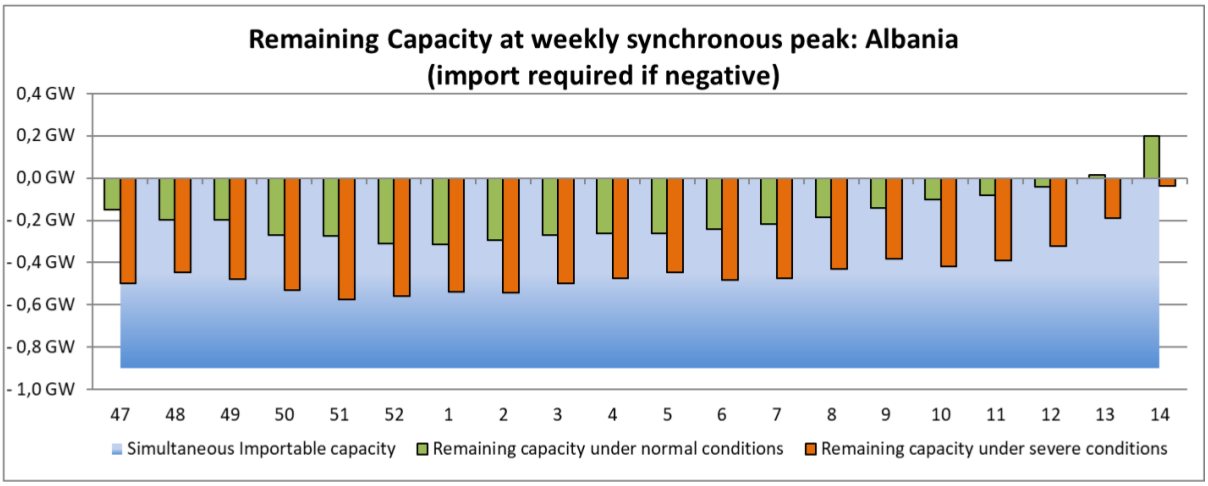
Albania: Winter outlook 2019/2020

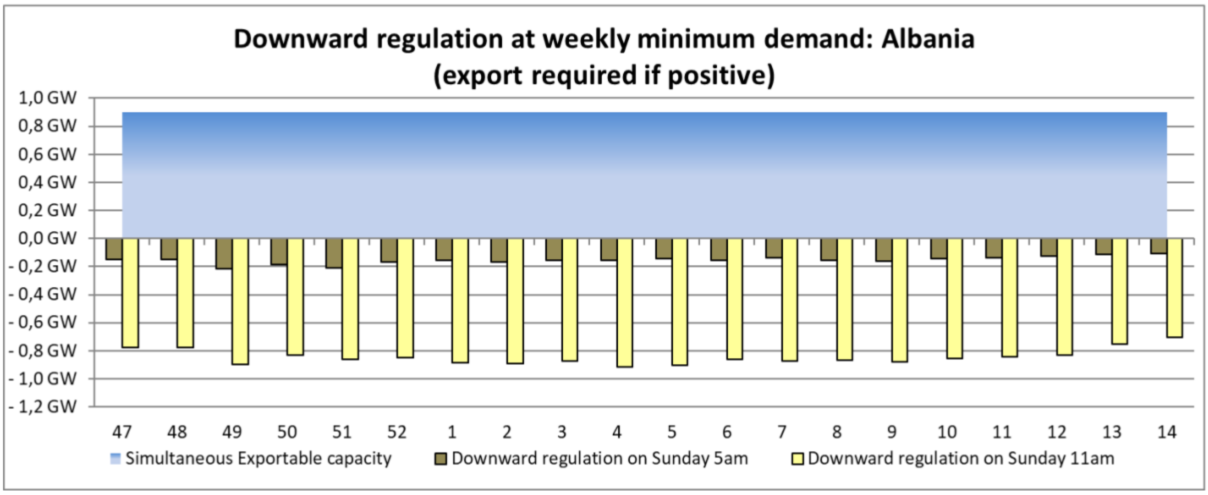
Regarding winter 2019/2020 in Albania, there is no foreseen event or issue to endanger system adequacy. In the main, system adequacy will be fulfilled by hydro generation and the firm import contracts, performed by the DSO. In recent years, there has been an increase in the installed generation capacity; consequently, Albania's dependency on import is slightly reduced. The maintenance schedule is reduced to a minimum, providing enough capacity for import, or for export in the case of high hydro inflows.

Potential critical periods and foreseen countermeasures

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







Albania: Summer review 2019

The summer season of 2019 is considered a normal one (with a maximum temperature of 38 oC), in terms of ambient temperatures and values of the main parameters of the Albanian power system.

Inflows in the Drin River cascade, which is the main source of the country's generation, were at the seasonal average. This helped maintain normal levels in the reservoirs of the Drin Cascade together with import contracts performed by DSO companies.

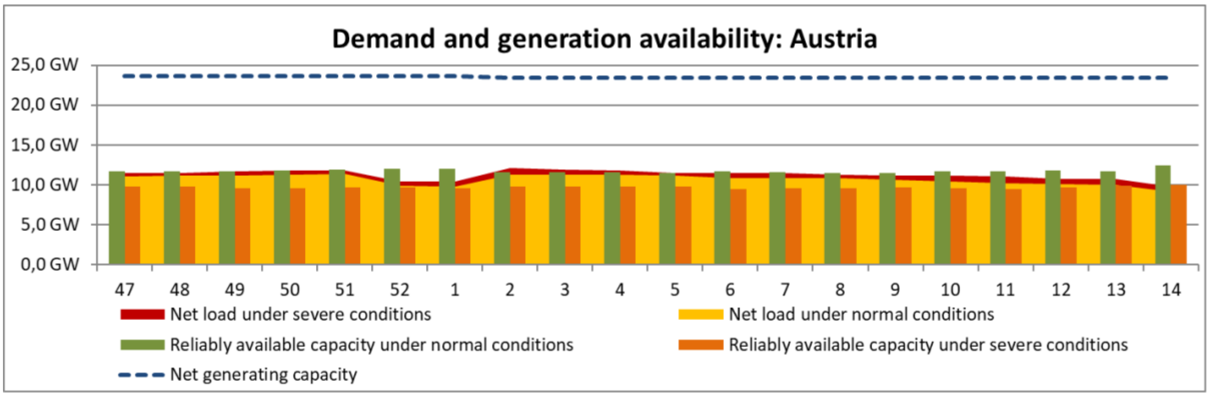
No adequacy or downward regulation issues were identified during the past season.

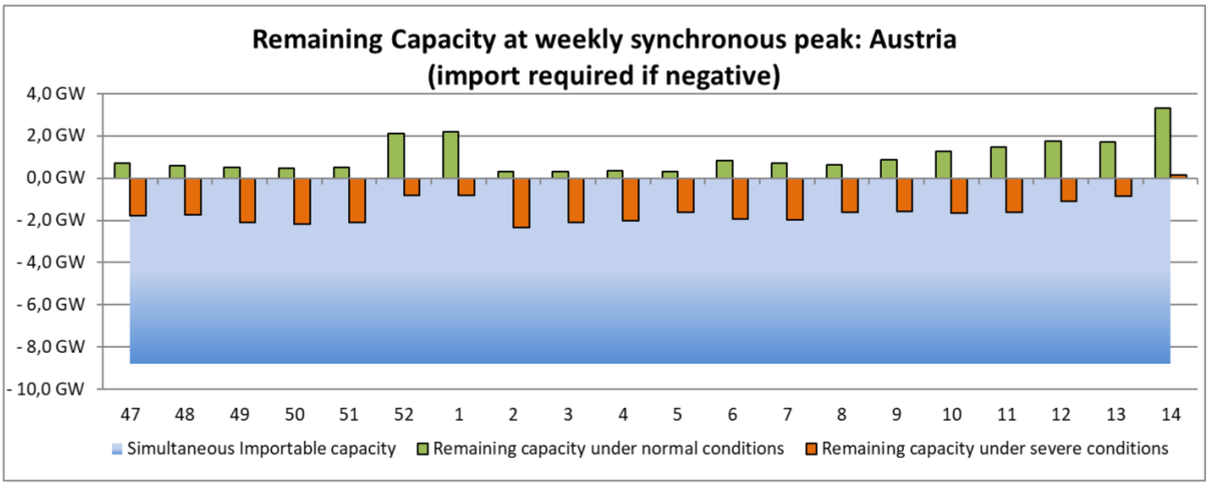
Austria: Winter Outlook 2019/2020

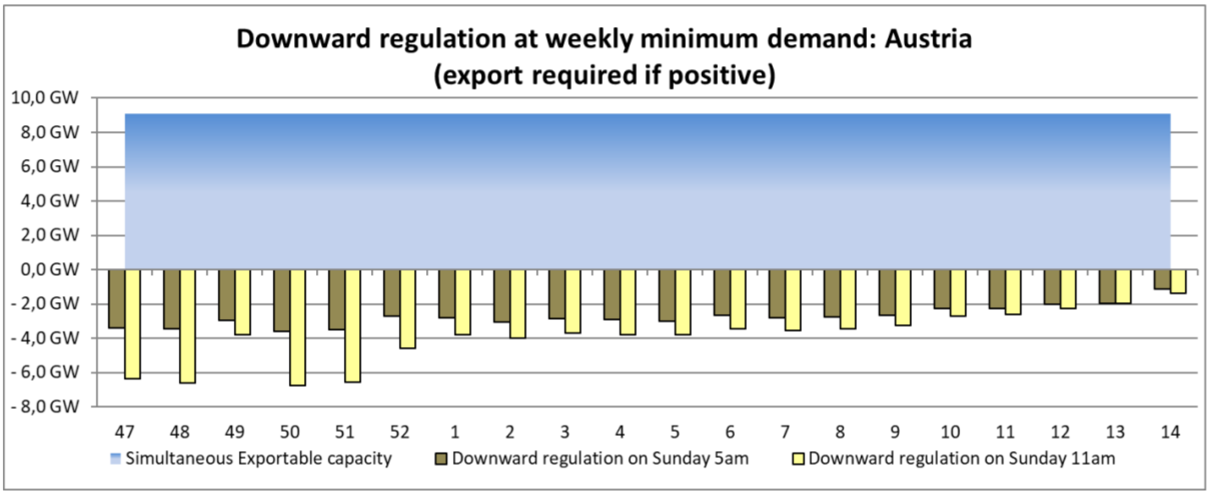
Potential critical periods and foreseen countermeasures

The available generation capacity decreased due to the mothballing of thermal power units in Winter 2018/2019. Under normal conditions, the remaining capacity remains between 0–2 GW whereas under severe conditions it indicates a deficit up to 2.36 GW.

In the long run, Austria depends on gas imports for producing power and heat whereas in the short and middle run, gas import reductions can be compensated by stored gas from the Austrian gas storages.







Austria: Summer review 2019

This summer period was the 2nd warmest since 1767, when monitoring activities started. The temperature curve exceeded the mean of 1981–2010 by 2.7°C (2003 was the warmest summer when the mean temperature exceeded the long term mean by 2.8°C).

All in all, precipitation was low in summer 2019—it was 30% below the average and thus the 7th driest Summer since 1858 when precipitation monitoring started. After a good hydro production in June, the dry summer led to a below-average generation by 'run-of-river' units.

Belgium: Winter Outlook 2019/2020

Low adequacy risk for winter 2019/2020

The Belgian power system will depend on import for the winter 2019/2020 under severe conditions. The import need could go up to 2 GW in January and February. Planned unavailability of nuclear power plants Doel 1, Doel 2 and Tihange 1, after Christmas, are the main driver for this import need.

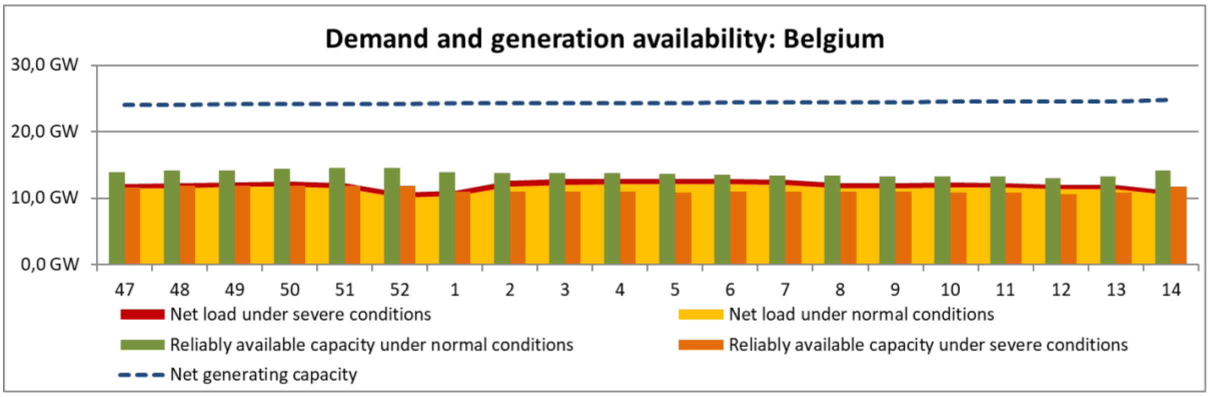
The simultaneous import capacity for Belgium is set to 3.45 GW, which corresponds to the average monthly NTC import of Belgium during last winter on synchronous borders and the expected NTC value in Q4 2019 of Nemo HVDC interconnection between Belgium and Great Britain. The Elia grid situation for 2019–2020 is expected to be equivalent to last winter.

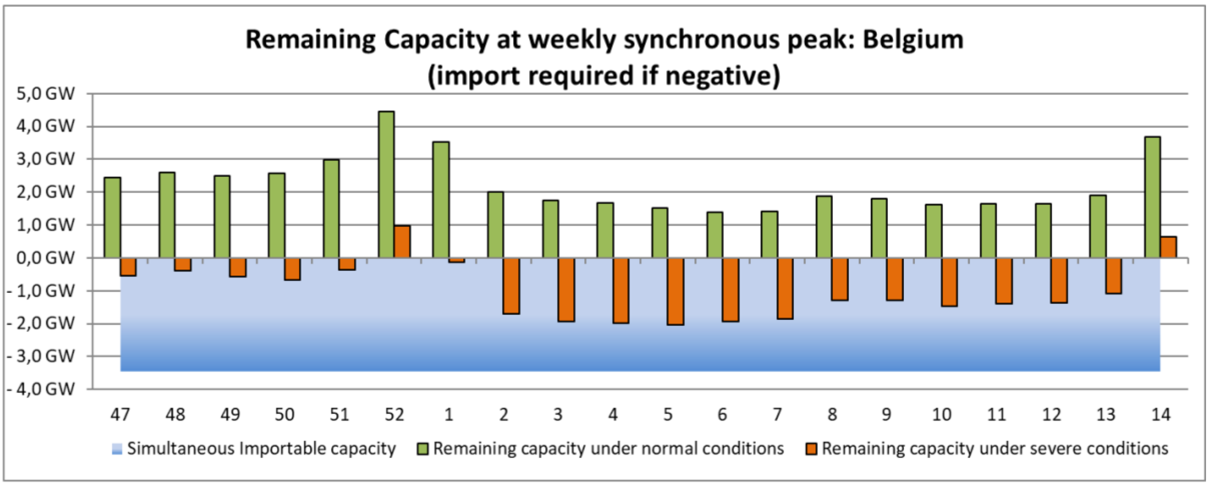
For winter 2019/2020, the Belgian Federal Minister of Energy decided there was no need to contract strategic reserves to ensure compliance with the legal adequacy criteria; this decision was based on probabilistic calculations made by Elia in November 2018 (and updated during summer 2019).

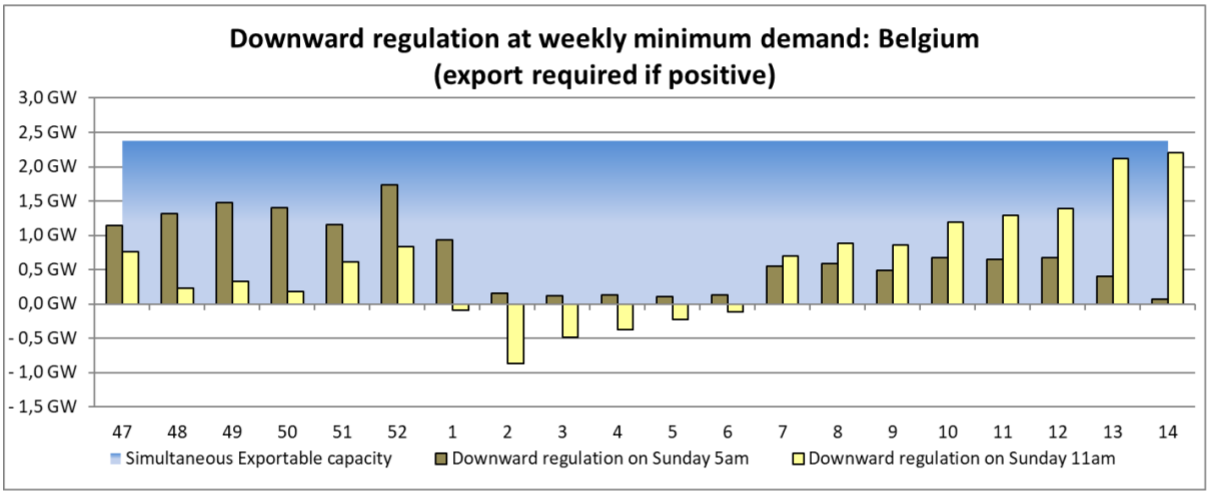
Compared to winter 2018/2019, some units returned to the market. The Winter outlook 2019/2020 considers this information. Returning units are:

- Ham (39 MW)
- Izegem (20 MW)
- Angeleur (2x25 MW)
- Vilvoorde (265 MW).

Considering the abovementioned generation unit return, the availability of the Nemo HVDC interconnection and the relatively high availability of nuclear park (compared to last winter), Elia expects a low adequacy risk during winter 2019/2020.







Belgium: Summer review 2019

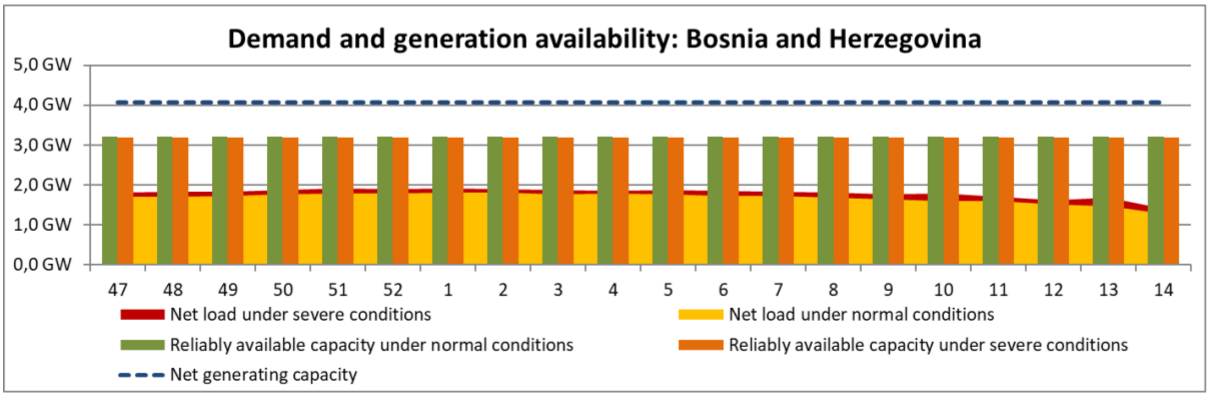
The nuclear generation park in Belgium was fully available during July and August. This high amount of inflexible generation combined with a typical low summer load, high RES penetration and maintenance of 500 MW of pumping capacity on the hydro power plant of Coo led to low electricity prices and mostly export for Belgium during this period.

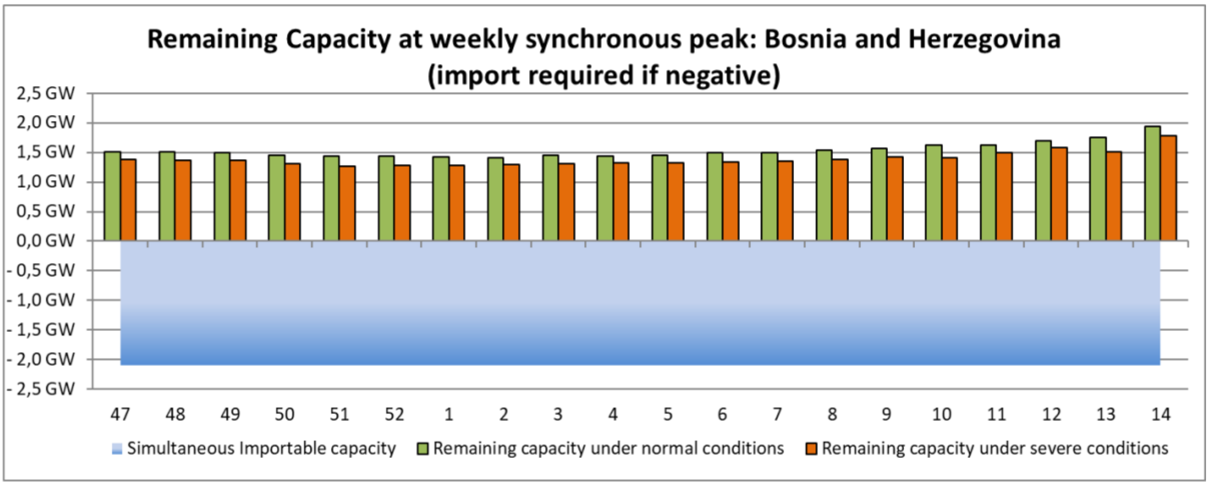
Export on the Nemo HVDC cable to Great-Britain helped significantly but in some extreme cases, negative price clearing occurred on the day-ahead market together with nuclear modulation (e.g. on 10 August 2019).

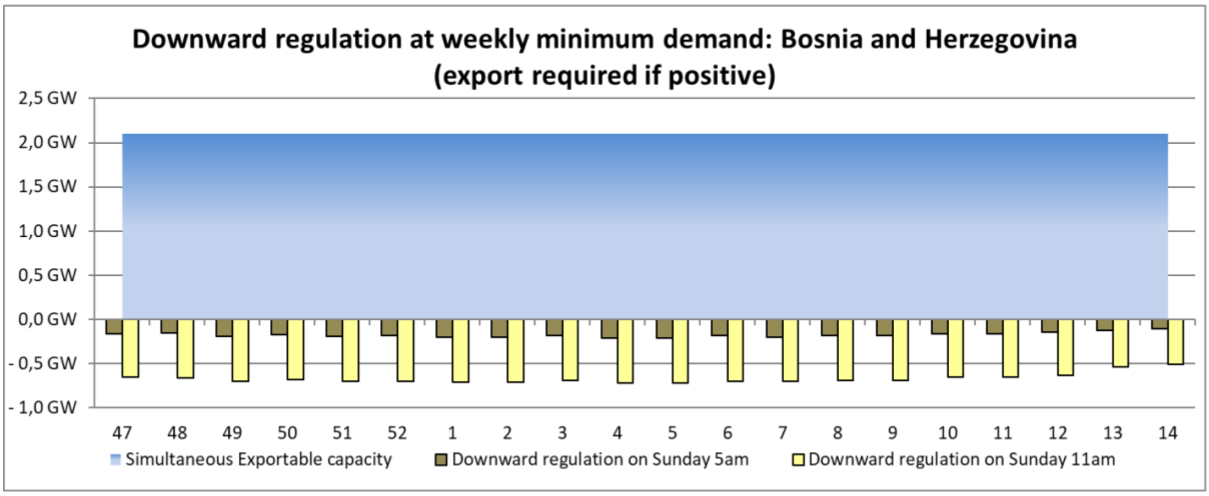
An additional 800 MW offshore wind park capacity will be installed before next summer. Together with other RES installation on the grid (wind onshore or solar), this incompressible summer trend might get worse until the implementation of the nuclear phase-out in Belgium.

Bosnia and Herzegovina: Winter Outlook 2019/2020

In winter 2019/2020, a positive monthly power balance is expected. Demand assumption in Winter Outlook 2019/2020 compared to Winter Outlook 2018/2019 was reduced, as the biggest consumer—an Aluminium factory in Mostar (approximately 175 MW of demand)—will remain disconnected from power system. This consumer was disconnected in summer 2019.







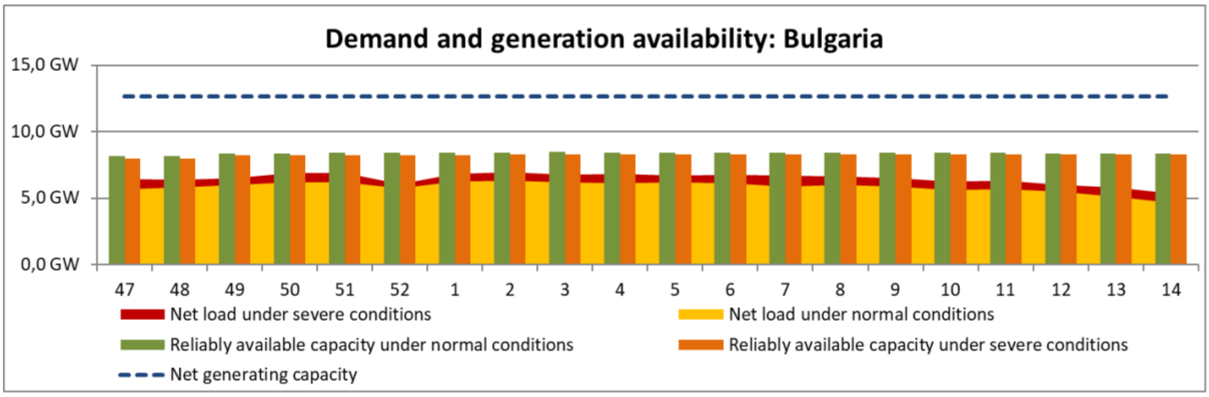
Bosnia and Herzegovina: Summer review 2019

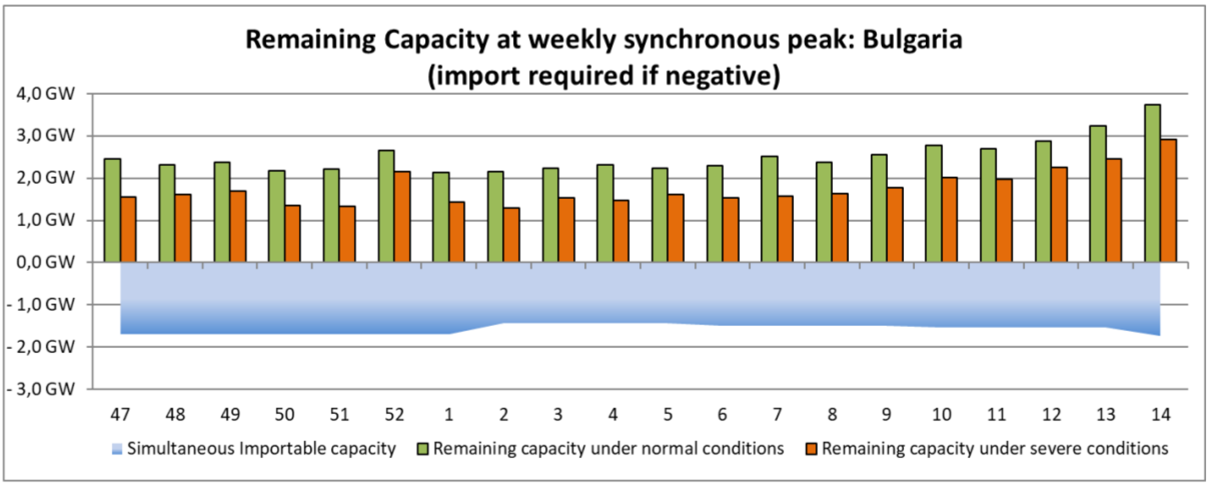
In summer 2019, there were no unexpected situations that affected the power system supply in Bosnia and Herzegovina. A lowest demand of 709 MW was registered on 14 July at 06:00, and was lower than last year because the aluminium factory in Mostar was disconnected on 10 July. Highest demand was registered on 27 June at 15:00, and was equal to 1586 MW. Monthly power balances were positive during this period.

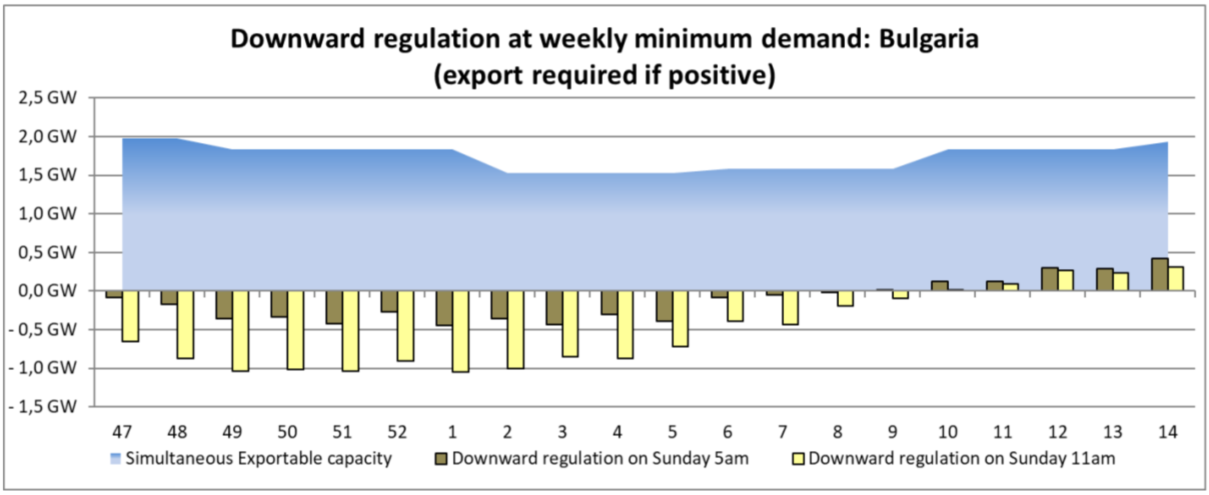
Bulgaria: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected for the coming season. Due to the ongoing rehabilitation process of the largest hydro cascade in Bulgaria, its generating capacity will be reduced roughly by half during winter 2019/2020. Coupled with the low inflow levels during the past summer and the constraints on water resources for electricity production due to the shared use of the hydro reservoirs, Bulgaria could be faced with adequacy issues in the event of prolonged cold spells.







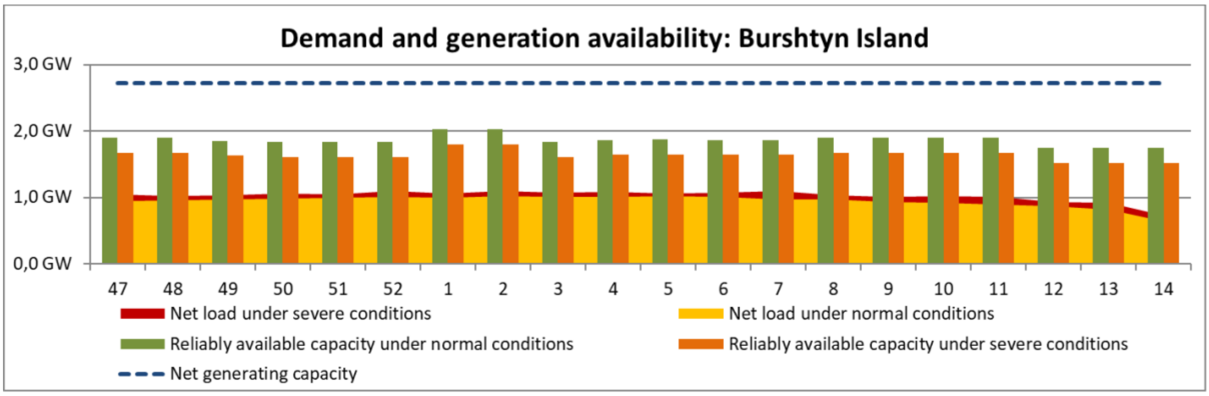
Bulgaria: Summer review 2019

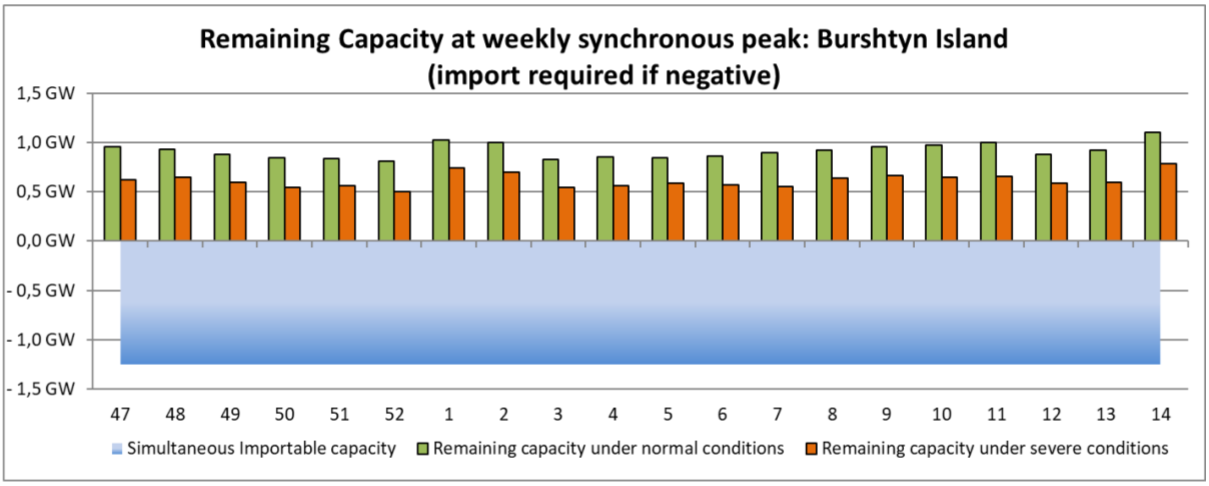
Although the summer period was hotter than usual, this did not have a strong impact on demand peaks, which were below the peak levels registered in 2015 and 2017. No adequacy or downward regulation issues were identified during the past season.

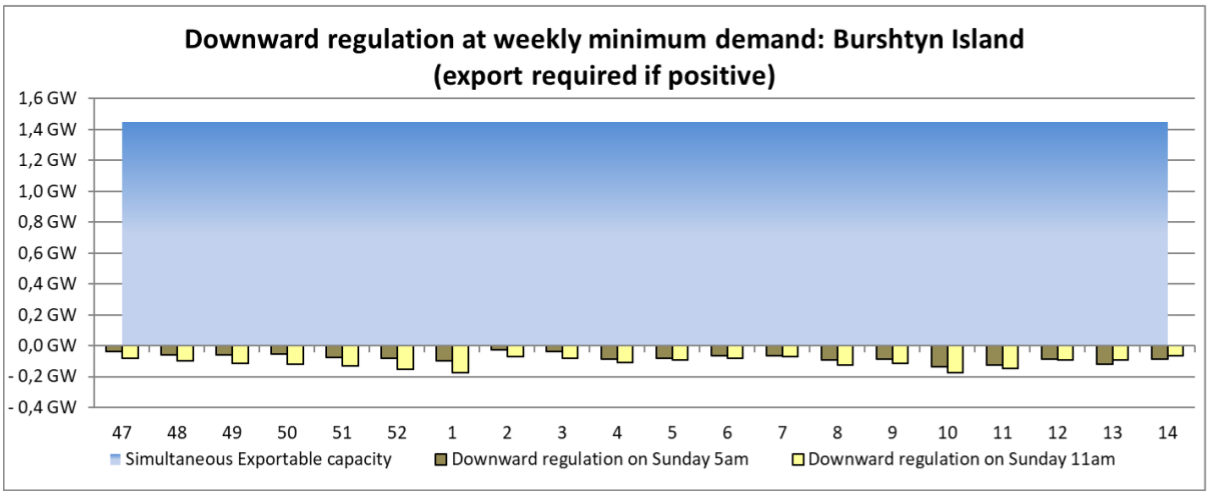
Burshtyn Island: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







Burshtyn Island: Summer review 2019

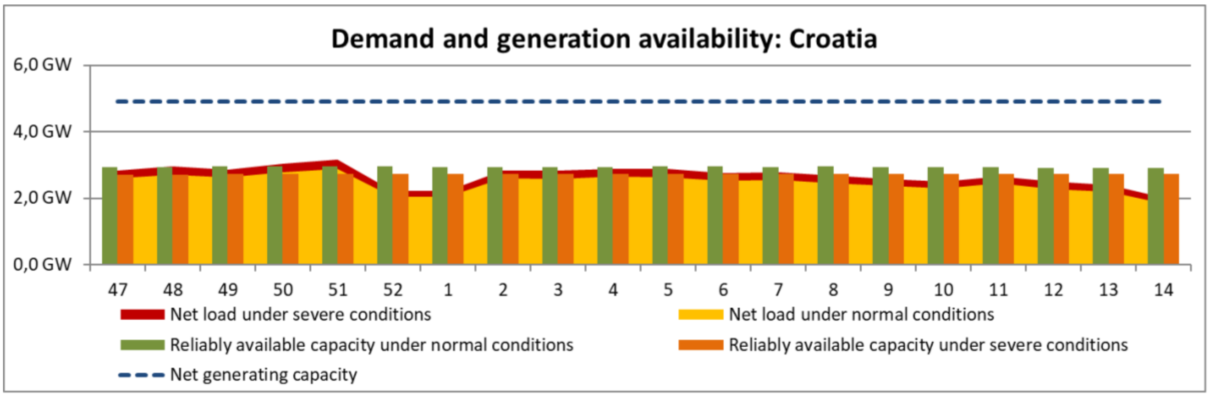
No adequacy or downward regulation issues were identified during the past season.

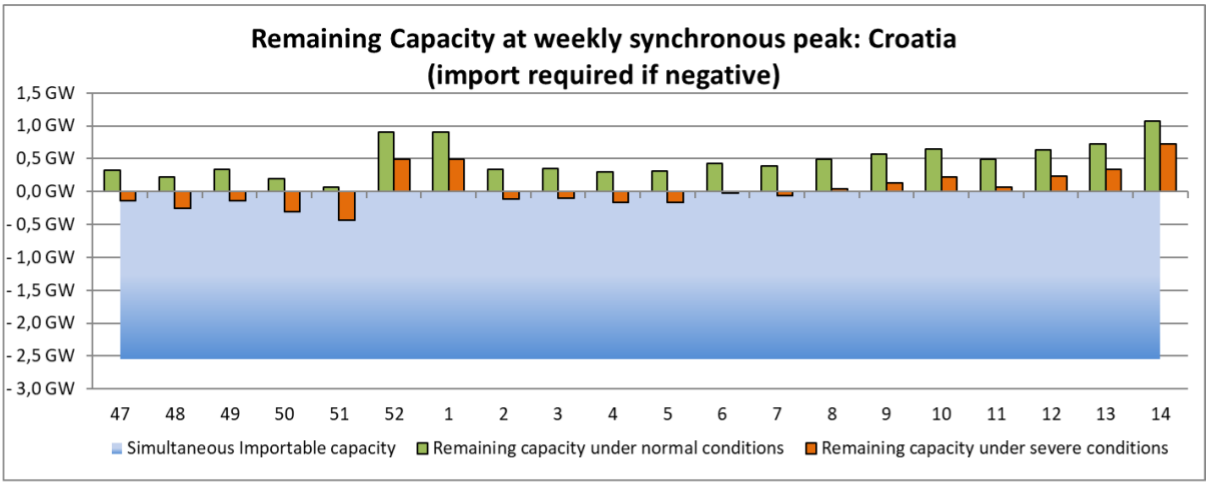
Croatia: Winter Outlook 2019/2020

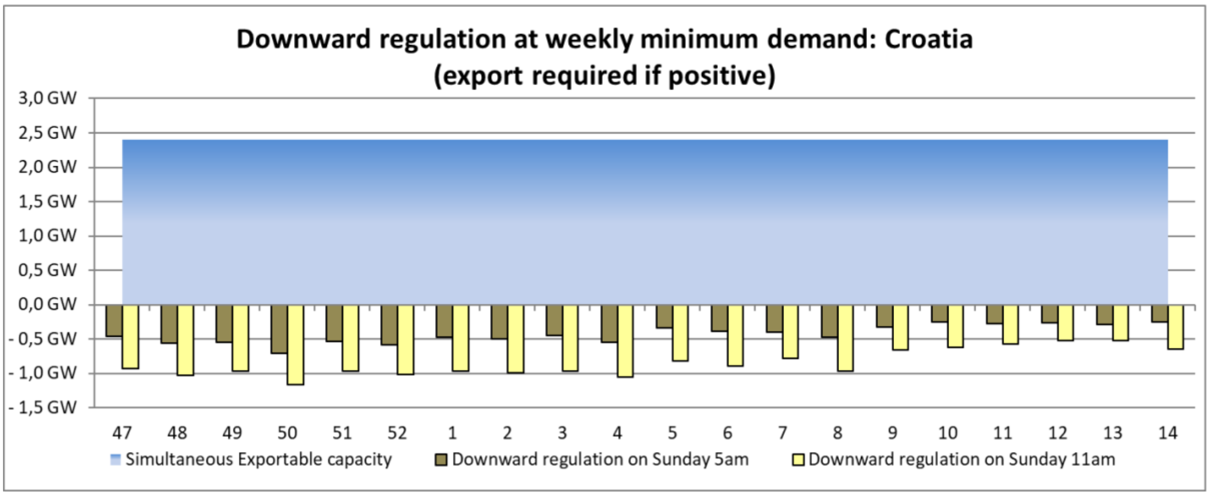
A number of thermal generation units are expected to be not dispatched during the winter 2019/2020 due to the limits on emission values and economic reasons. As usual, maintenance is to be avoided during winter.

Potential critical periods and foreseen countermeasures

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







Croatia: Summer review 2019

The lack of precipitation and wind in Croatia during last summer was unfavourable for the electricity generation. Imports made on average approximately 50% of the electricity totally supplied, the maximum percentage even being approximately 80%.

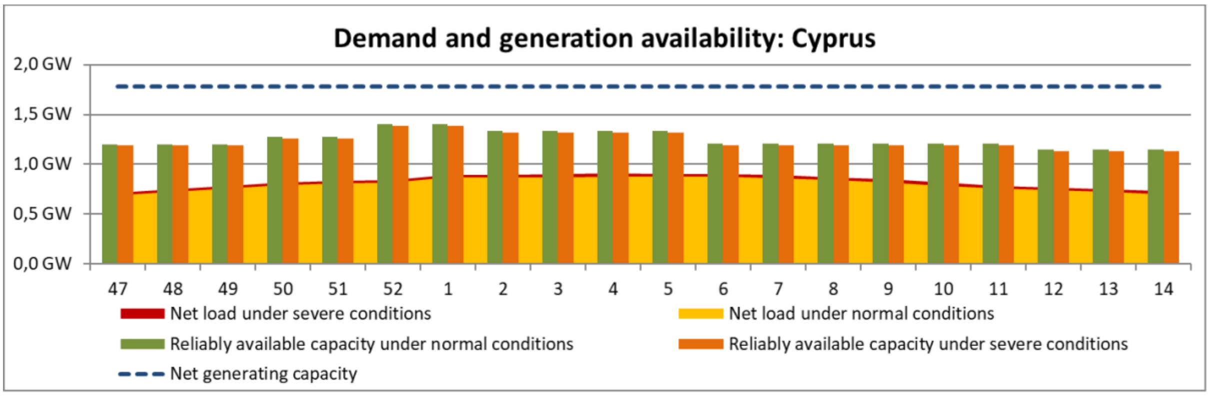
A period of extremely hot weather had already appeared in the second half of June and caused peak demand to be just slightly lower than in July and August, which is rather unusual for the Croatian power system.

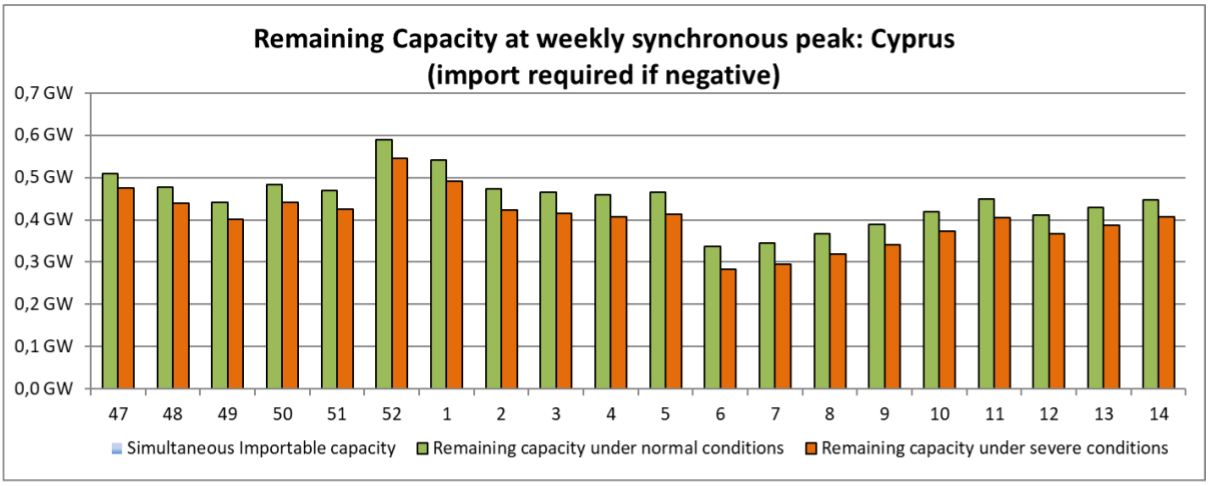
The highest summer demand was nearly the same as previous year, i.e. approximately 3000 MW. No significant interruption of supply occurred, nor were there any downward regulation issues recorded in summer 2019.

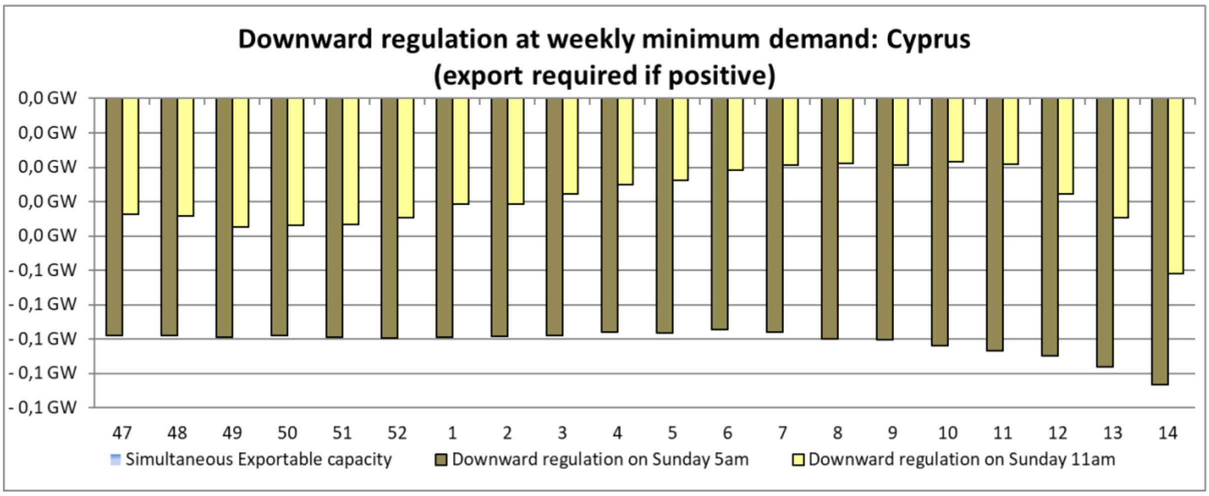
Cyprus: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







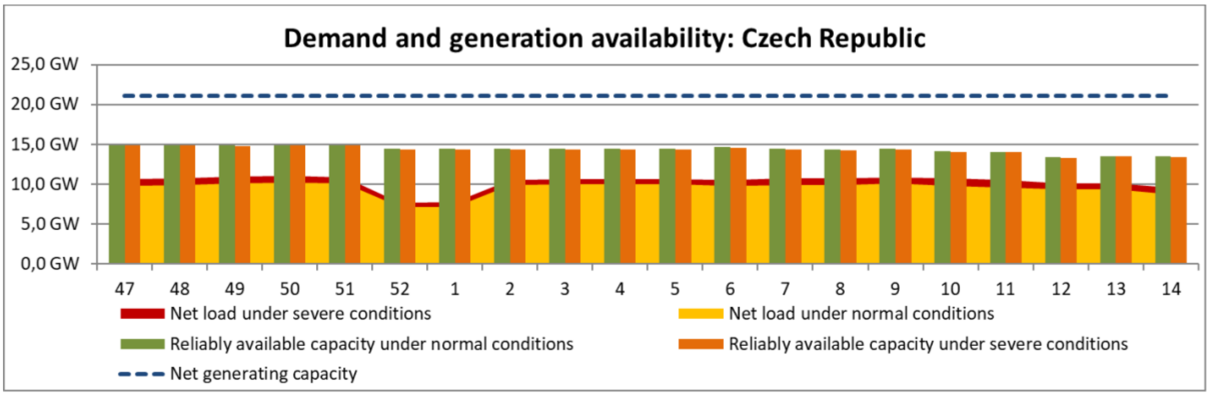
Cyprus: Summer review 2019

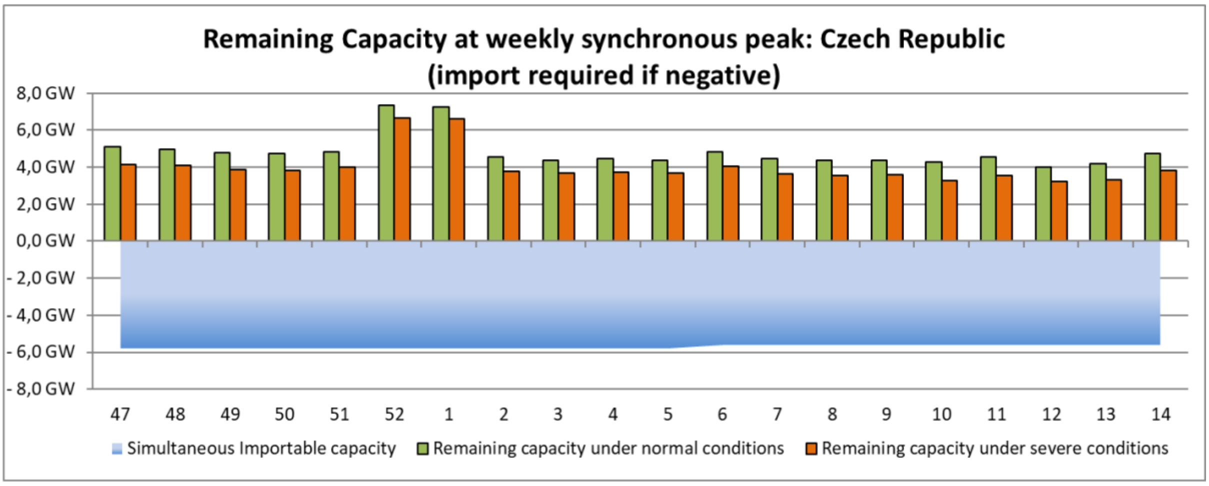
No adequacy or downward regulation issues were identified during the past season.

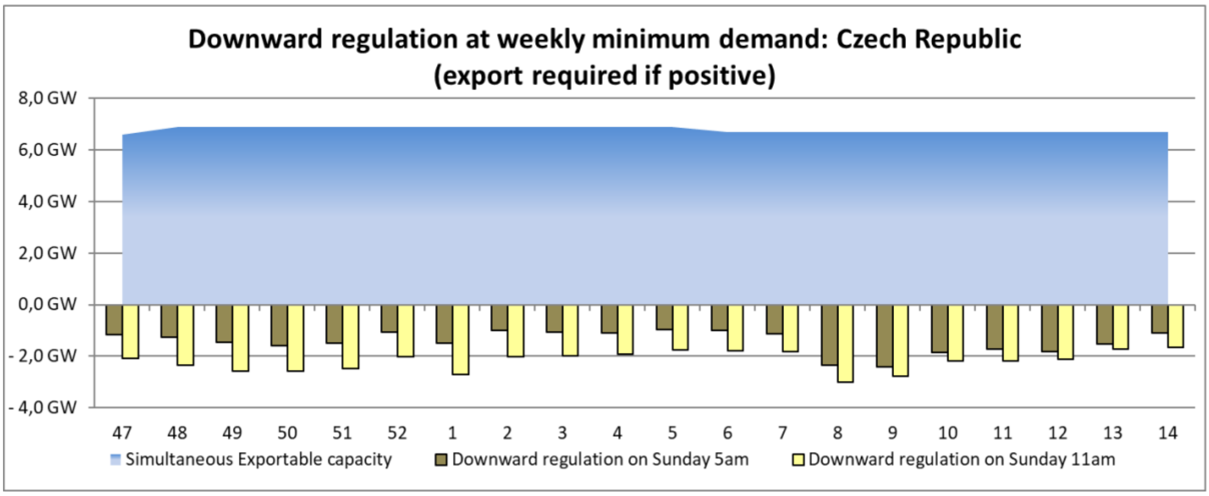
Czech Republic: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







Czech Republic: Summer review 2019

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

Denmark: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

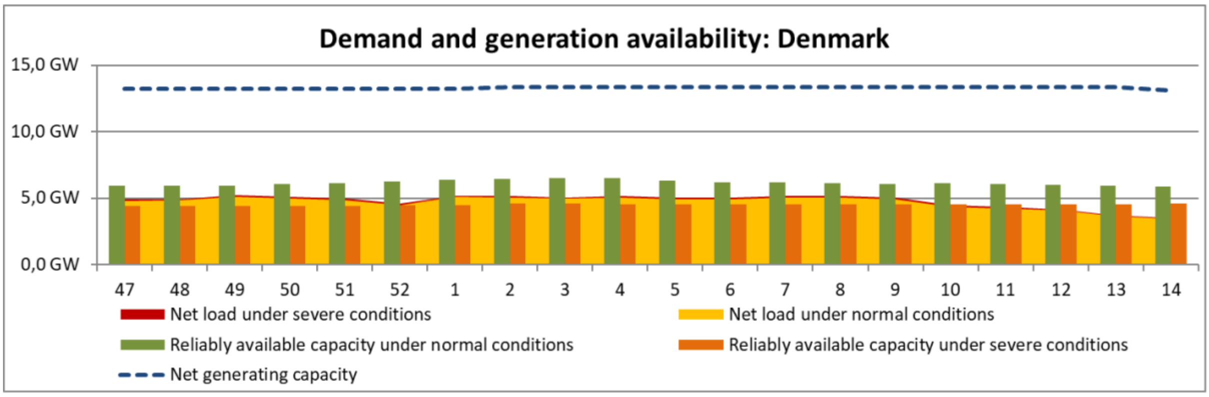
Energinet (TSO in Denmark) expects a stable winter. The power situation seems fine as planned power plant outages are minimised and restrictions on the interconnectors to Germany, Netherlands, Sweden and Norway are also at a minimum.

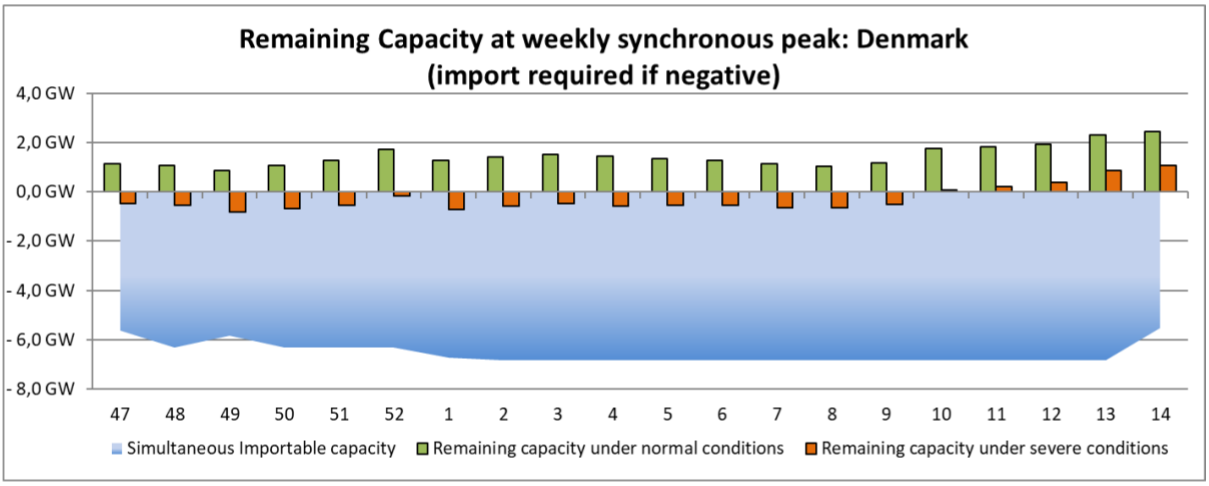
The control system at Kontiskan has to be upgraded in Q4 of 2019, which will limit the cross-border capacity for a couple of months between Western Denmark (DK1) and Sweden (SE3).

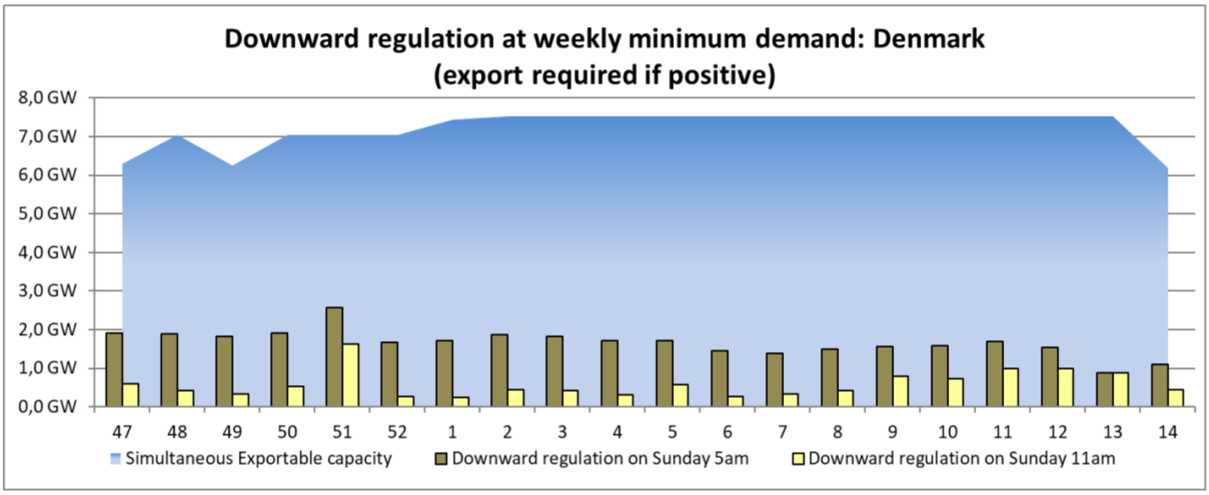
Most critical periods for downward regulation and countermeasures

Energinet does not expect any problems with downward regulation. There will be a large amount of downward regulation, especially in times of high wind production.

In periods with high wind production, Energinet expects countertrade on the Danish–German border and on borders between Sweden and Denmark. The amount of countertrade will be down-regulated in DK1 and DK2.







Denmark: Summer review 2019

Summer 2019 was characterised by rather favorable wind conditions in both Denmark and Germany. This resulted in a total wind production of 4278 GWh and 26464 GWh for the months of May, June, July and August in Denmark and Germany, respectively. Compared to summer 2018, this is an increase of 26% in Denmark and 13% in Germany. This was mainly a result of the summer being colder than the summer 2018, which was defined by heat waves throughout Europe.

As a consequence of a relative large wind production, summer 2019 also saw an increase in the number of hours with negative prices in the day-ahead electricity market. In Western Denmark (DK1) there were 18 hours of negative prices, while there were 6 hours of negative prices in Eastern Denmark (DK2). Similarly, there were 22 hours of negative prices in Germany. For Denmark, this is a significant increase compared to last summer, where there were no hours with negative prices.

Moreover, the generous wind conditions also contributed to lower electricity prices in Denmark during summer 2019. The average price for the summer period (May to August) was 274 DKK/MWh in DK1 and 281 DKK/MWh in DK2. In comparison to last summer, this is a decline of more than 20 percent.

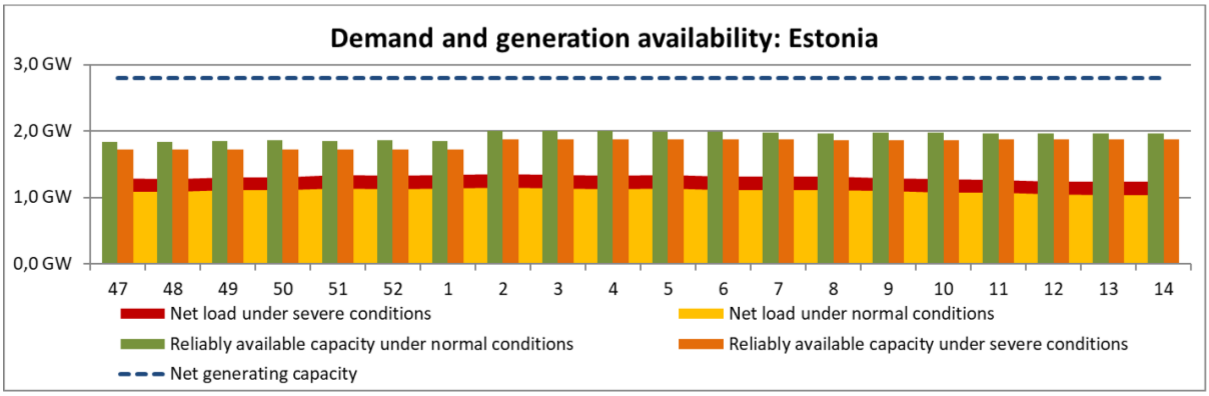
Compared to last summer, the average transmission capacity from Western Denmark to Germany (DK1→DE) increased from 58.5% to 68.9% of maximal NTC. This is a result of Tennet Germany's implementation of the European Commision request to gradually increase minimum cross-border capacities. The average transmission capacity of the Konti-Skan and Skagerrak HVDC interconnections was slightly lower than summer 2018, which can primarily be attributed to planned maintenance as well as a partial Skagerrak unplanned outage.

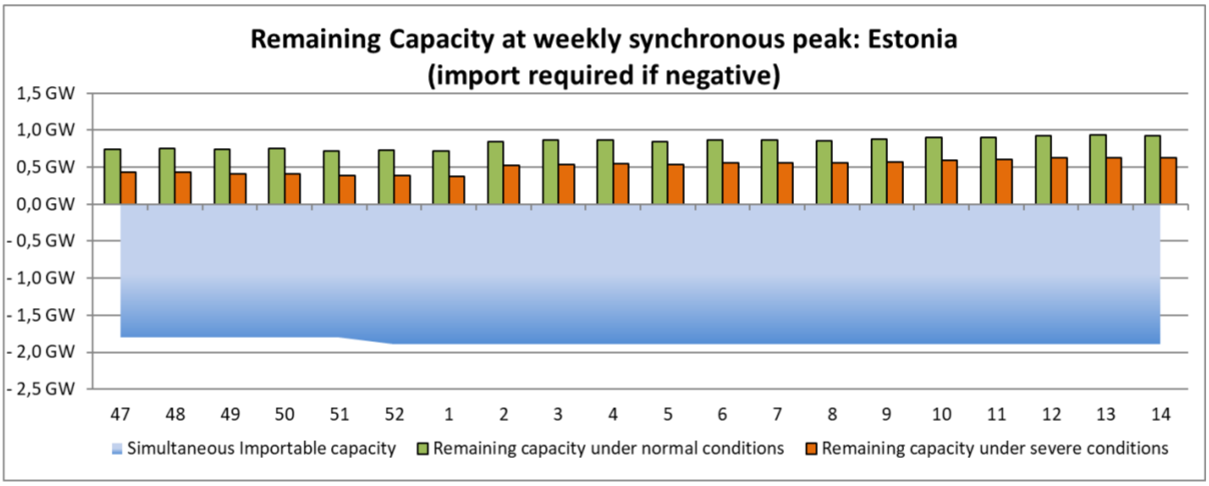
In general, summer 2019 was to a large extent defined by southbound electricity flows. This implied that West Denmark acted as a transit country by importing electricity from Norway and Sweden and exporting electricity to Germany. Southbound electricity flows are rather common in summer months, due to hydro storages being at their largest capacity, implying a large supply of inexpensive Nordic electricity.

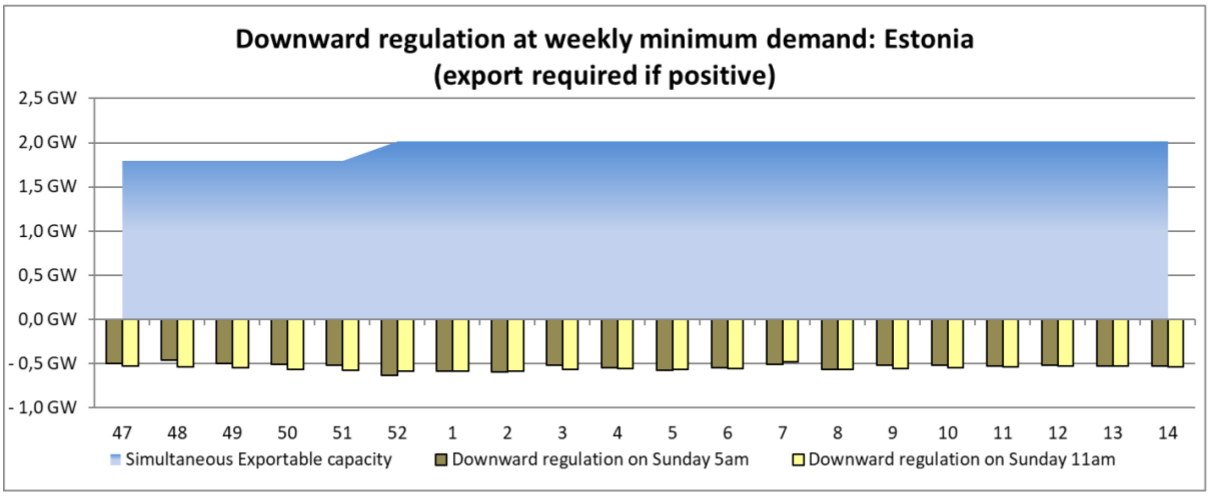
Estonia: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







Estonia: Summer review 2019

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

Finland: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

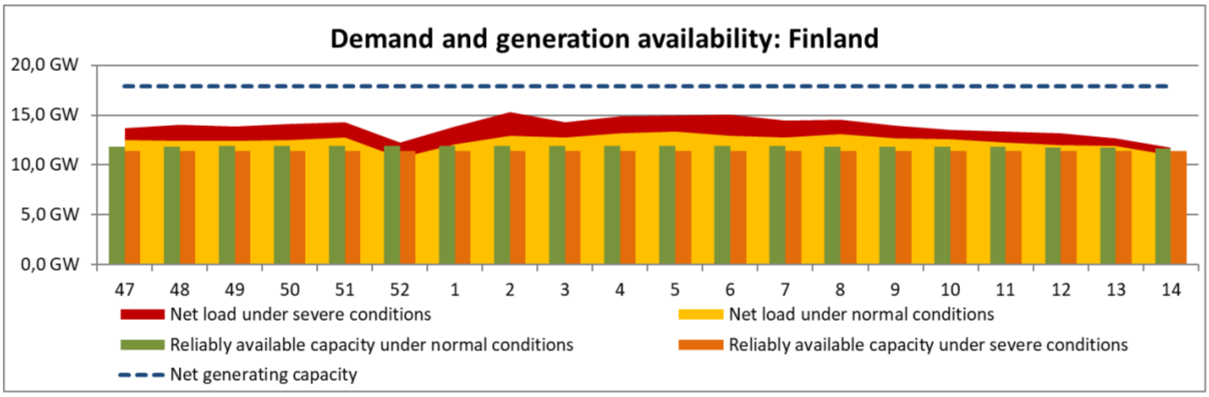
As in the previous winters, Finland is a deficit area during peak demand hours. The electricity demand is strongly dependent on ambient temperature. The most critical situation is in January and in February, when coldest temperatures are typically reached.

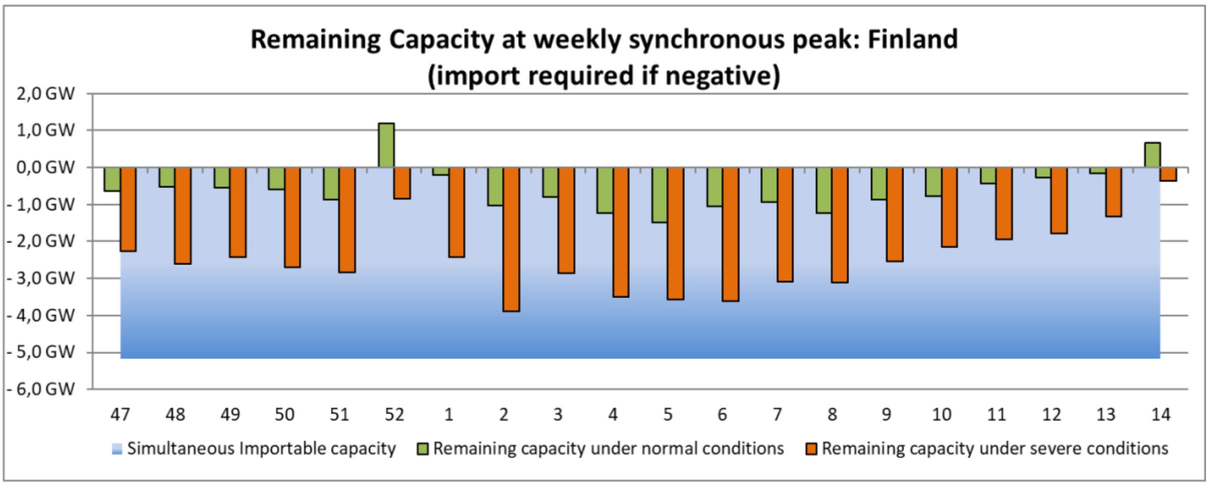
Compared to the previous winter, the situation has remained quite the same. The peak demand estimate under severe weather conditions is approximately 15.3 GW.

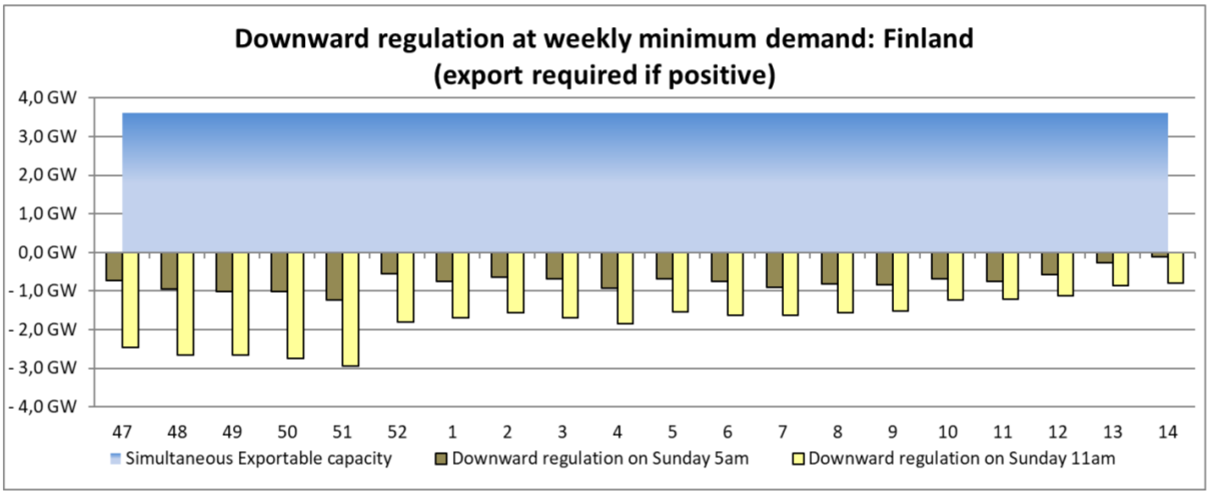
Available generation capacity without peak load reserve (Finnish strategic reserve) is expected to be nearly 11.2 GW, slightly less than in winter 2018/2019. Wind power capacity has increased slightly, but that has only a minor influence on the estimated available generation.

Import is needed to cover the demand during peak hours. The highest deficit under severe conditions when considering strategic reserves is 3.4 GW from week one to seven. The import capacity on interconnections, 5.1 GW, is sufficient to meet the deficit. However, adequacy risk exists in the event of a major power plant or interconnection unplanned outage coinciding with the cold weather.

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







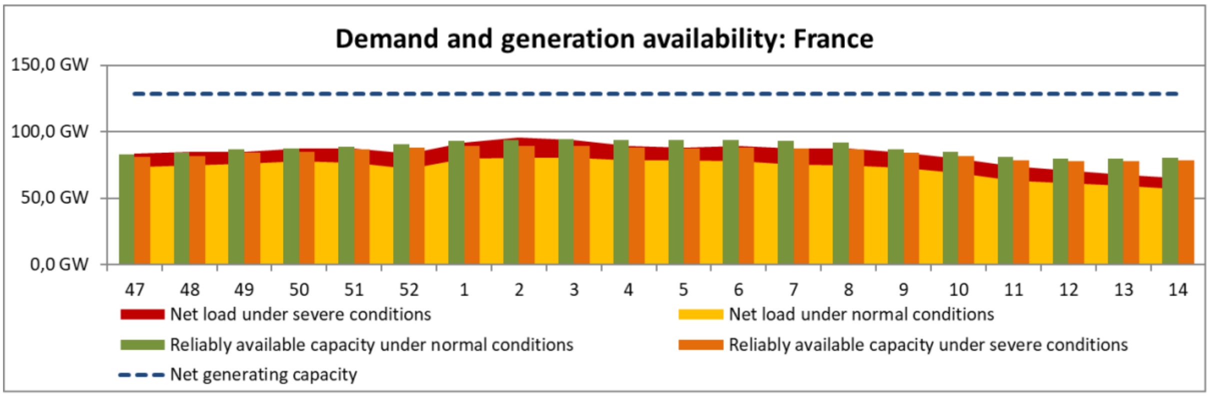
Finland: Summer review 2019

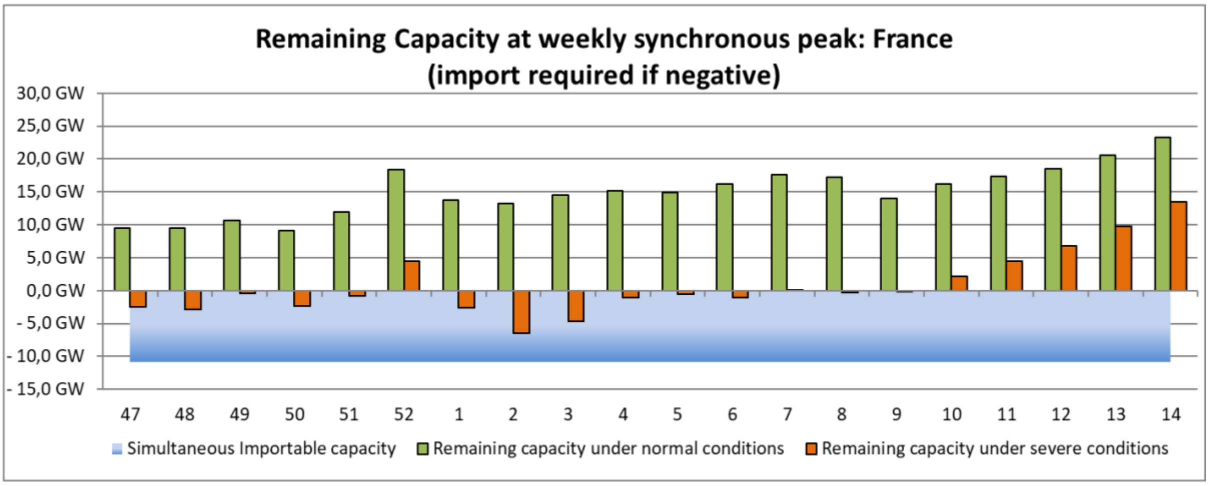
There were neither adequacy problems nor downward regulation issues during the summer of 2019.

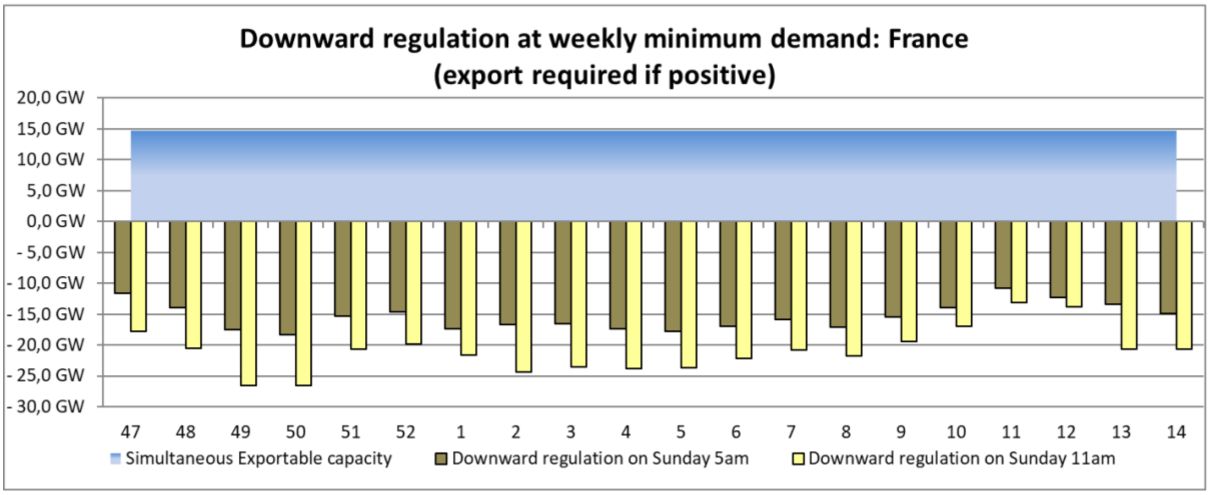
Several overhauls of both production units and transmission lines were carried out in summer according to schedule. These outages had no impact on system operation.

France: Winter Outlook 2019/2020

In winter 2019/2020, France expects the situation to be better than last year, mainly due to a more favourable nuclear maintenance plan. Indeed, all the nuclear units are expected to be available in January and early February when the risk of a cold wave is the highest. In this situation, the need for import should be lower than the previous winter. Nevertheless, RTE (French TSO) will remain attentive to potential delays on maintenance plan and outages, considering the events that occurred during last winter on different power plants. If some maintenance falls behind, margins would be tighter than expected but the adequacy risk should be handled by resorting to more imports. Moreover, should imports not be enough to cope with such a situation, RTE will activate out-of-market measures such as the Industrial Interruptible Service, lowering the voltage level and, as last resort, limited local demand-shedding.







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 (a 1–in–20 year cold wave), the most critical periods for adequacy should be early January (weeks 2–3), with a need for 5 GW imports to cope with a 97.5 GW demand at pan-European synchronous peak time (19:00 CET).

France: Summer review 2019

General comments on past summer conditions

Summer 2019 was marked by two heat waves that affected the entire country. They were quite short (6 days) but exceptional because of their intensity. Thus, at 25–30 June, the heat wave was remarkably early and the new absolute record in metropolitan France was recorded on the 28 June with 46°C in Occitan. Then, from 21 July to 26 July, the temperature often exceeded 40°C in the northern part of the country and many absolute records were broken.

With 34.4 TWh in July and 31.5 TWh in August, gross domestic energy consumption was stable in July (-0,4%) and down in August (-2.6%) compared to summer 2018. The consumption drop in August is explained by temperatures being relatively close to normal at the beginning of the month and lower than the beginning of August 2018, and by the decline of economic activity.

The months of June and August were marked by solar production which increased respectively by 15% and 5% compared to last year (thanks in particular to the 9% increase of the installed capacity). The hydraulic sector has experienced the biggest decline among all the electric power generation sectors, with a decrease of 11% of the energy produced in July and August compared to 2018. This decrease is explained by a significant rainfall deficit exceeding 20% over the two months. Finally, the energy generated by thermal units is up 11% for the month of July and down 12% for the month of August compared to last year. This was particularly important during the heat wave at the end of July.

The French balance of exchanges remains exporting, with 7 TWh in June and 5.4 TWh in July and August, respectively.

Specific events and unexpected situations that occurred the past summer

On 7 June 19:00, during the Miguel storm, instant wind generation reached its monthly record of 11.4 GW, which represents a load factor of 73%. Twenty three percent of the French consumption was covered by wind generation at this point. Over the day, the average wind generation was 59% of installed capacity; and on average it covered 20% of demand. Wind generation remained high the next day, covering 17% demand on average. As demand was decreasing for the weekend and wind generation was rising, nuclear generation was modulated sharply to 26.1 GW, the lowest in more than 15 years. This modulation is due both to the market prices and to TSO requests in real time.

Between 25 and 30 June, France experienced an exceptional heat wave characterised by its intensity and precocity. A peak demand of 58.7 GW was recorded on 27 June at 13:00—it is the second highest (after 2017) instantaneous demand value observed in June since 2011. During this period, the average solar generation reached 25% of installed capacity. The highest solar generation rate (75% of installed capacity i.e. 6.5 GW) was recorded on 26 June 14:00.

France experienced another exceptional heat wave episode that extended from 21 to 26 July. A peak demand of 59.1 GW was recorded on 25 July (Thursday). On this day, the average temperature was above normal by more than 8°C. This peak exceeded the peak value recorded last summer which stood at 57.6 GW on 26 July, 2018. The fossil fuel thermal sectors as usual were more solicited in these periods in order to cover the increase of demand and to compensate for the fall of nuclear production due to environmental constraints.

Germany: Winter Outlook 2019/2020

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.

The pumped-storage power plants (PSPs) of the 'Kraftwerksgruppe Obere Ill-Lünersee' (turbine: 2.1 GW; pumping: 1.4 GW), which are installed in Austria but assigned to the German control block, are again included in the German dataset. For the same reason, the pumped-storage power plant Kühtai and storage power plant Silz (total turbine: 0.8 GW; total pumping: 0.25 GW) are also included in the German dataset.

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

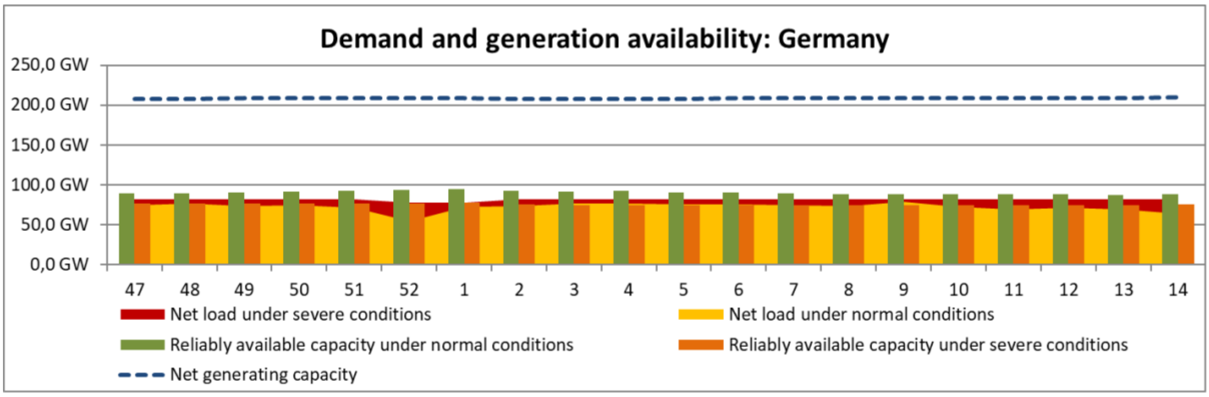
- Lignite units in stand–by ('Sicherheitsbereitschaft'): was set to achieve the climate protection targets. Lignite fired power plant blocks with a total capacity of 2.7 GW enter step-by-step standby mode for backup purposes. Currently, power plants with a capacity of 2.0 GW are in backup mode already. 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 is defined as consumption units, which can reliably reduce their demand for a fixed capacity upon request by the German TSO. Currently, approximately 1.4 GW of interruptible demand is available.

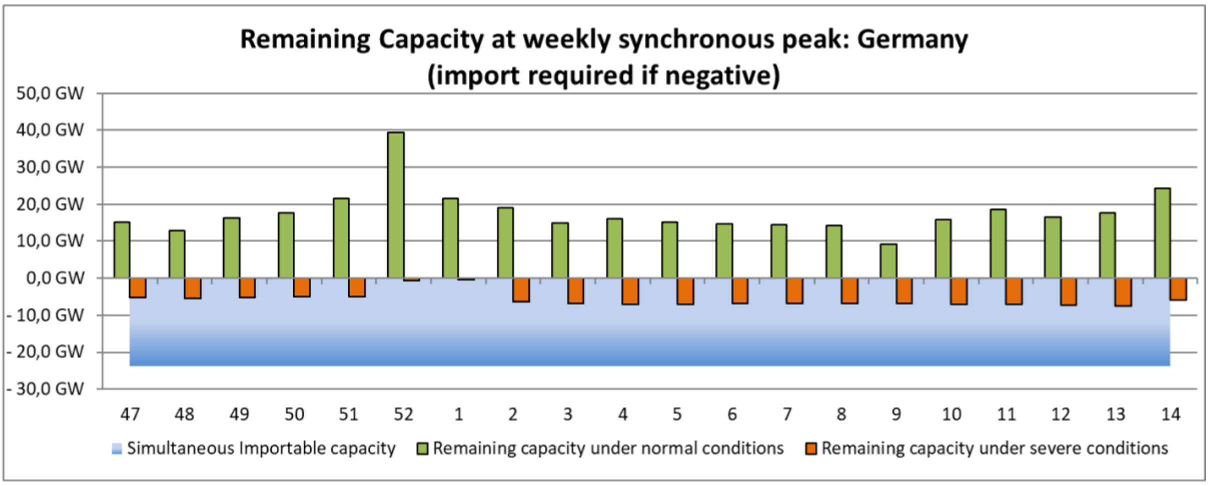
Most critical periods for maintaining adequacy margins and countermeasures

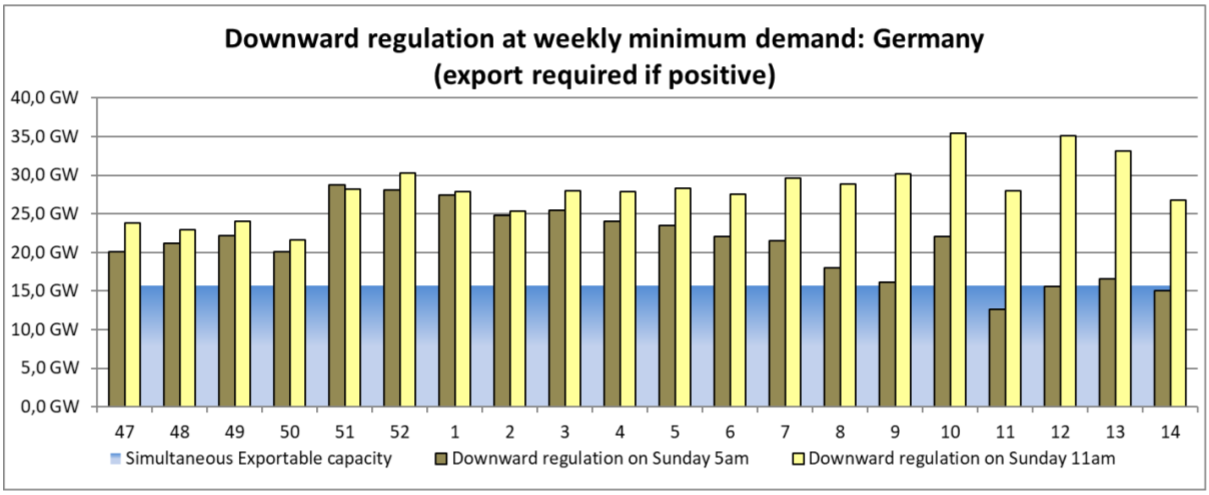
The period around Christmas and the turn of the year could potentially be critical due to a possible oversupply in the German control area. Although that was not the case in previous years due to the improved market behaviour of the balancing responsible parties, dedicated measures are available, if 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.

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 2019

General comments on past summer conditions

According to the German weather forecast service (‘Deutscher Wetterdienst’, DWD), a multiplicity of temperature records was set during the last summer.

In June, several local temperature records were broken. Furthermore, the average mean temperature in Germany in June was 19.8°C, which is also a temperature record. The sunshine duration in June also reached an all-time high.

The second half of July was also exceptionally warm. On 24 July the all-time temperature record of Germany was broken (40.5°C). The precipitation in June and July was very low compared to the mean average of the past years.

Specific events and unexpected situations that occurred during the past summer

In summer 2019 there were three significant events concerning the system adequacy in Germany: On the 6, 12 and 25 June the German TSO faced huge system imbalances, which were caused by different reasons. Investigation of these events is still ongoing (a more detailed description is available at regelleistung report[14]). Amongst other reasons, on the 6 and 12 June deviations in the renewable energy forecast led to these imbalances. In addition, the planned unavailability of EPEX further worsened the situation on 12 June.

On 25 June, the imbalances were not caused by forecast deviations but the prices on EPEX during the period of imbalances were extraordinarily high.

On all three days the TSOs activated the full amount of Interruptible Load Agreements and system reserves. Furthermore, the TSOs had to buy energy on the EPEX Spot for balancing purposes and activate emergency power in Germany and at neighbouring TSOs. On the 12 June, even the extraordinary procedure within the ENTSO-E (‘50/100 mHz procedure‘) was activated to control the imbalance.

As a consequence of the situation, the 4 German TSOs initiated ad-hoc measures to prevent further imbalances, for example increasing the amount of procured balancing power.

Low water levels on the Neckar led to unavailabilities of some power plants for grid reserves for a few days in the south of Germany.

[14] https://www.regelleistung.net/ext/download/JuliSystemBilanz

Great Britain: Winter Outlook 2019/2020

General comments and specific assumptions

Great Britain expects the winter margins to be adequate and well within the Reliability Standard set by the Government. During the winter of 2019/2020, Great Britain's operational surplus is forecast to be slightly higher than last year due to lower demand expectation.

The demand under normal condition used 30 years average demand, and the sever condition used a 1 in 20 figure. Customer Demand Management (CDM) is expected to be available during severe conditions.

The breakdown rate for the normal condition is the average of the last 3 years. For the severe condition, the breakdown rate is the highest value of the last 3 years.

Most critical periods for maintaining adequacy margins and countermeasures

Under normal conditions, the highest demand is 46.35 GW in week 50 (11 December 2019). During week 50, the corresponding remaining capacity is 5.39 GW, the lowest forecast surplus for the winter of 2019/2020. However, we believe that Great Britain will still be able to export via the interconnectors.

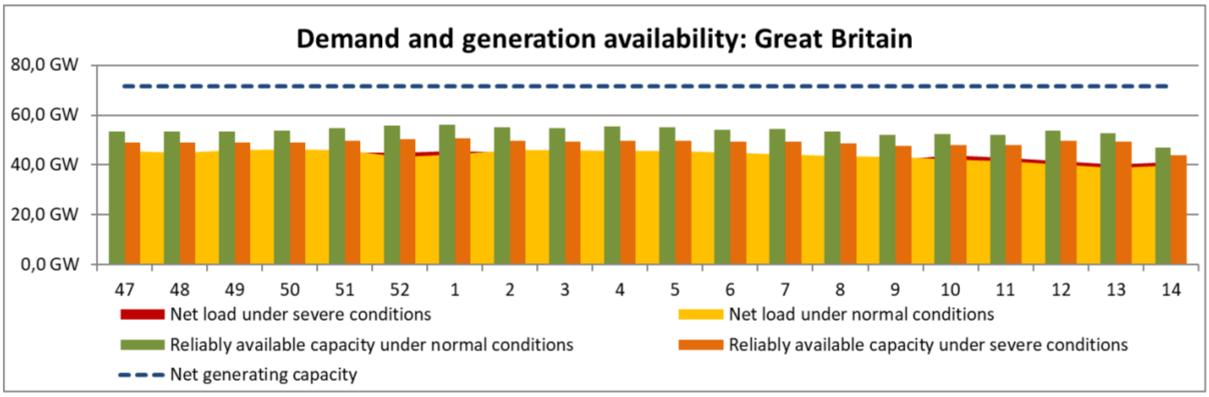
Under severe conditions, the highest demand is forecast as 47.85 GW in week 50 (11 December 2019). The corresponding remaining capacity is 3.55 GW, which is the lowest remaining capacity. However, we believe Great Britain will still be able to export some power via the interconnectors.

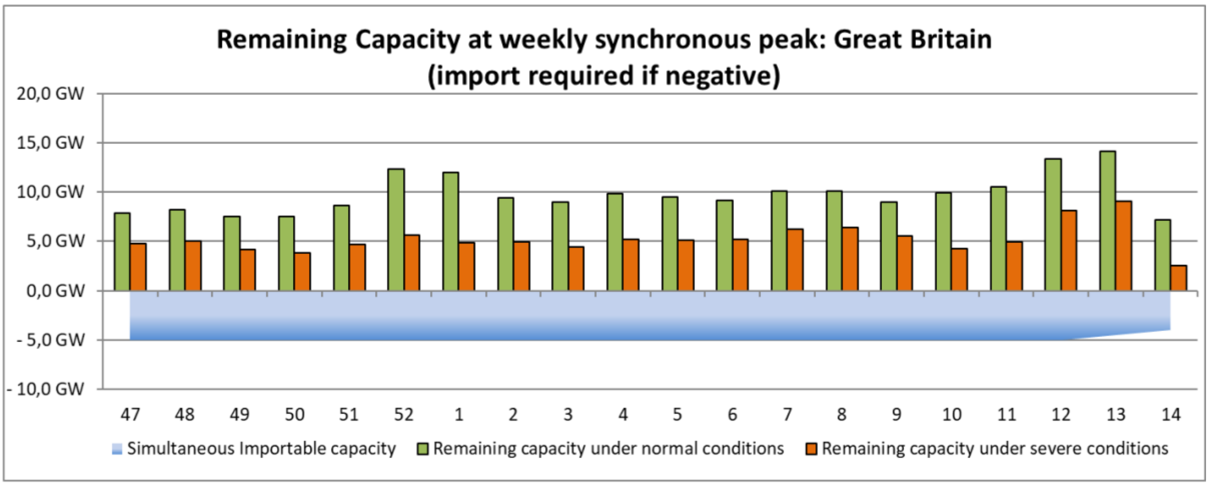
Planned outages on the interconnectors are French pole 4500 MW in week 14 (30 March 2020 to 5 April 2020), bipole 2 1000 MW in week 15 (6 April 2020 to 10 April 2020) and EWIC 500 MW in week 6 (5 February 2020 to 6 February 2020).

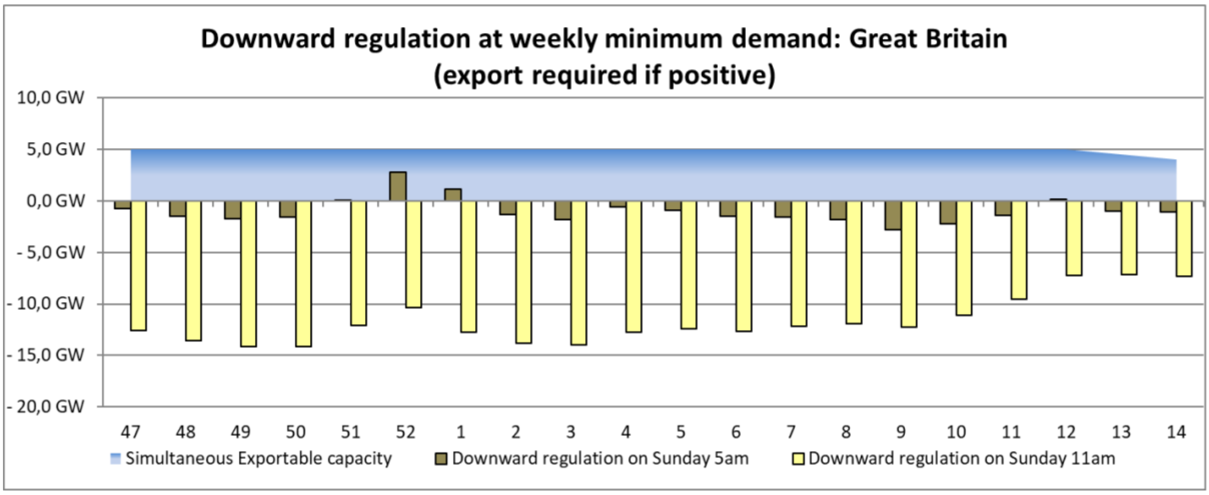
Most critical periods for downward regulation and countermeasures

For the overnight minimum period week 52 (29 December 2019), Great Britain has the lowest downward regulation capabilities (−2.73 GW) due to the low demand of 20.3 GW around the Christmas holidays. Some action may be required on the flexible wind generators if the interconnectors are not importing sufficiently.

For the daytime minimum period, week 14 (1 April 2020) has the lowest downward regulation capabilities (7.04 GW).







Great Britain: Summer review 2019

General comments on 2019 summer conditions

Margins during the summer were comfortable and manageable. Summer 2019 in Great Britain was warmer and wetter than normal, with almost average sunshine. 29 June 2019 was the hottest day with a maximum recorded in the United Kingdom.

Specific events and unexpected situations that occurred during the last summer

At 16:53 on 9 August 2019 a power outage occurred owing to a rare and unusual set of circumstances. A gas-fired generator and a windfarm tripped within 1 second of each other following a lightning strike. Frequency dropped to 48.8Hz and the Distribution Network Operators (DNOs) implemented the automatic Low Frequency Demand Disconnection (LFDD) scheme, resulting in a power outage of about 500 MWh affecting 1.1 million customers. Frequency was returned to 50Hz on the transmission system within 5 minutes, and the DNOs reconnected the demand in between 15 and 45 minutes.

The longest coal-free run in Great Britain (since the Holborn Viaduct power station opened in 1882) ended on 4 June 2019 after lasting for 18 days and 6 hours and 10 minutes.

There were no generation closures and no new conventional generation commissioning during the summer. There were several planned outages on the interconnectors:

- French interconnector Pole 4 (29/4–17/5), Pole 1 (3/6–10/6), Bipole 1 (17/6–28/6), Bipole 2 (17/7–19/7).
- Britned interconnector: Bipole (13/5–15/5) and Bipole (16/9–18/9).
- NEMO interconnector: (23/9–27/9).
- EWIC interconnector: (7/5–13/5) and (19/8–21/8).
- Moyle interconnector: Bipole (11/6–20/6).

Lowest system demand was 15.8 GW on Sunday 11 August 2019 at 04:30. The lowest afternoon demand was 18.4 GW on Saturday 17 August 2019 15:00. The highest PV generation was 9.2 GW on Friday 28 June 2019 at 13:00. No Electricity Margin Notices (EMNs) were issued and Great Britain had some localised NRAPMs (Negative Margin Notices).

Greece: Winter Outlook 2019/2020

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 second 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 the operating criteria under normal conditions.

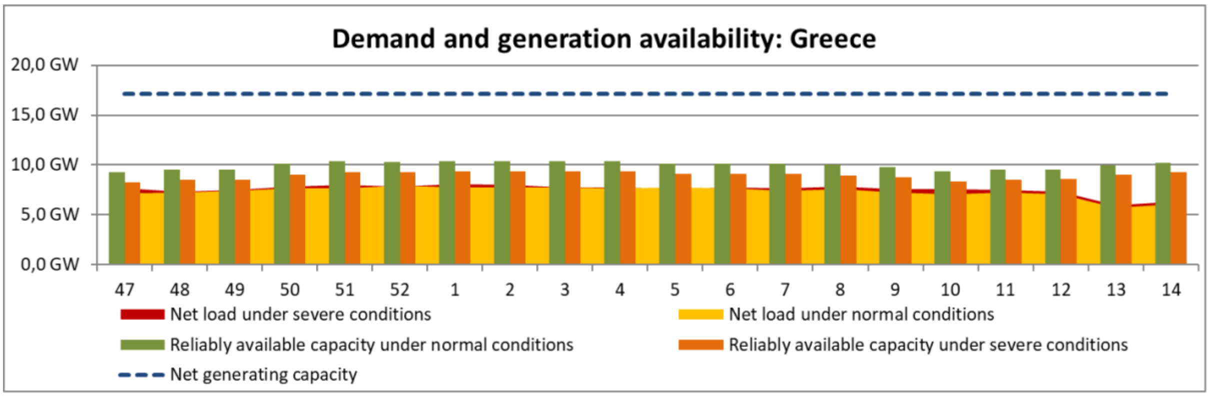
The role of interconnectors is currently important for adequacy, mainly in case of gas supply problems. For those situations, there is the possibility of using bi-fuel operation as an alternative fuel (diesel).

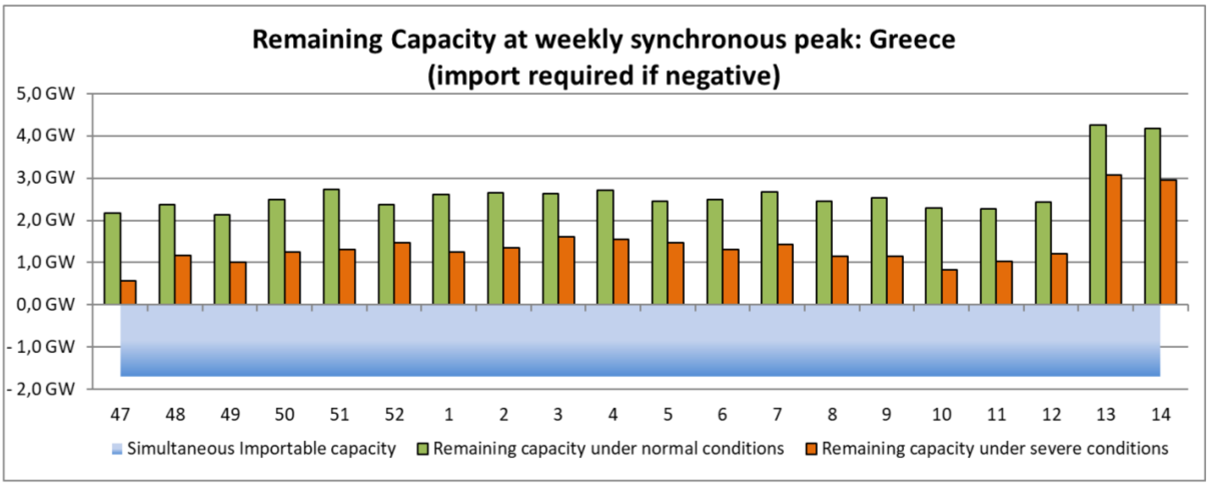
The most critical periods for downward regulating capacity are usually from 00:00 to 06:00, mainly on weekend days.

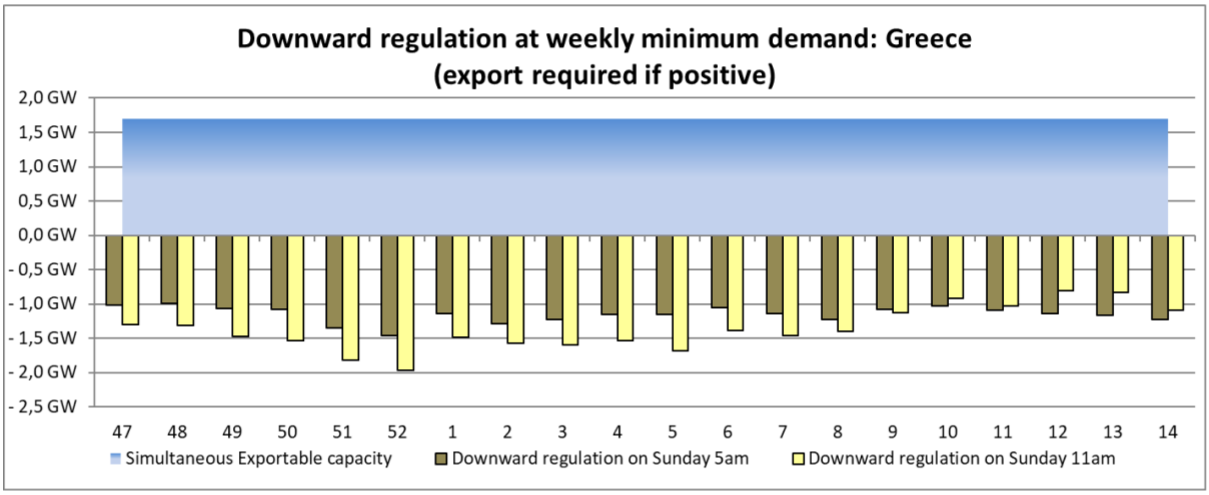
The countermeasures adopted are:

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

The interconnectors are not being used to balance the reserve exchange.







Greece: Summer review 2019

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 temperatures ranging around normal levels for the season.

During this summer, 5 lignite generation units with a total nominal production of approximately 1500 MW withdrew due to depreciation.

Hydro generation was moderate during the summer.

During the summer, some fire incidents occurred, affecting the transmission capacity.

Hungary: Winter Outlook 2019/2020

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 intermittent generation on the other, the Hungarian power system does not expect adequacy issues for the coming winter. However, there are risks that must be carefully managed. These risks are as follows:

- 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 an unavailability of 800 MW capacity;
- Hungary usually imports 2–3 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 causes higher uncertainty in operational planning periods and real time system operation. The NGC of PV may reach 2 GW in the first part of 2020;
- The Hungarian electricity system is significantly dependent on gas imports. In the event that the gas supply wanes or terminates, 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 at this rate for a relatively long period of time cannot be compensated for by domestic sources nor by additional import. In the event that there is no continuous gas supply, it is possible to run out of alternative fuels within two weeks. Moreover, it is necessary to consider a further decrease of imports as a consequence of available capacity limitation in the gas-fired power plants of the adjacent electricity systems. To prevent a long term and large scale demand disconnection, close cooperation and assistance among TSOs and the provision of access to the regional sources are essential.

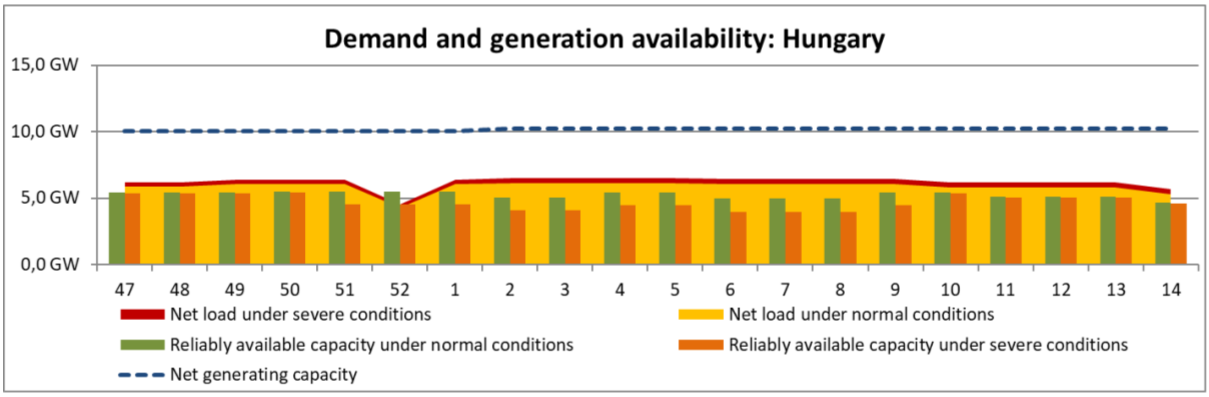
Most critical periods for maintaining adequacy margins and countermeasures

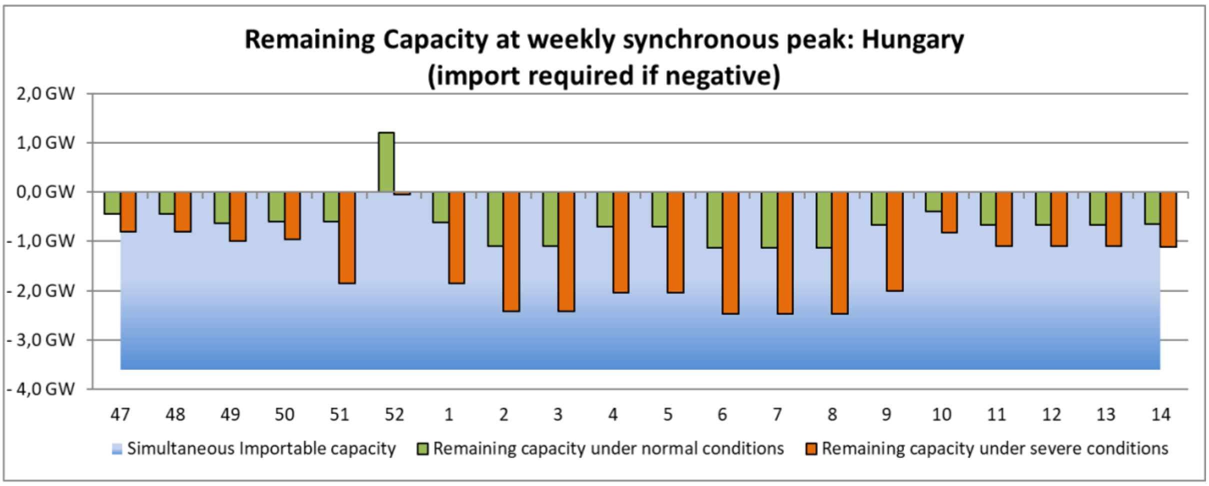
The level of maintenance during the winter period is very low, owing to performed and planned maintenance outside of the high demand period of the year. The highest capacity under maintenance is planned to be approximately 840 MW on 1 April.

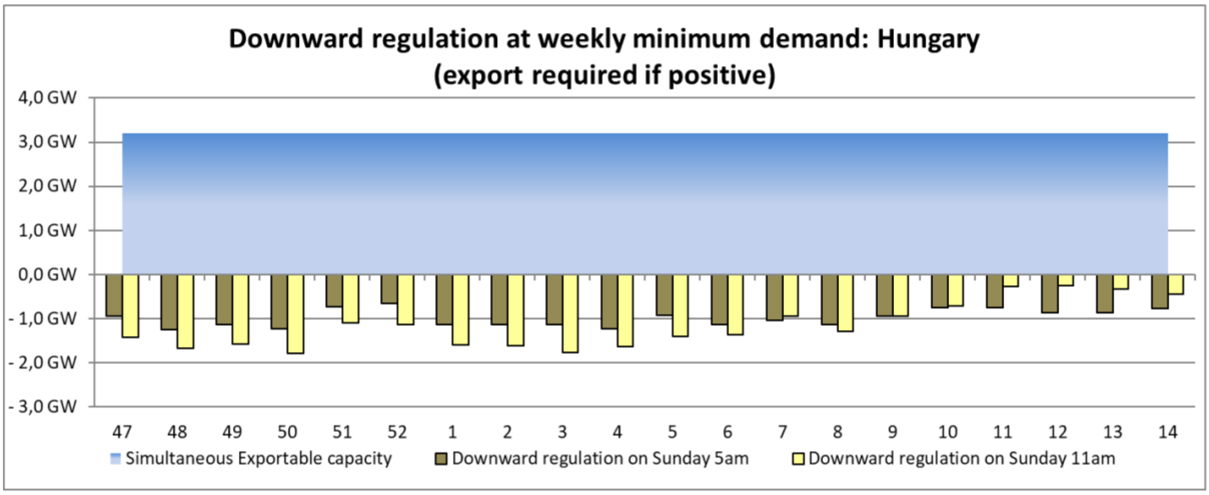
Most critical periods for downward regulation and countermeasures

In the Hungarian electric power system, the adequacy 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 are during the holiday period in January. 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 2019

General comments on 2019 summer conditions

The summer temperature of 2019 on average was similar to the most recent years. However, in June the highest summer system peak demand in history was recorded. An increase of energy demand was recorded. Outages of generators were rather low and the grid remained reliable.

Specific events and unexpected situations that occurred during the last summer

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

The peak demand was higher than last summer (6633 MW and 6358 MW respectively) and it was the highest demand that we have ever registered in summer.

There were no significant generation outages, they were between 50 and 1039 MW.

Iceland: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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

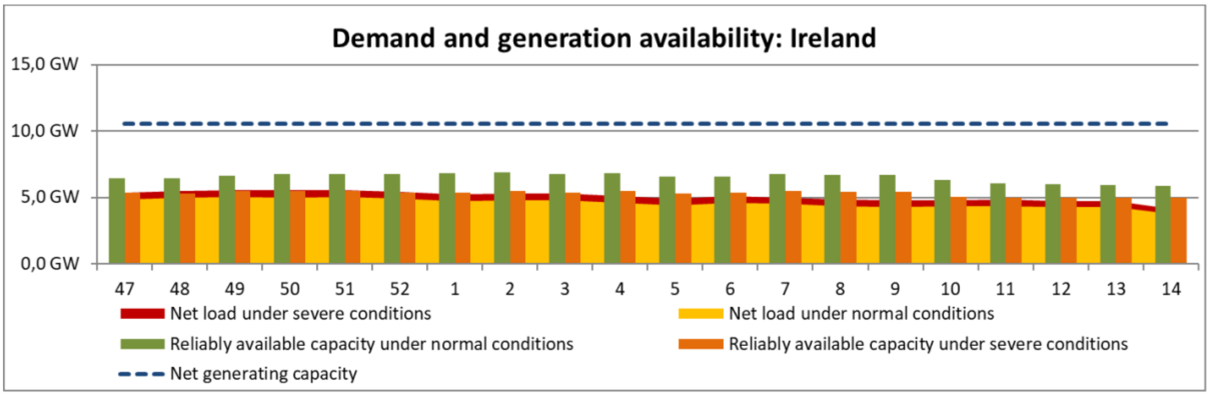
Iceland: Summer review 2019

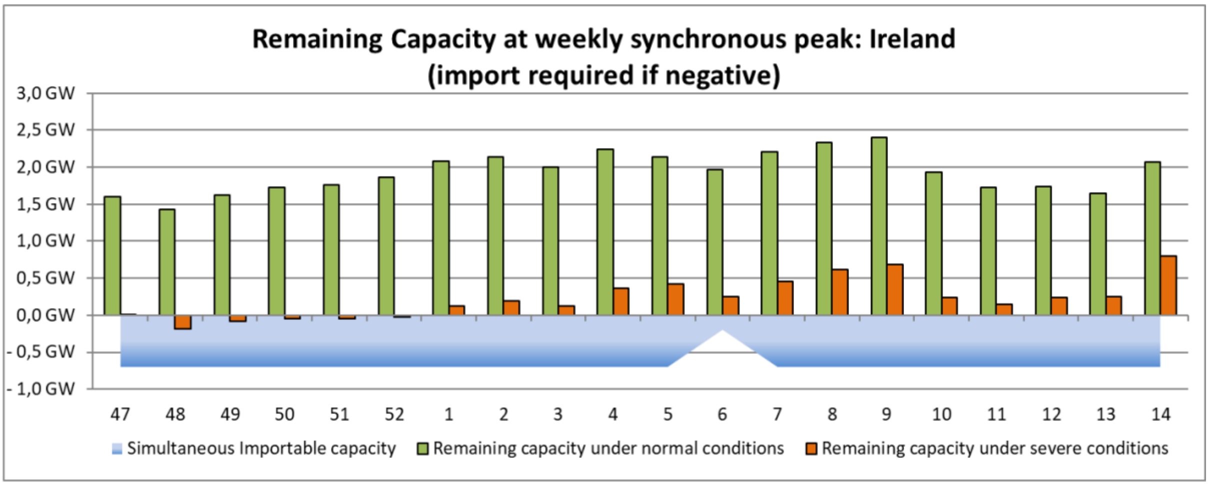
No adequacy or downward regulation issues were identified during the past season.

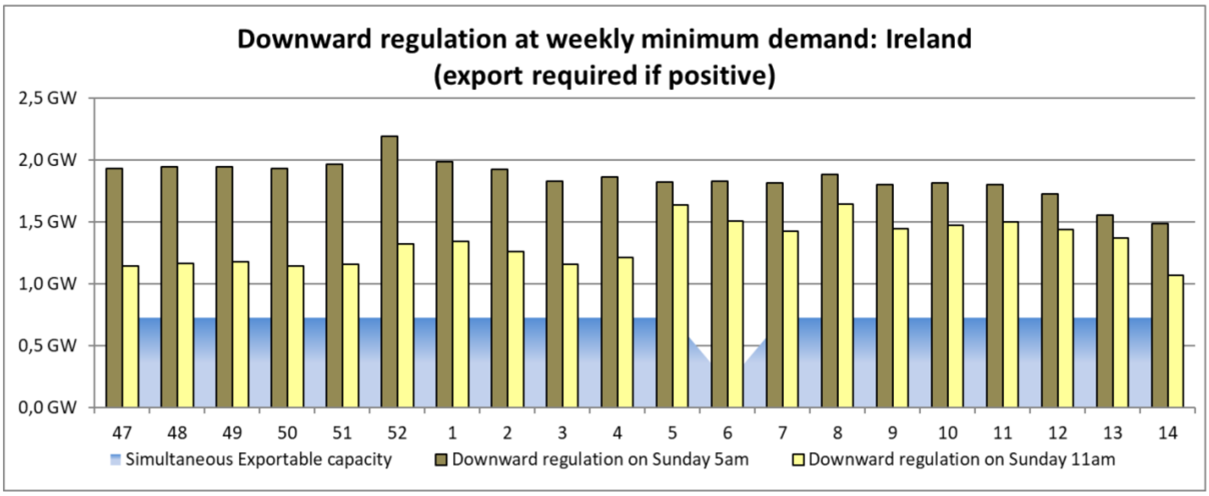
Ireland: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

Adequate generating capacity is expected for the coming winter period.





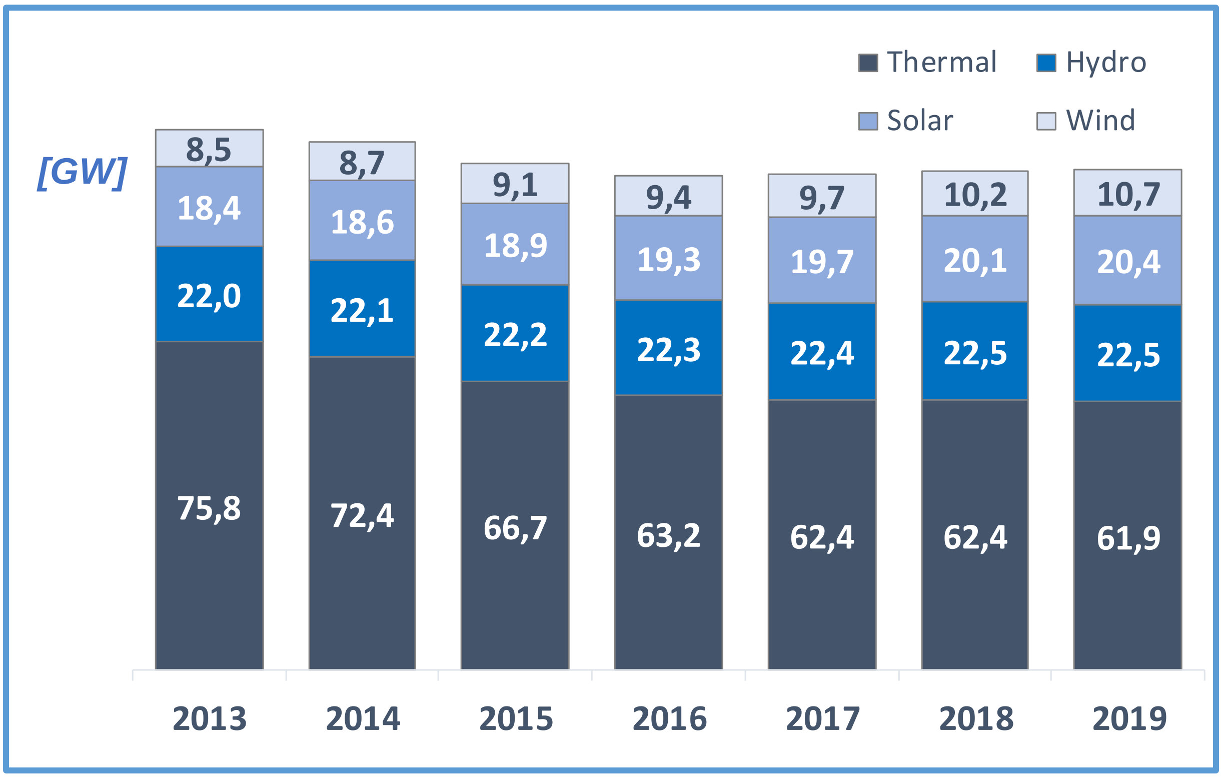


Ireland: Summer review 2019

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

Italy: Winter Outlook 2019/2020

In recent years, the Italian Power System has faced a significant reduction of the conventional (thermoelectric[15]) power fleet. The growth of variable (e.g. wind and PV) generation, together with an annual consumption decrease (from 340 TWh in 2008 to 320 TWh in 2018), put commercial pressure on traditional generators, leading to the decommissioning of several power plants. Between 2013 and 2019, the following phenomena affected the power system operation with a significant impact on adequacy in Italy: approximately 14 GW installed generation capacity was phased out. The total amount of conventional available capacity fell from 75.8 GW in 2013 to 62.4 GW in 2019. Furthermore, an additional 3.5 GW conventional power capacity is not available due to environmental and other permitting issues. This trend is displayed in the figure below.



These phenomena have affected the power system adequacy in Italy and some important warning signals were already registered over the last few years, in particular, during summer 2015, winter 2016/2017 and summer 2017.

[15] *This is understood to include geothermal, biomass and bioenergy power plants*

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

Nevertheless, since 2017 this trend seems to have slowed down, not least as a consequence of the new capacity remuneration mechanism which has been approved by the European Commission and will be effective as of 2022.

Main outcomes of the adequacy assessment

Under normal conditions, no problem regarding system adequacy is envisaged in the Italian system. Even though in the northern area the generation capacity is expected to be lower than the demand, the import from neighbouring countries and southern bidding zones prevents an impact on the electricity supply of this area.

Under severe conditions**,** necessity of import is more significant and more weeks would need imports to ensure adequacy compared to normal conditions. It is possible to guarantee the coverage of peak demand and reserves only via the contribution of the import from neighbouring countries, in particular in the northern area. However, in the event of significant unplanned outages of generation and/or transmission assets, interconnectors congestions or simultaneous system-wide scarcity of resources, the deficit cannot be fully covered by imports.

Concerning the ‘external’ risk factors for the security of supply, it should be noted that the Italian generation fleet heavily relies 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 most critical period is expected during January and February.

Under severe conditions, the situation for the winter 2019/2020 could lead to the need for imports for several weeks from December until the end of February.

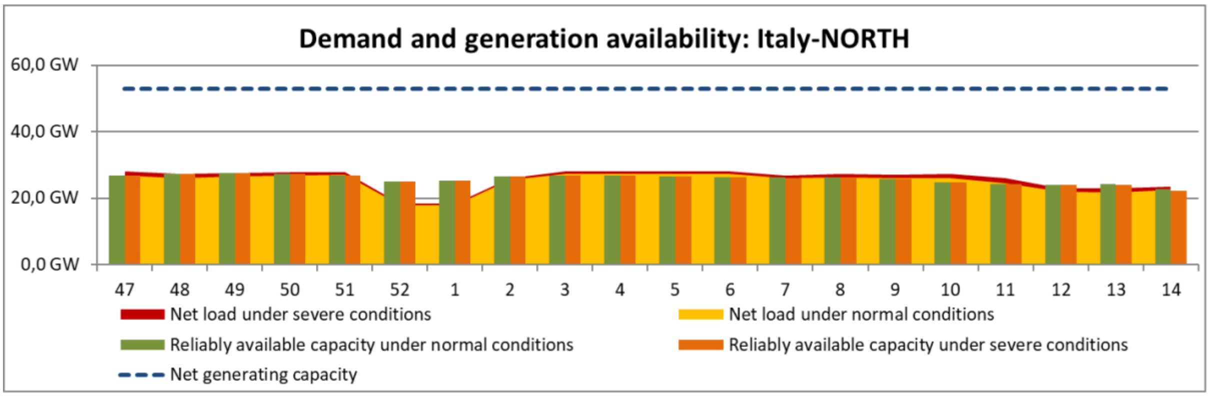
A wise planning (and coordination) of grid and generation outages has been implemented at regional level, but postponement and/or cancellation of planned outages would be feasible if necessary.

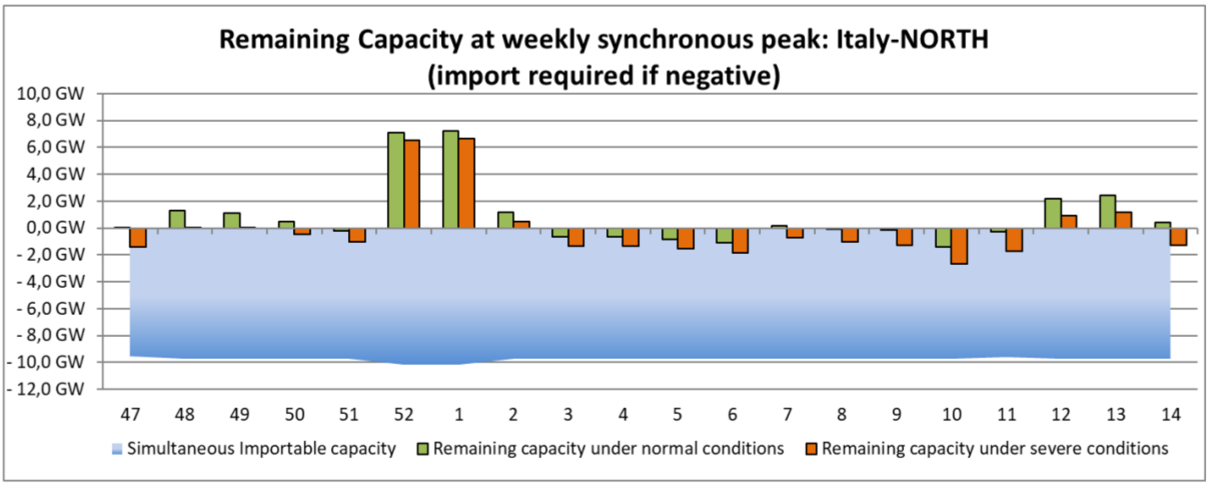
Improved regional coordination processes (including regional weekly adequacy assessment–STA project) will support the definition of the most proper and efficient available countermeasures in case the risk of incurring in critical situations is detected in the short-term.

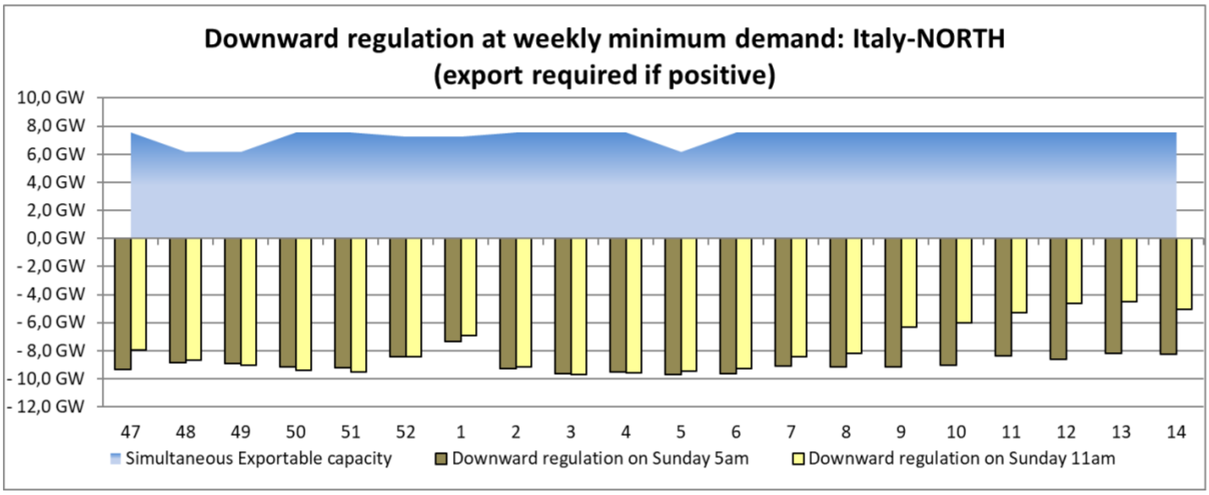
Downward regulation–most critical periods and countermeasures

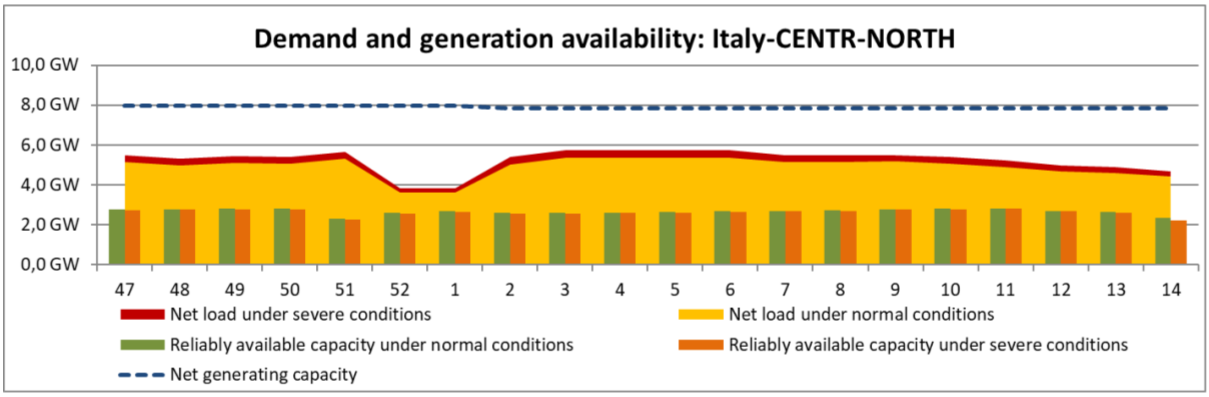
High renewables production (wind and solar) during low demand periods, considering the level of other not flexible generation, could lead to a lack of downward regulating capacity, especially in the Southern Bidding Zones (e.g. South, Sicily and Sardinia).

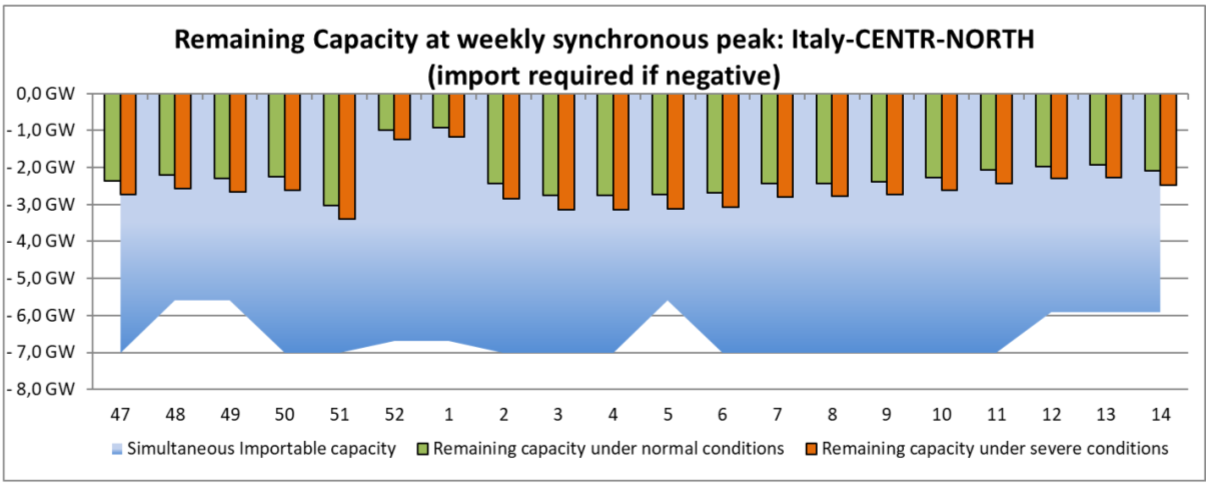
The worst period for downward regulation is expected to be over the Christmas break. To cope with this risk, the Italian TSO (Terna) has prepared preliminary action and emergency plans and, in case of need, will adopt the appropriate countermeasures. Most notably, to guarantee system security, Terna could adopt enhanced coordination with neighbouring TSOs and special remedial actions, such as the curtailment of not flexible generation. Further special actions, such as NTC import reductions, could be planned in cooperation with neighbouring TSOs to maintain grid stability and a suitable voltage profile.

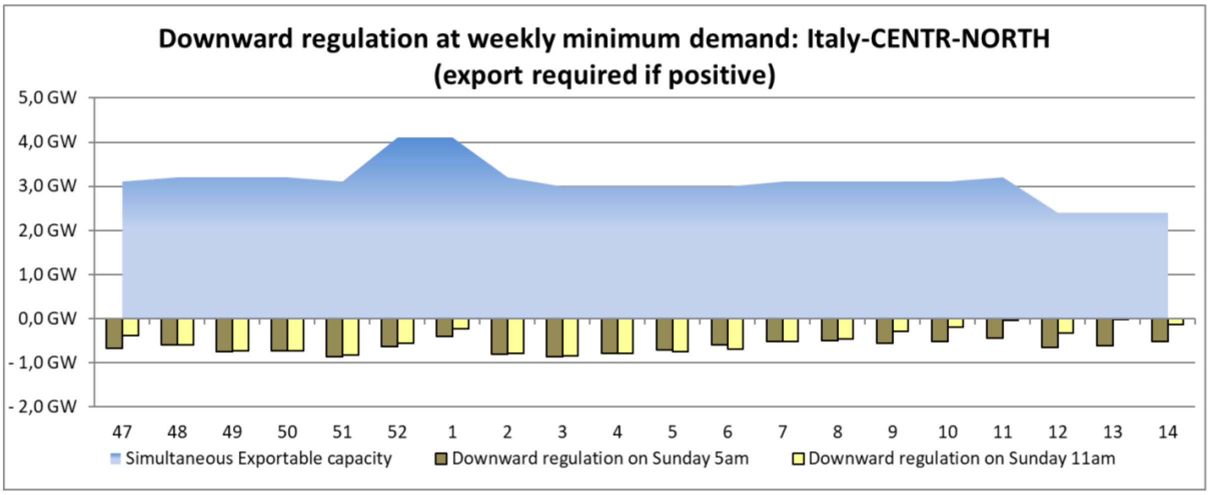

Demand and generation availability: Italy-NORTH
60,0 GW
40,0 GW
20,0 GW
0,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

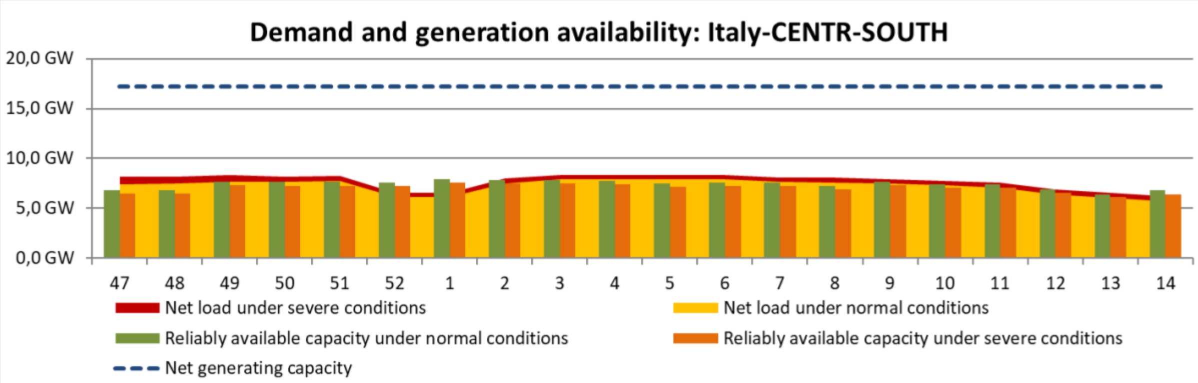

Remaining Capacity at weekly synchronous peak: Italy-NORTH
(import required if negative)
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
- 2,0 GW
- 4,0 GW
- 6,0 GW
- 8,0 GW
- 10,0 GW
- 12,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions


Downward regulation at weekly minimum demand: Italy-NORTH
(export required if positive)
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
- 2,0 GW
- 4,0 GW
- 6,0 GW
- 8,0 GW
- 10,0 GW
- 12,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

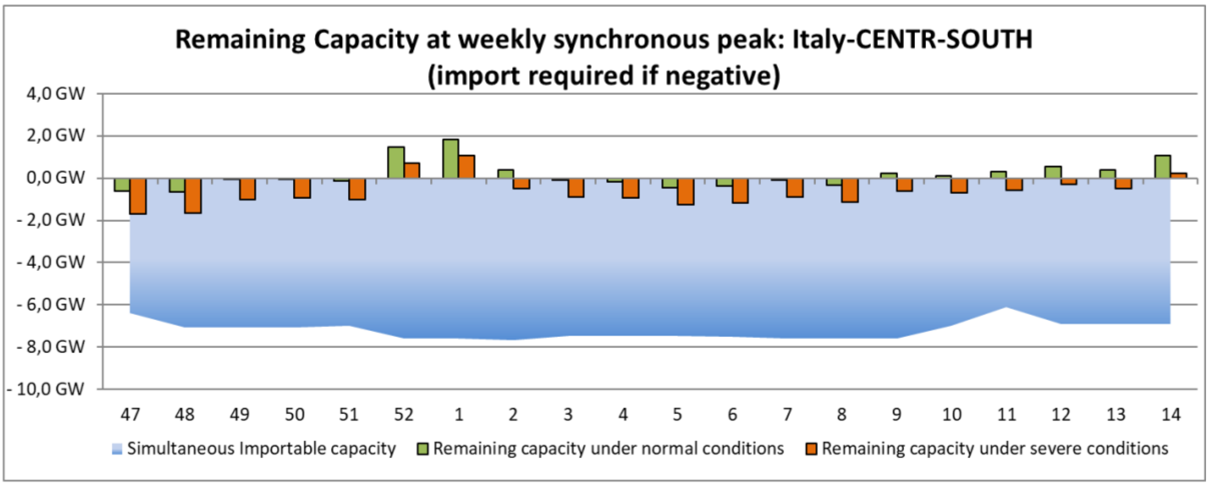

Demand and generation availability: Italy-CENTR-NORTH
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe 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
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

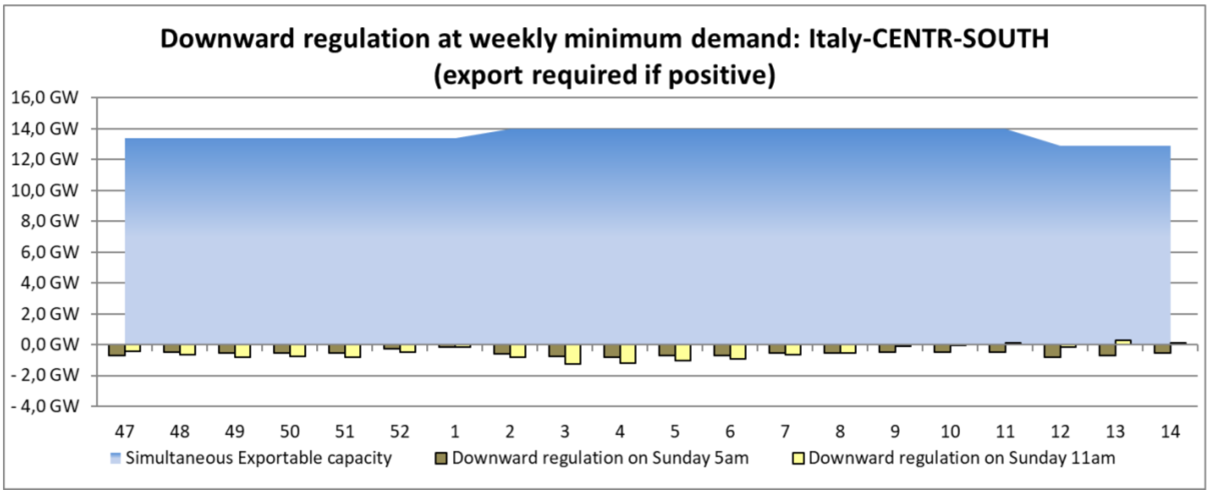

Downward regulation at weekly minimum demand: Italy-CENTR-NORTH
(export required if positive)
5,0 GW
4,0 GW
3,0 GW
2,0 GW
1,0 GW
0,0 GW
- 1,0 GW
- 2,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am



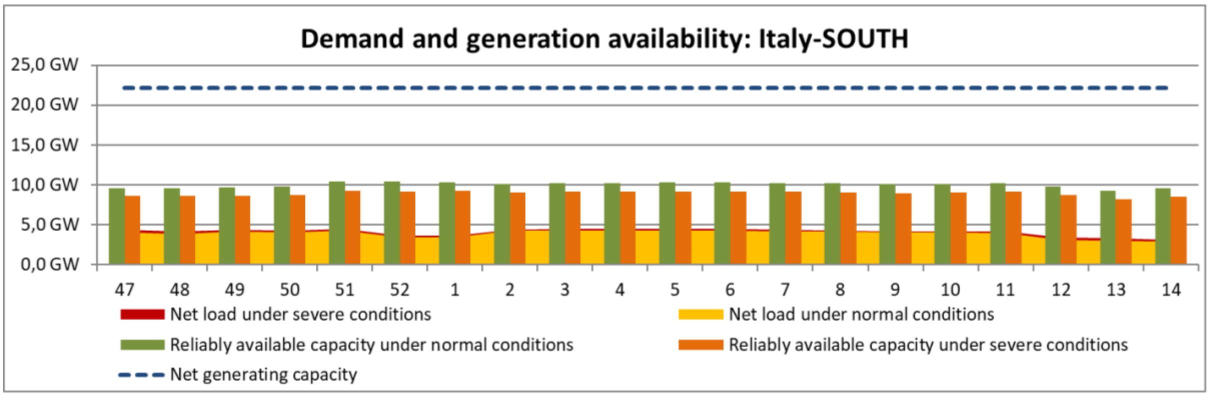
Demand and generation availability: Italy-CENTR-SOUTH
20,0 GW
15,0 GW
10,0 GW
5,0 GW
0,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity



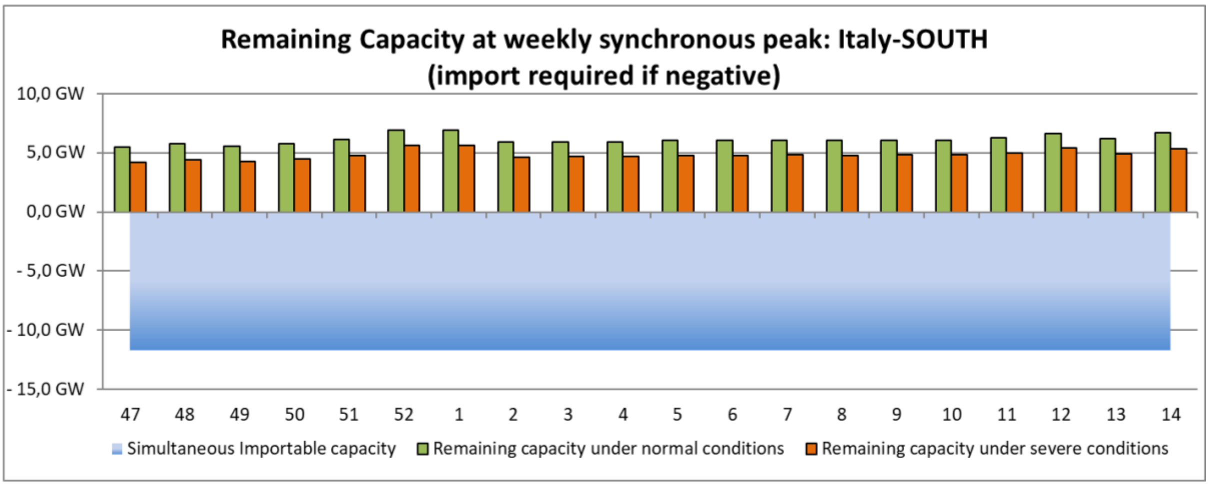
Remaining Capacity at weekly synchronous peak: Italy-CENTR-SOUTH (import required if negative)
4,0 GW
2,0 GW
0,0 GW
- 2,0 GW
- 4,0 GW
- 6,0 GW
- 8,0 GW
- 10,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions



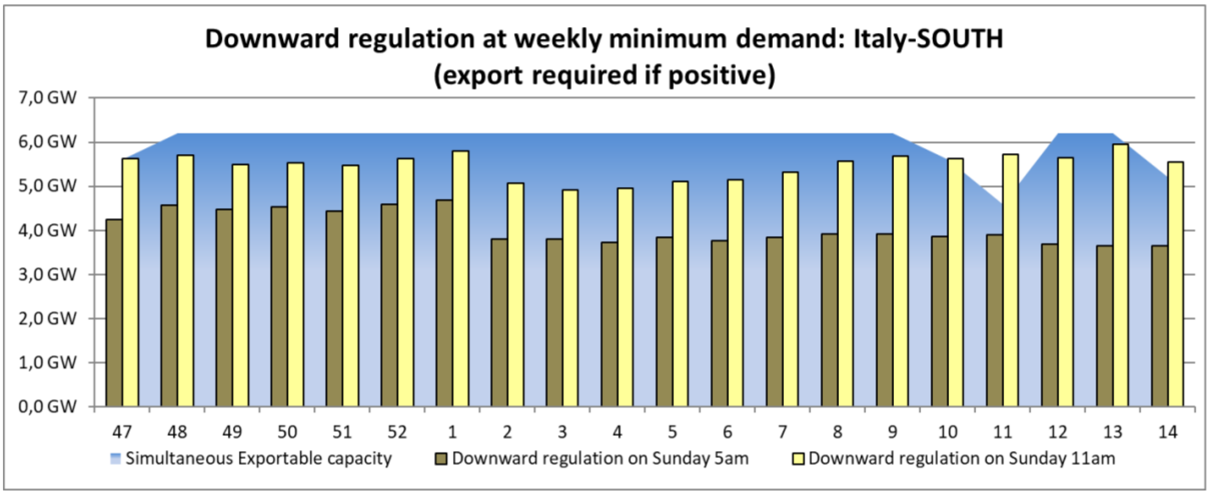
Downward regulation at weekly minimum demand: Italy-CENTR-SOUTH (export required if positive)
16,0 GW
14,0 GW
12,0 GW
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
- 2,0 GW
- 4,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am



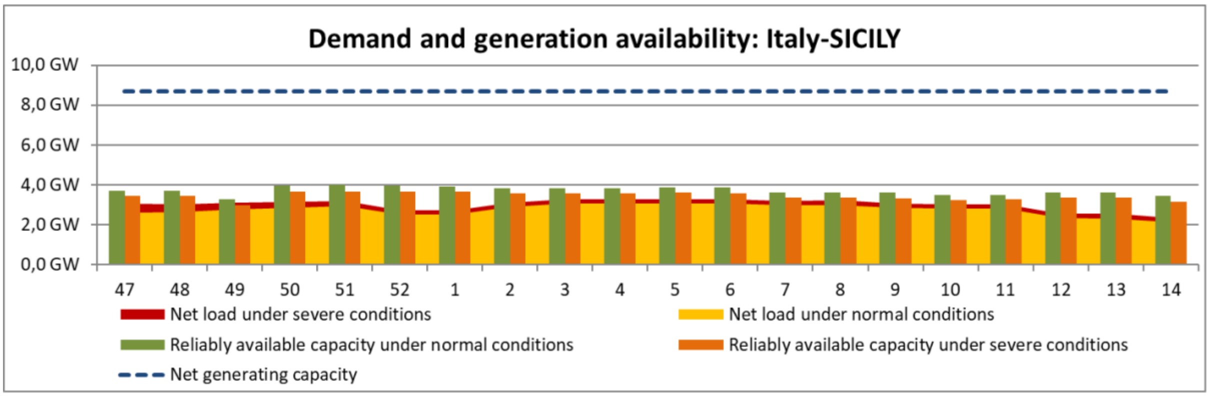
Demand and generation availability: Italy-SOUTH
25,0 GW
20,0 GW
15,0 GW
10,0 GW
5,0 GW
0,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

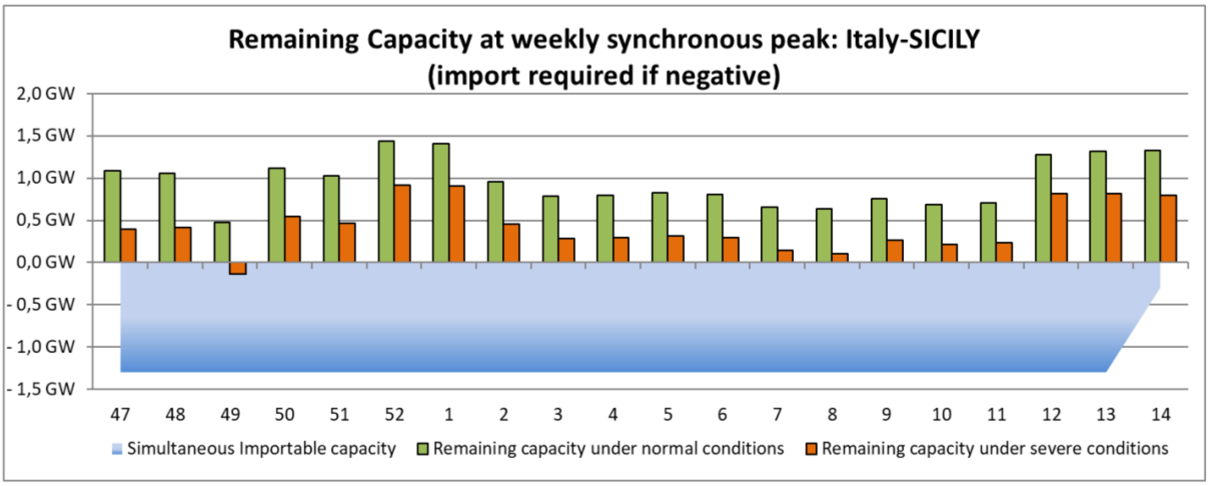


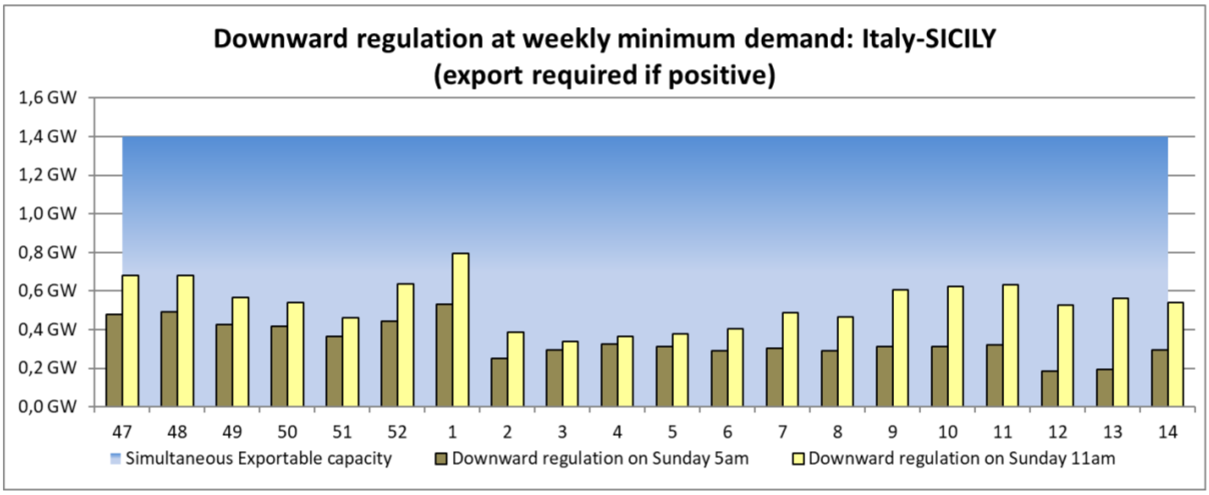
Remaining Capacity at weekly synchronous peak: Italy-SOUTH
(import required if negative)
10,0 GW
5,0 GW
0,0 GW
- 5,0 GW
- 10,0 GW
- 15,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

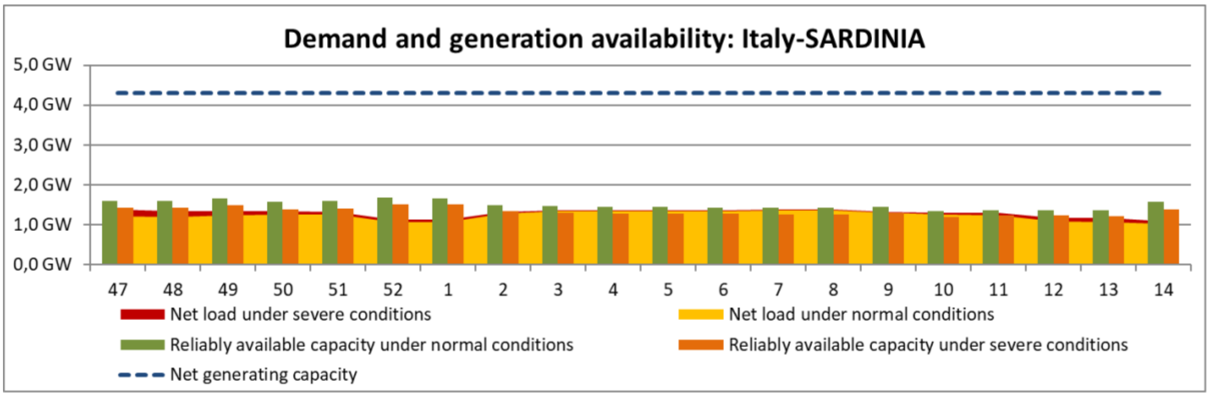


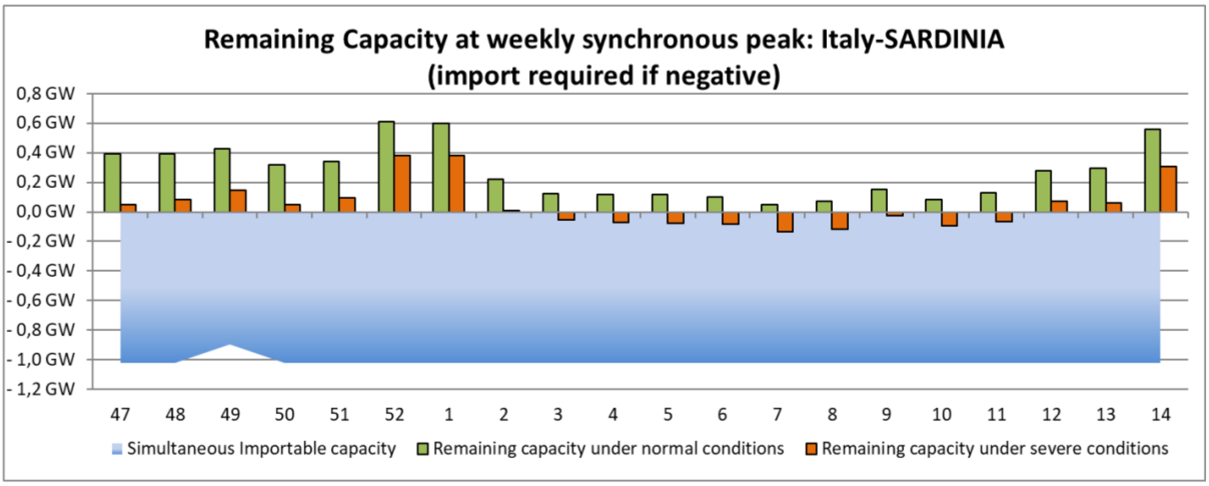
Downward regulation at weekly minimum demand: Italy-SOUTH
(export required if positive)
7,0 GW
6,0 GW
5,0 GW
4,0 GW
3,0 GW
2,0 GW
1,0 GW
0,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

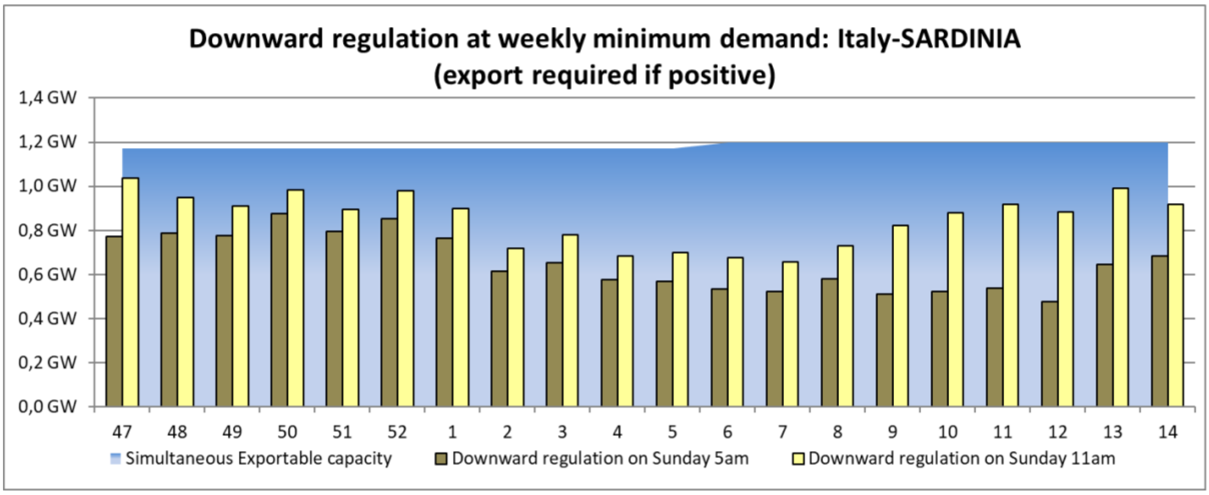

Demand and generation availability: Italy-SICILY
10,0 GW
8,0 GW
6,0 GW
4,0 GW
2,0 GW
0,0 GW
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe 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
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
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
47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am







Italy: Summer review 2019

General comments on 2019 summer conditions

Summer 2019 recorded an energy demand 1.26% higher than the value of the same period in 2018.

Compared to 2018, temperatures were higher only in the period from the second ten-day period of July to the first ten-day period of August (+3°C for average temperatures). With reference to the whole summer period, the temperature profiles of both years 2018 and 2019 are very similar—the average temperature in summer 2019 was 0.18°C higher than in summer 2018.

In summer 2019, the Italian system did not face significant adequacy problems, due to the intensive and effective coordination with neighboring TSOs.

Specific events and unexpected situations that occurred during the last summer

In the period under consideration, several forest fires involving HV power lines occurred in Southern Italy and the two main islands. Nevertheless, these fire events did not affect the security of the electrical system operation.

Latvia: Winter Outlook 2019/2020

The demand in Latvia depends on weather conditions, especially ambient temperature for a specific day and hour. The TSO is not expecting load shedding under normal and severe conditions—the demand is expected to be covered during the whole winter period. Under normal conditions, the demand is expected to be 2.4% higher compared to the previous year in a particular hour; and under severe conditions demand is expected to be higher by 5% compared to the previous year in a particular hour. The system service reserve is 100 MW under normal and severe conditions during the whole year.

The expected peak demand in 2019 and 2020 varies between 0.89 GW and 1.13 GW under normal conditions. The total installed capacity for the Latvian power system is approximately 2.92 GW during the whole winter period. The fossil power plants are approximately 1.03 GW, the hydro power plants (run-of-river) are approximately 1.6 GW and the rest of capacity corresponds to 0.21 GW of other RES capacity (wind, bio fuel and solar). Other non-RES generation are small CHP power plants distributed in Latvia with a capacity of approximately 0.1 GW. During winter 2019/2020, all gas power plant capacity will be available as there is no maintenance or overhauls planned. During the whole winter period a couple of units from hydro power plants (HPPs) on the Daugava river are in maintenance (from 0.12 GW to 0.3 GW). The maintenance and overhauls do not influence the available capacity on HPPs on Daugava river because the limiting factor of production is water inflow in the Daugava river. It is assumed that in winter 2019/2020 the available capacity of HPPs under normal conditions on Daugava river is approximately 500 MW (the average historical generation in winters); but under severe conditions the availability is decreased to 400 MW due to a lower water inflow level. The full generation capacity of HPPs on the Daugava river can be utilised between April and June when flooding is observed.

Most critical periods for maintaining adequacy margins and countermeasures

The peak demand under normal and severe conditions is expected be covered during the whole observed winter period. No gas supply shortages are expected, which could limit gas power plant operation.

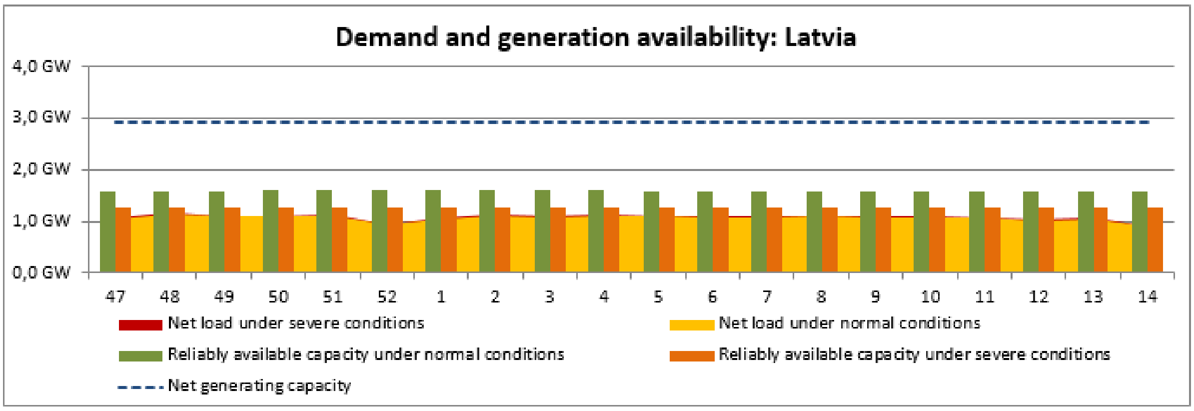
In moments when generation capacity in Latvia is not sufficient to supply demand, the Latvian TSO relies on electricity imports from neighbouring countries via cross-border interconnectors.

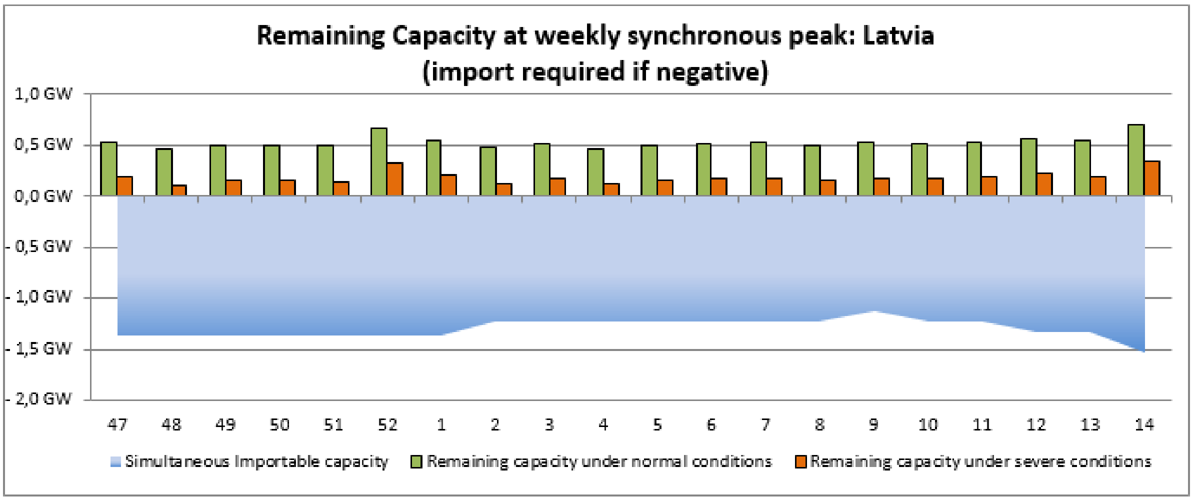
Most critical periods for downward regulation and countermeasures

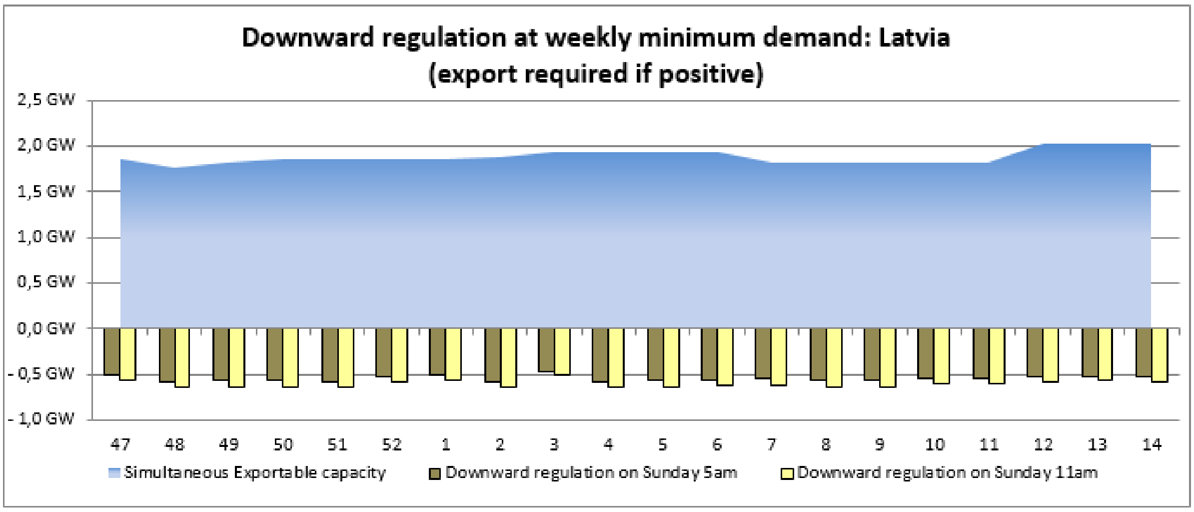
The amount of inflexible generation in Latvia is very low. Therefore no problem is foreseen with the operation of inflexible generation during night-time, nor during daytime minimum demand hours. The inflexible generation is approximately 210 MW.

Potential critical periods and foreseen countermeasures

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







Latvia: Summer review 2019

The average temperature in Latvia during the summer was slightly higher than normal.

The water inflow in Daugava river this summer was close to normal and the production of hydro generation was close to expectations.

The Latvian power system relied on imports from neighbouring countries.

No significant unplanned outages of the interconnectors were observed and most of the time demand was covered with imports from neighbouring countries.

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

Lithuania: Winter Outlook 2019/2020

The demand estimation under normal conditions was based on the statistical data of the previous three years. However, during the winter season, consumption is highly dependent on weather conditions. Compared to the previous winter, total demand is expected to be approximately 3.3% higher, with a maximum (under normal conditions) of 2093 MWh in the end of January.

Since the last winter season, net generating capacity increased by 17 MW and currently is equal to 3550 MW.

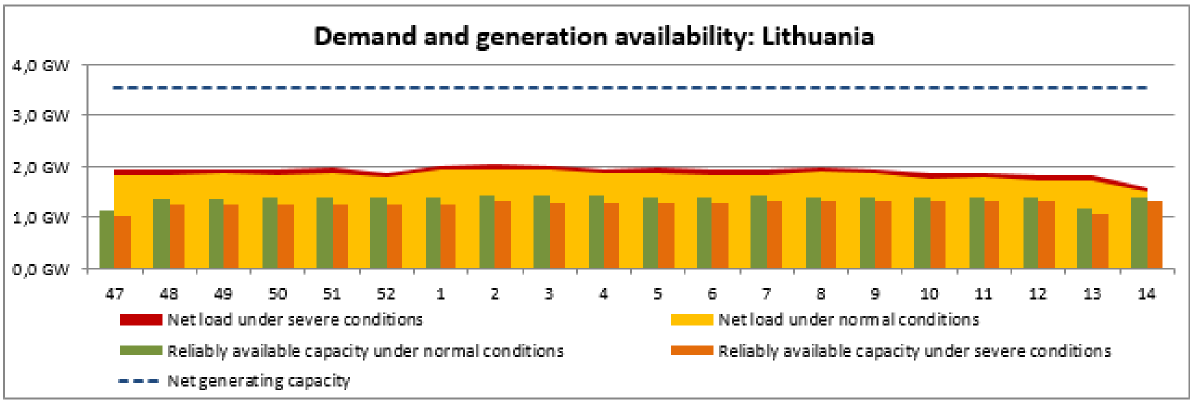
The total volume of frequency restoration reserves and replacement reserves will decrease from 920 MW to 875 MW (25% of total NGC in Lithuania) from 2020. Furthermore, the scheduled maintenance in winter 2019/2020 is low—the largest maintenance works will affect only 6% of total NGC in Lithuania. This is planned to occur twice in winter 2019/2020 during maintenance of two generating units of the Kruonis Pumped Storage Plant at weeks 47 and 13

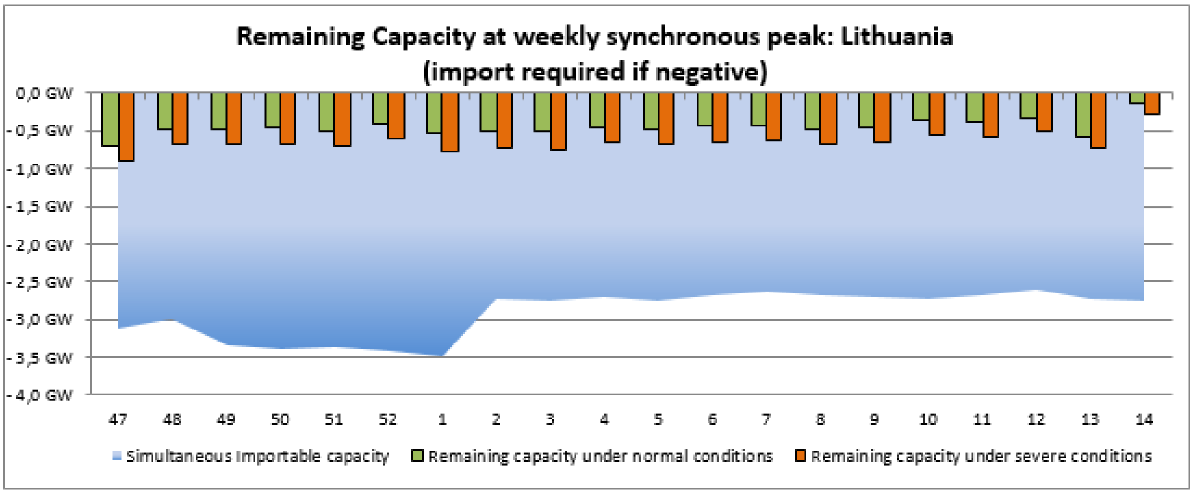
No significant transmission capacity constraints of the Lithuanian power system interconnections with Latvia, Sweden and Poland are foreseen for the upcoming winter season. However, low import capacities from the Kaliningrad region (Russia) are expected between weeks 2 and 14 in 2020. This is a result of the planned maintenance of the Kaliningrad Thermal Power Plant.

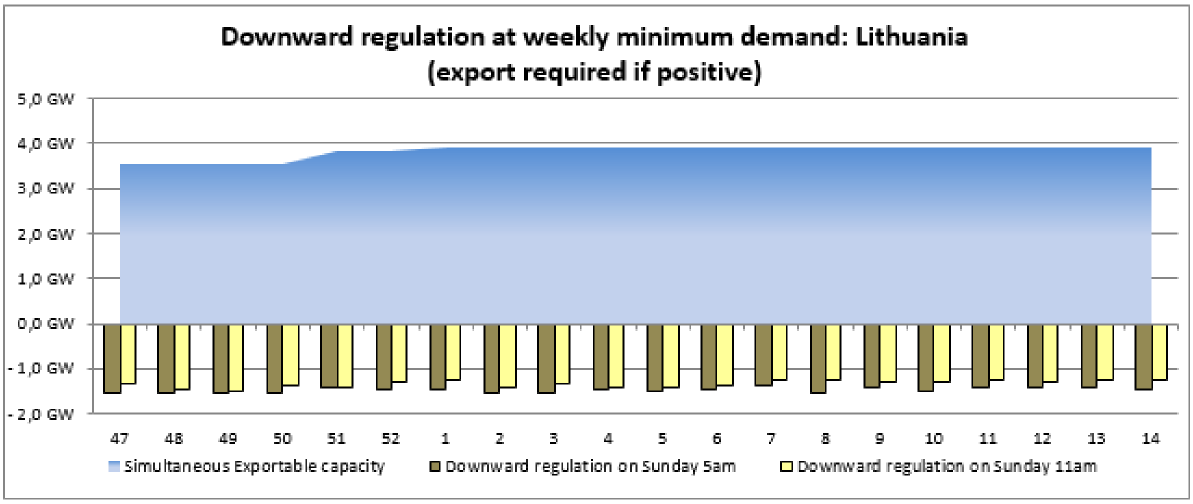
Cross-border import capacity from Russia and Belarus highly depends on Estonia-Latvia cross-border capacity. Low cross-border capacity from Russia and Belarus is foreseen during weeks 47–48.

Potential critical periods and foreseen countermeasures

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







Lithuania: Summer review 2019

Total national consumption in the summer of 2019 was 0.5% higher than in summer 2018. The maximum demand (1740 MW) was reached in mid-June, whereas the minimum demand (859 MW) was in mid-July. The average summer balance portfolio consisted of 25% local generation and 75% imports from neighbouring countries. The largest proportion of imported electricity was from Sweden (40%) and Russia (39%).

In summer 2019, generation energy in Lithuania was 24% (156 GWh) higher than in the previous summer. The highest contributor was Kruonis pumped storage plant, producing 140 GWh more compared to last year. Generation from fossil fuel power plants was 18% higher (25 GWh). Wind and solar generation were also higher—6% (13 GWh) and 16% (5 GWh) respectively. However, due to lower precipitation, hydro run-of-river and pondage generation was 18% (11 GWh) lower. Generation from other renewable sources decreased by 11% (10 GWh) compared with summer 2018.

During summer 2019, import capacities from Latvia, Poland and Sweden power systems were as expected.

Import capacities from Kaliningrad and Belarus were higher most of the time compared to forecasted values. These import capacities in most cases were constrained by cross-border interconnection between Estonia and Latvia. From the second half of August, import capacity from Kaliningrad and Belarus was limited more often by the Belarus-Lithuania interconnection itself, due to the reconstruction and maintenance of the Belarussian power network.

Import capacity from Kaliningrad region to Lithuania was low during weeks 28–29 and 36–37 because of the maintenance activities of Kaliningrad Thermal Power Plant.

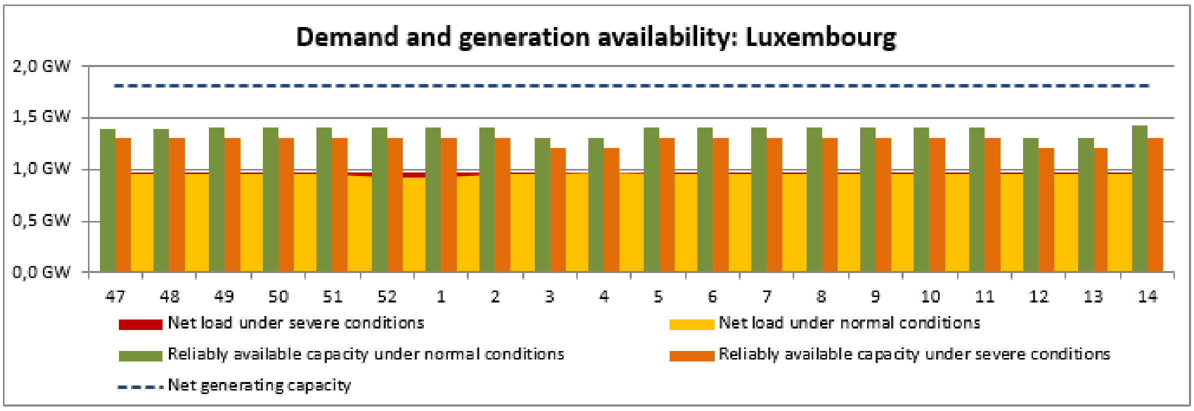
No adequacy or downward regulation issues were identified during the past season.

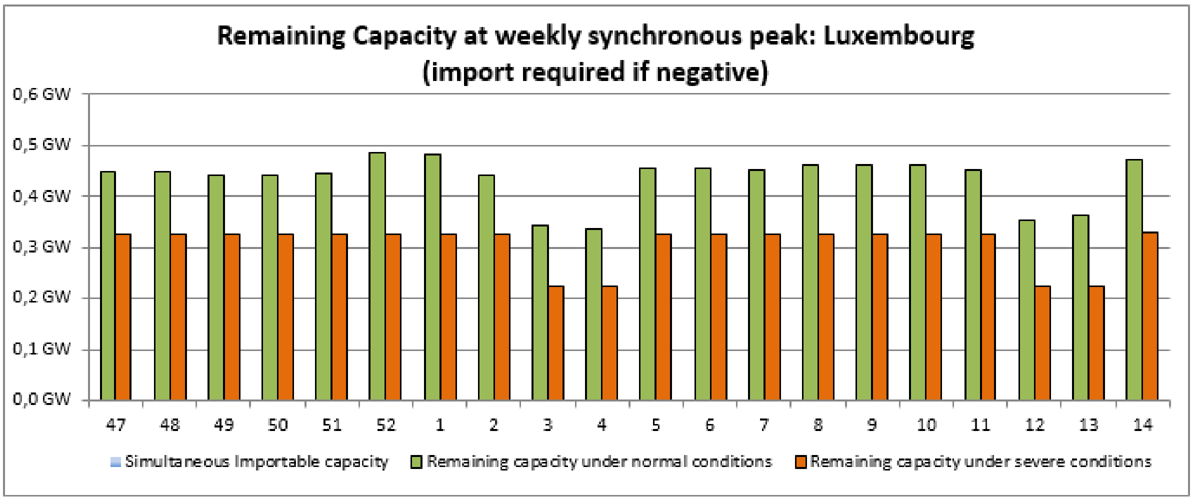
Luxembourg: Winter Outlook 2019/2020[16]

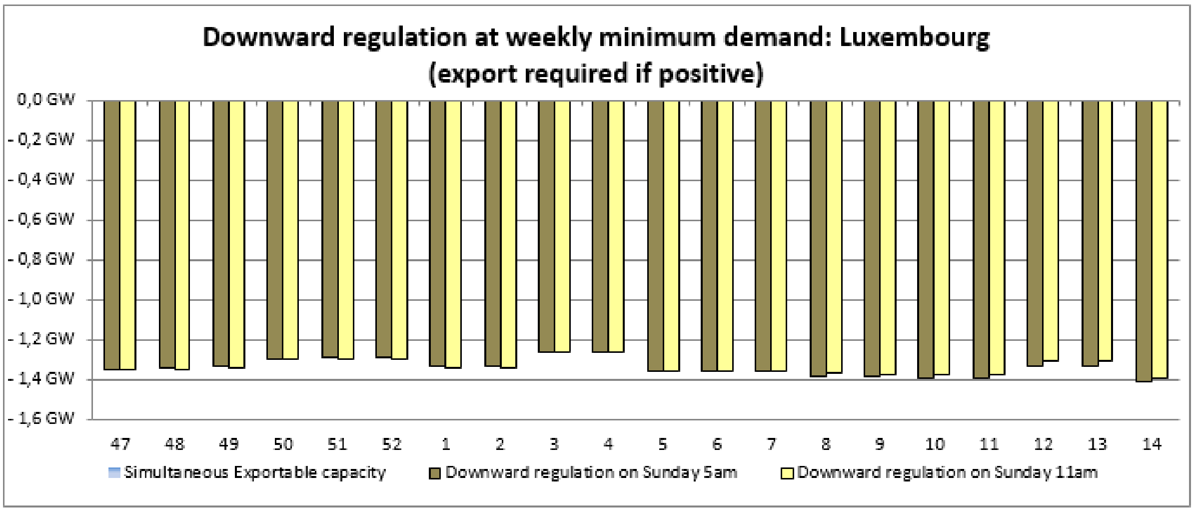
Potential critical periods and foreseen countermeasures

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

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







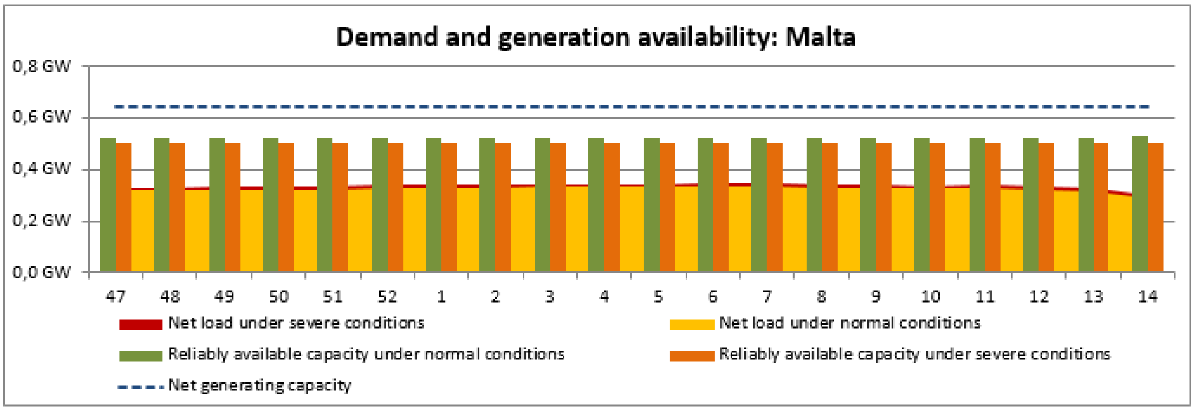
Luxembourg: Summer review 2019

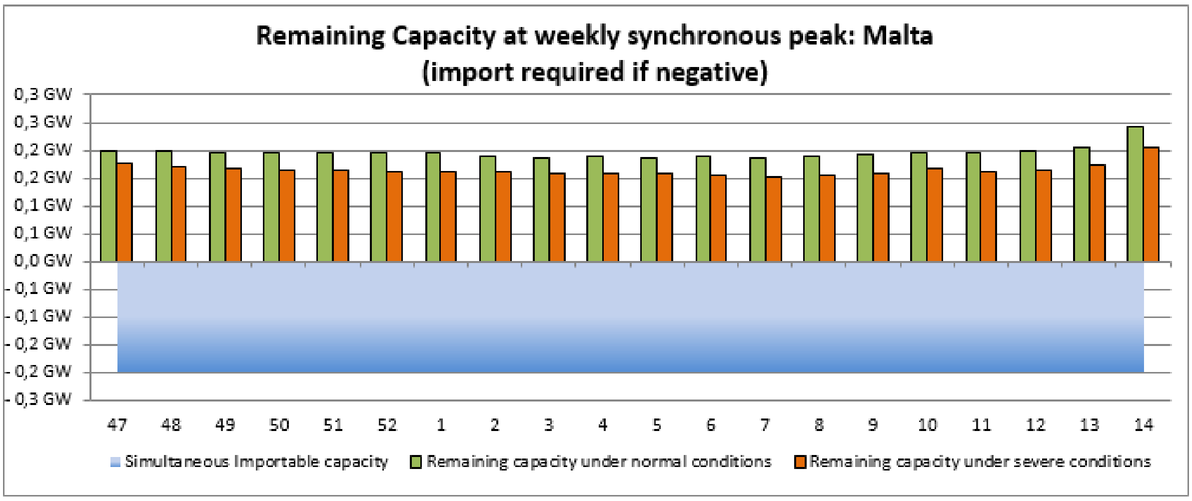
No adequacy or downward regulation issues were identified during the past season.

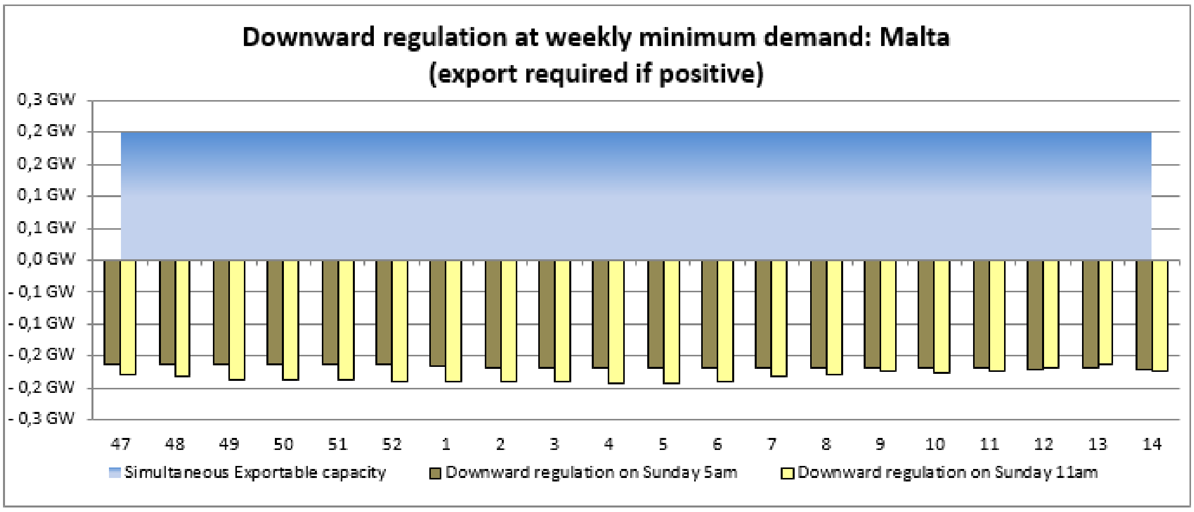
Malta: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







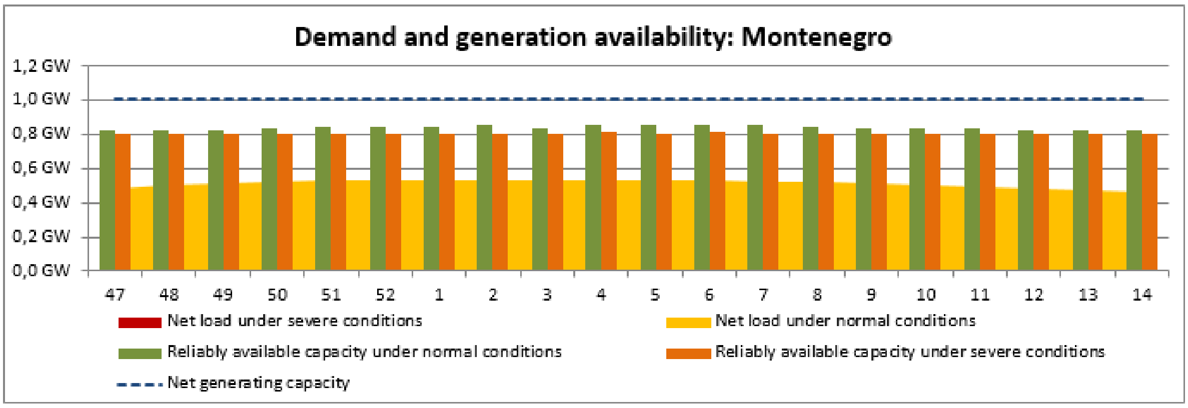
Malta: Summer review 2019

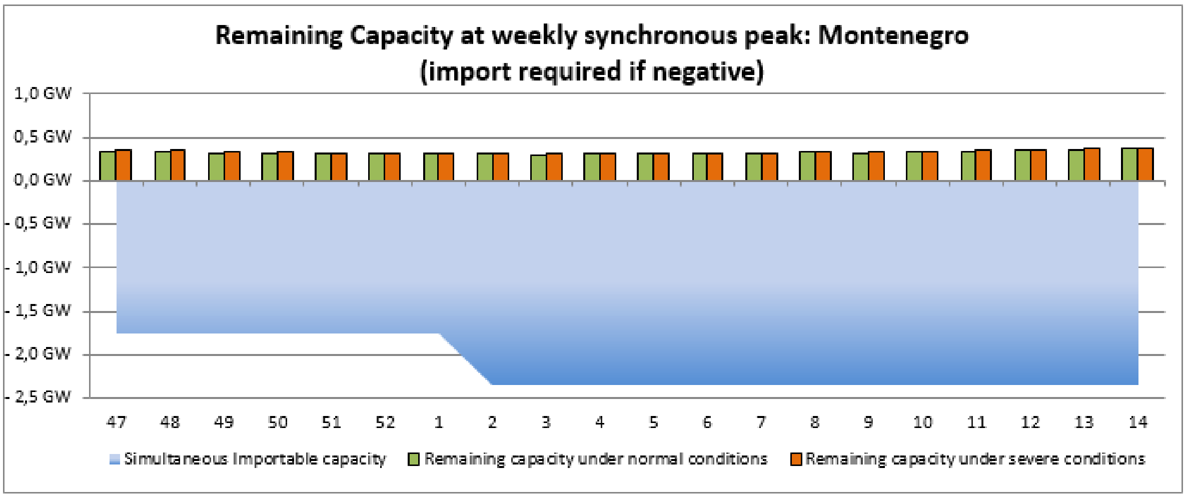
No adequacy or downward regulation issues were identified during the past season.

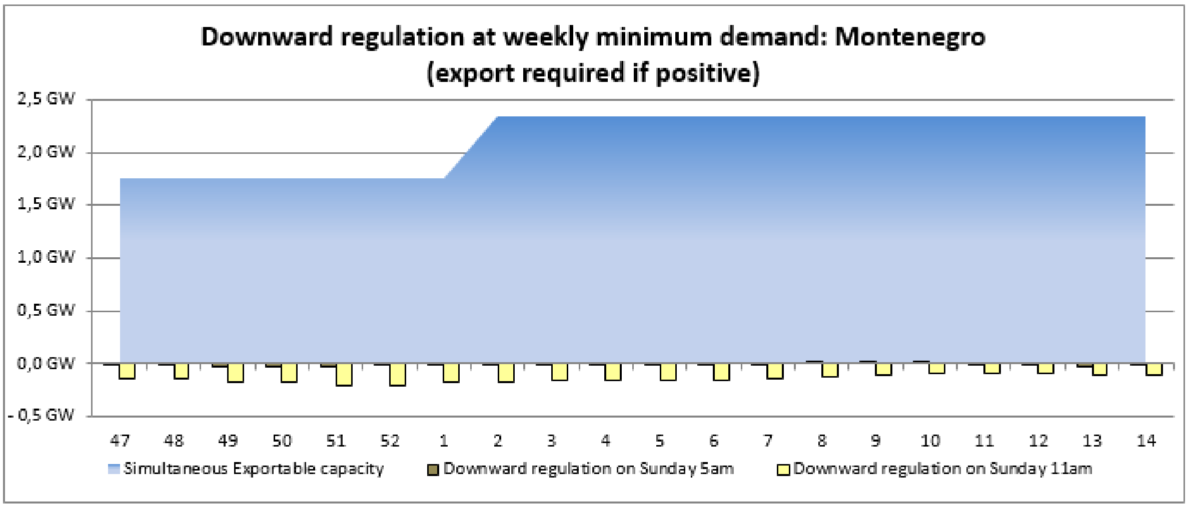
Montenegro: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







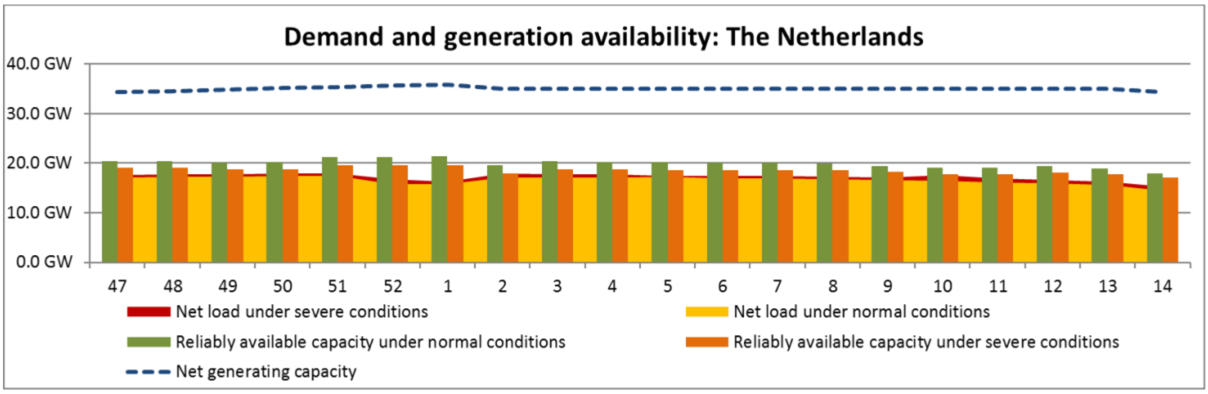
Montenegro: Summer review 2019

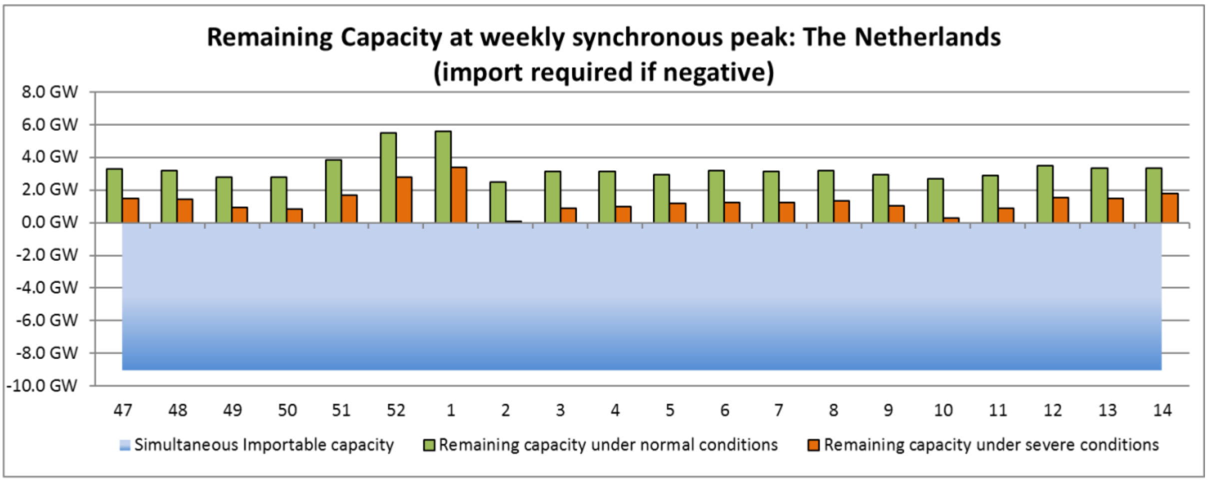
No adequacy or downward regulation issues were identified during the past season.

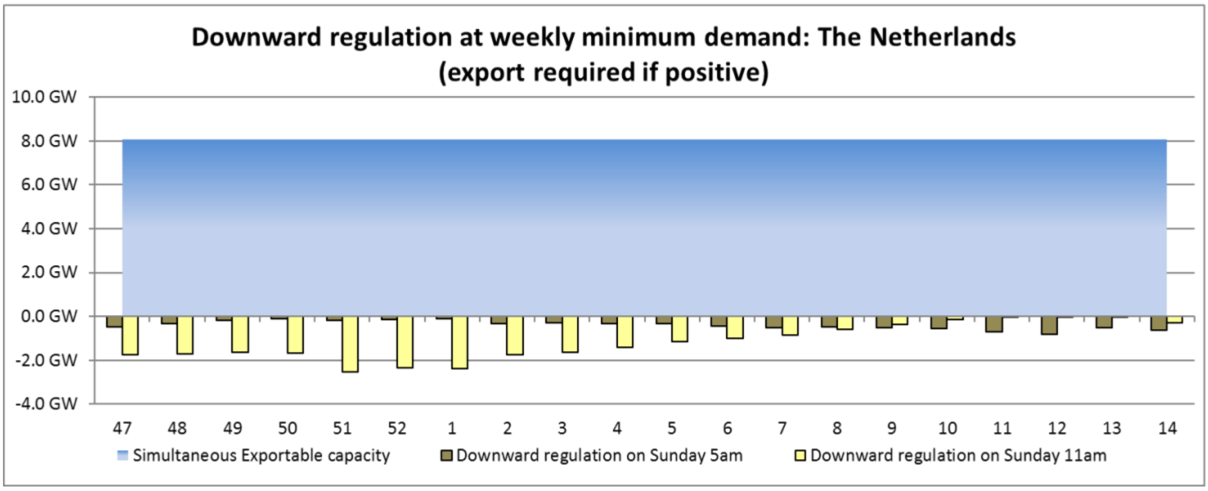
Netherlands: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







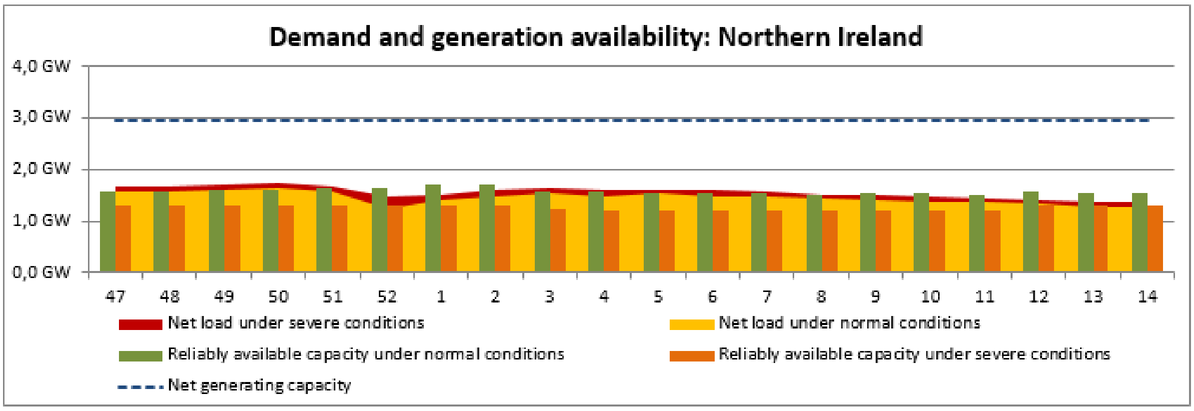
Netherlands: Summer review 2019

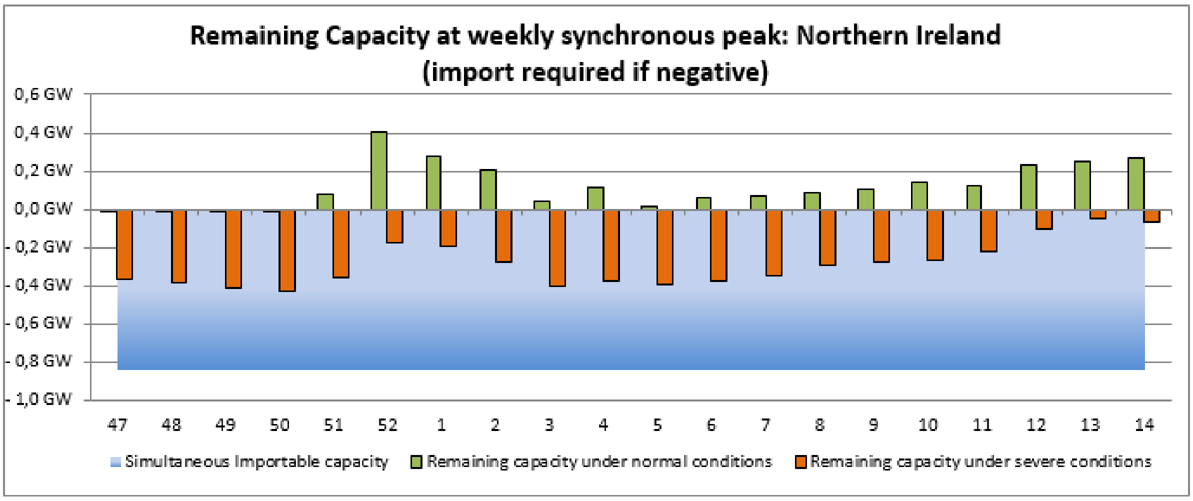
No adequacy or downward regulation issues were identified during the past season.

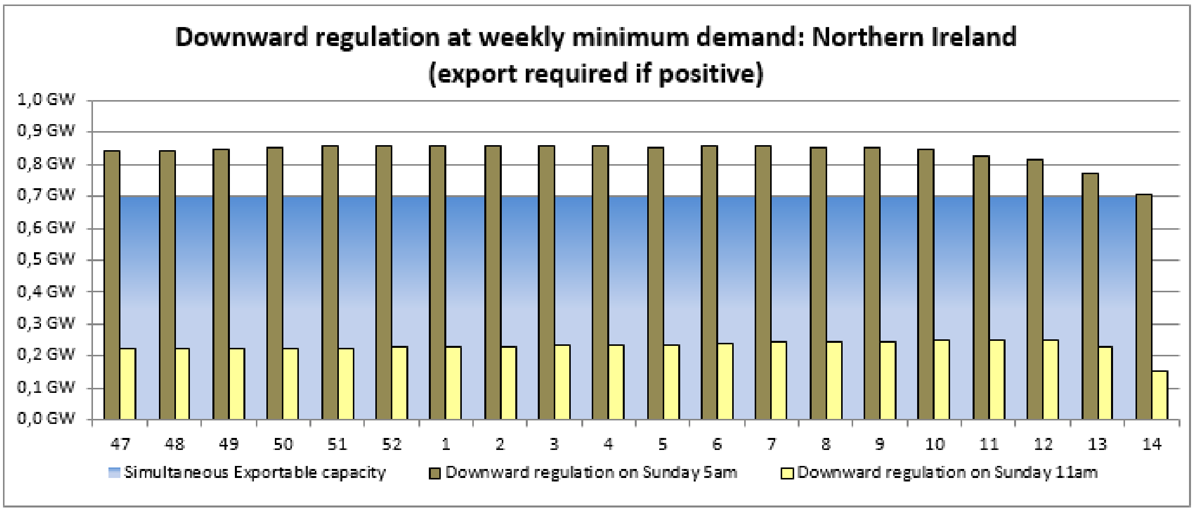
Northern Ireland: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







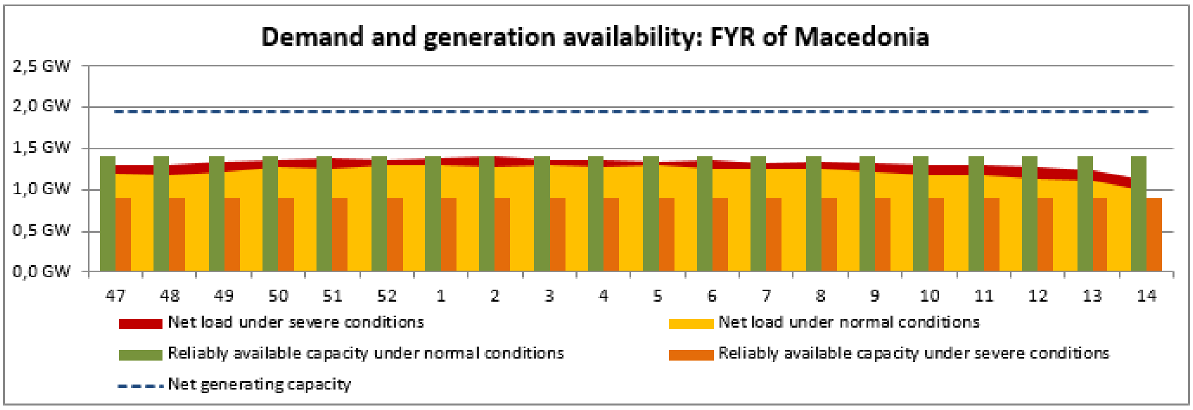
Northern Ireland: Summer review 2019

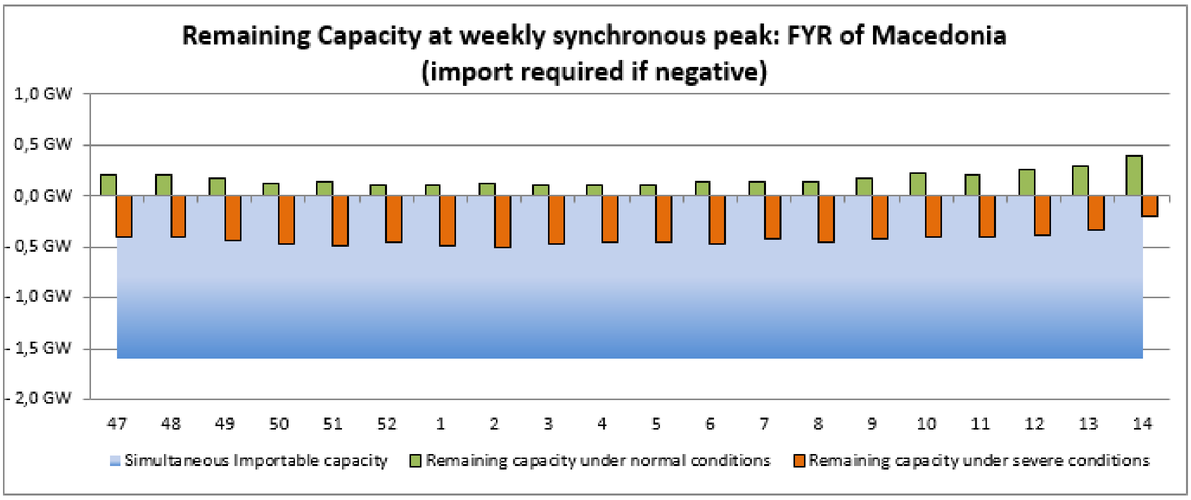
No adequacy or downward regulation issues were identified during the past season.

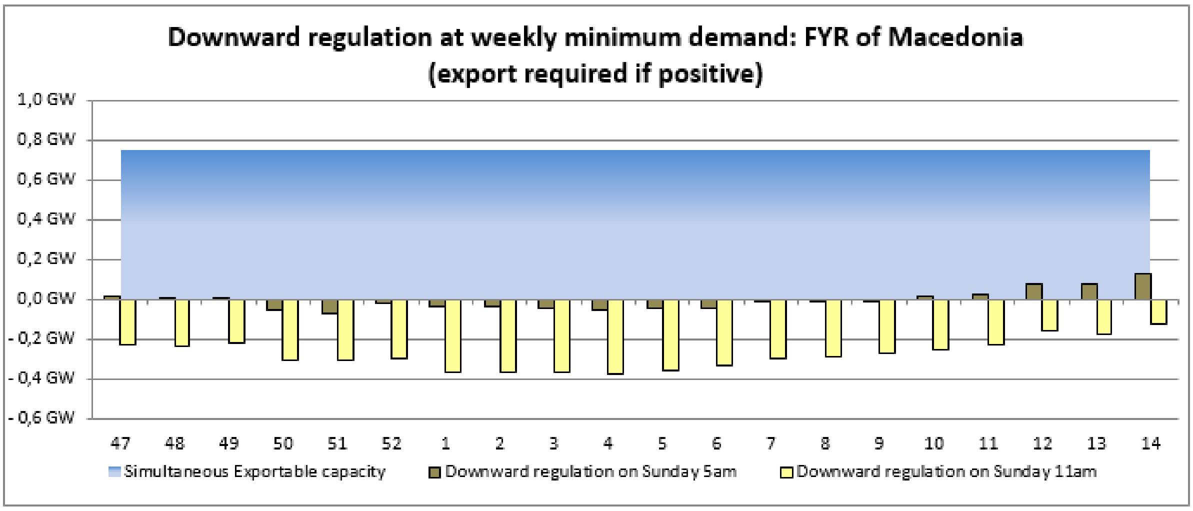
North Macedonia: Winter Outlook 2019/2020

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 completed on time. No overloads in the transmission network are expected because all the maintenance work was finished during the summer period.







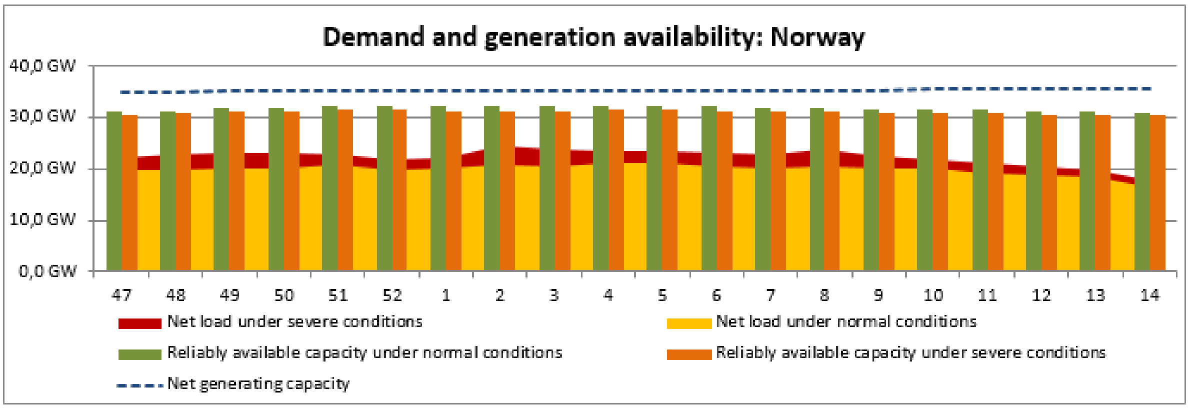
North Macedonia: Summer review 2019

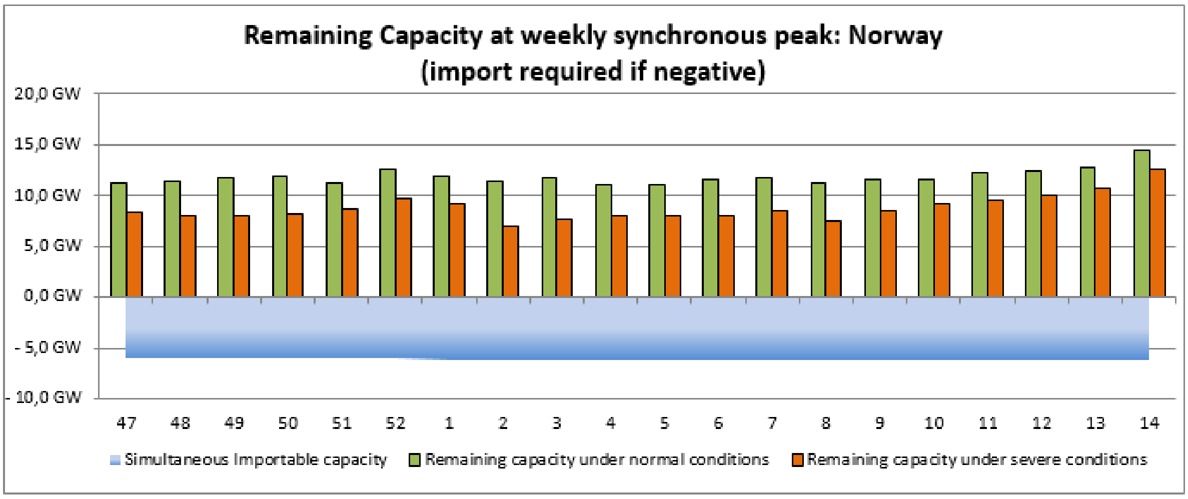
During the summer, all scheduled maintenance and overhaul works were completed according to the plan. Interconnection was available during the whole period and the system did not face any difficulty with regards to NTC quantity, cross–border allocation or with market participants. The summer period past without unexpected events of local or regional character.

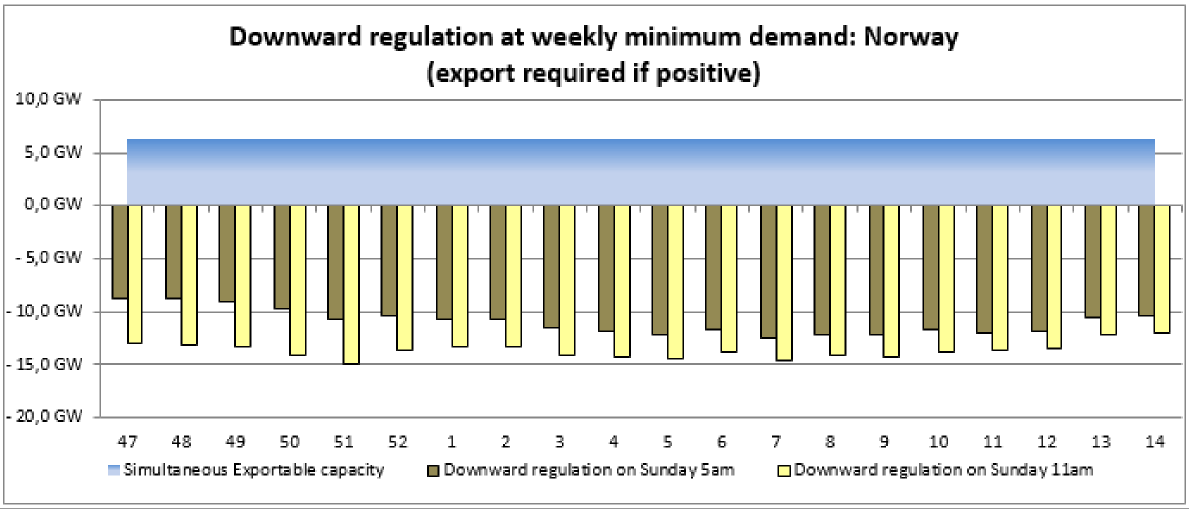
Norway: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







Norway: Summer review 2019

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

Poland: Winter Outlook 2019/2020

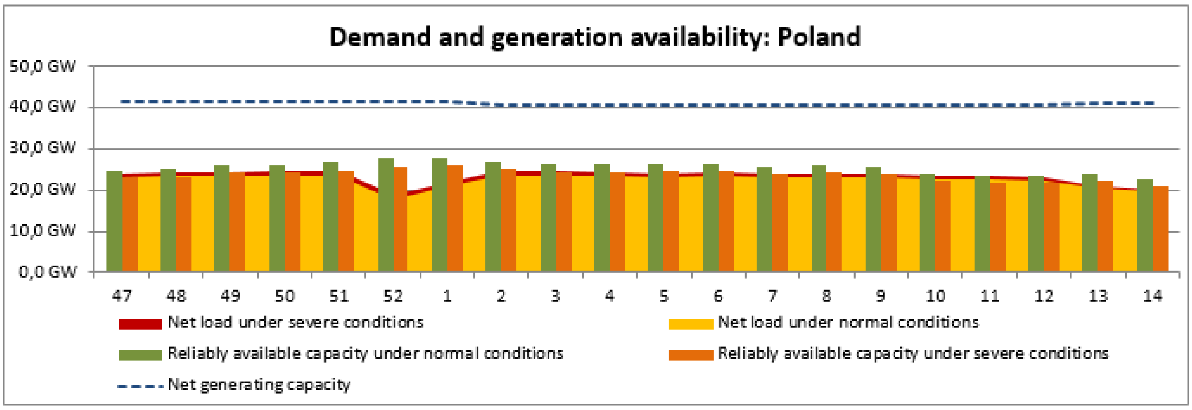
Potential critical periods and foreseen countermeasures

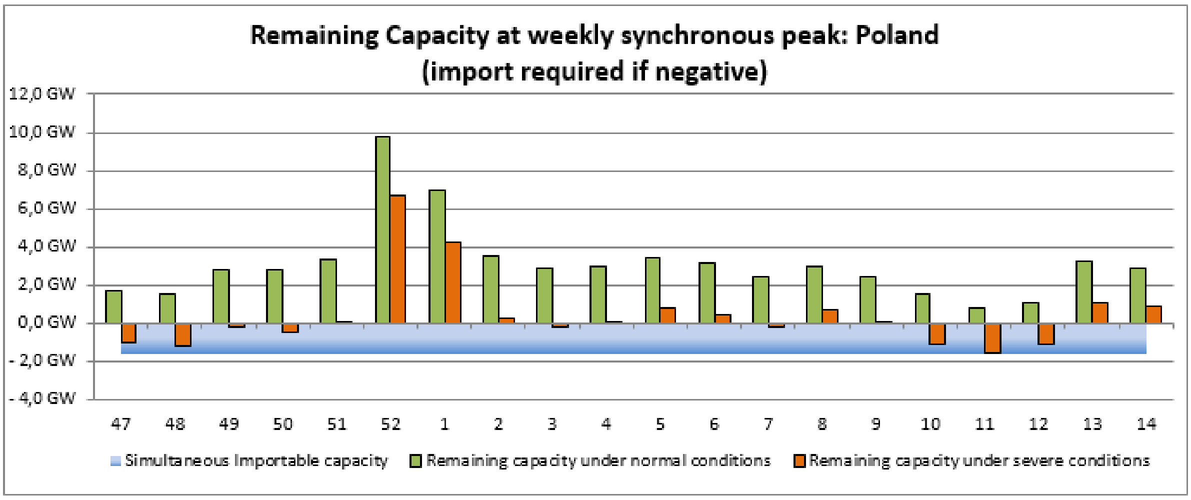
There are several coal units forecasted for decommissioning until the end of the year, however these capacities will be replaced by new, big units (c.a. 850 MW):

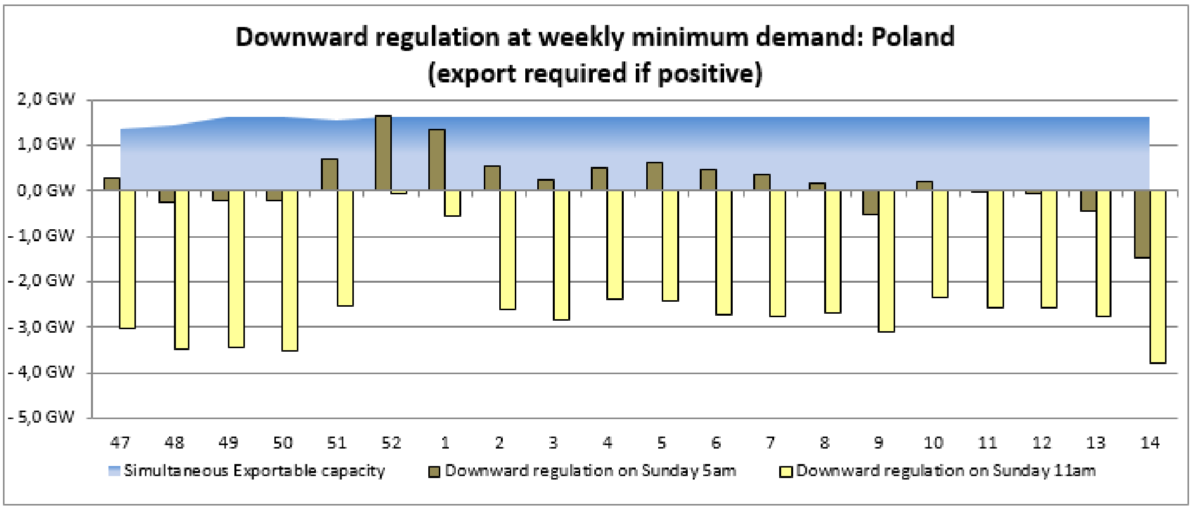
- One of them was commissioned in September (ongoing test phase till end of November),
- Synchronisation of the second is expected till the end of November, in operation since February 2020.

Based on these assumptions, no adequacy issues are forecasted for the coming winter. As usual the possibility to import via interconnections, especially on synchronous connections, may be a key issue under severe conditions.

Nevertheless, PSE has contracted at least 443 MW of DSR for the coming winter, which may be activated in the case of inadequacy. 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 2019

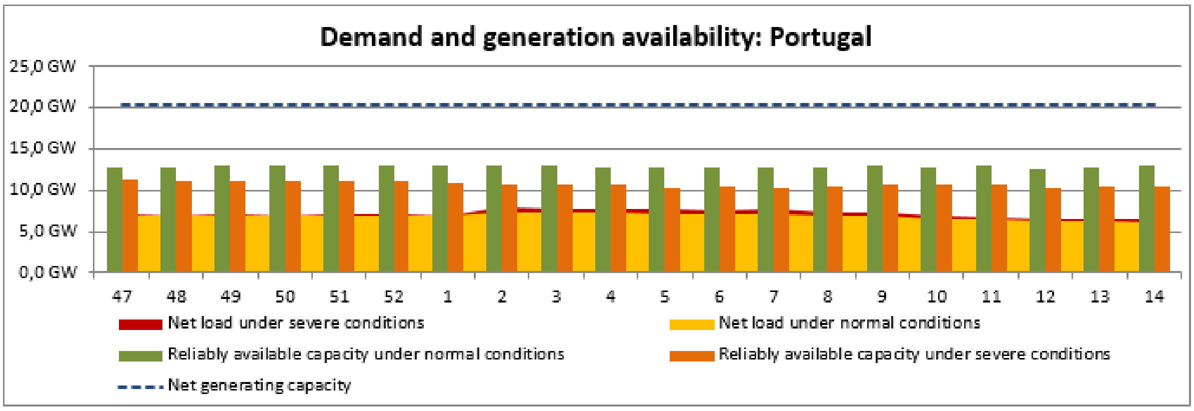
There were no adequacy issues recorded in summer 2019, even though a heat wave was observed in Europe at the turn of June and July. During this period, on 26 June 2019 summer's peak demand was recorded; another one in a row. It amounted to 22.49 GW.

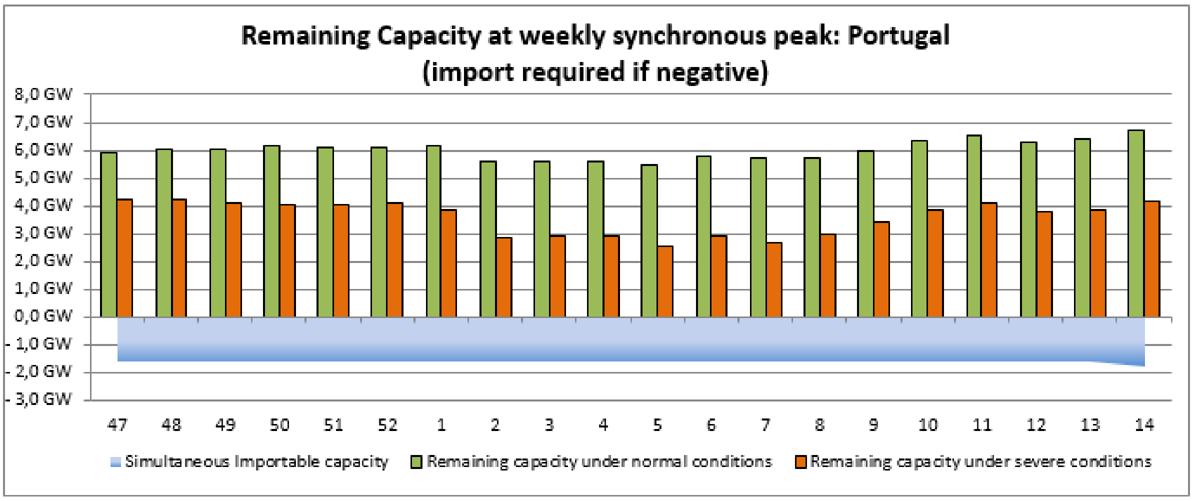
Portugal: Winter Outlook 2019/2020

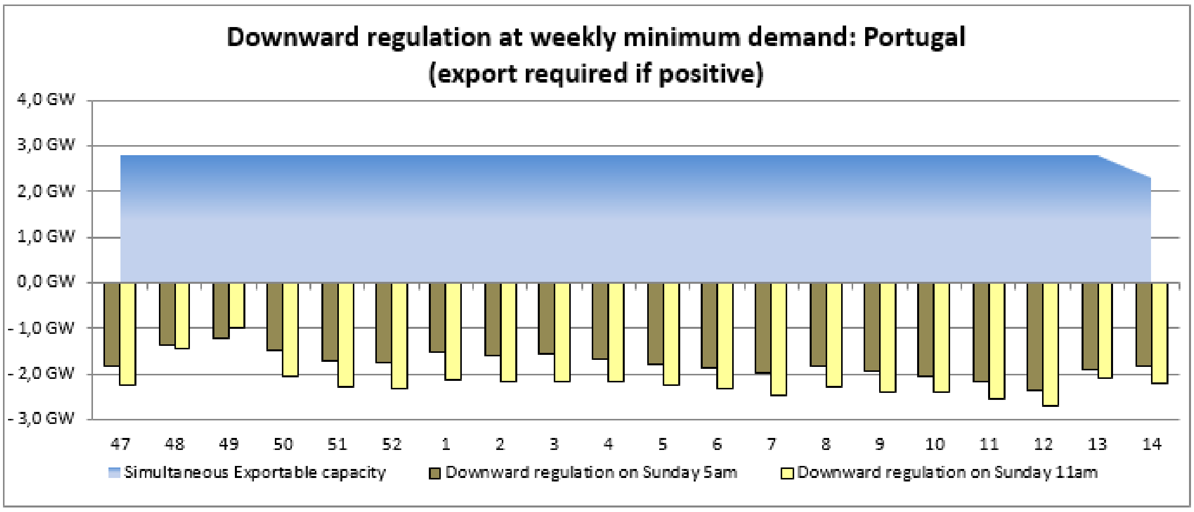
No adequacy risks for the Portuguese power system in the next winter season were identified in REN's (TSO's in Portugal) assessment, despite the hydro storage level at the end of September being close to the 10-year minimum at this time of the year.

From the adequacy perspective, the Portuguese system does not need to rely on imports. However, significant imports are expected if combined cycle power plants in Spain continue to be more market competitive than the hard coal plants in Portugal.

Regarding system downward regulation capability, appropriate margins have been identified to deal internally with the excess of inflexible generation.







Portugal: Summer review 2019

No events with negative impact on system adequacy occurred during the summer. An atypical weather scenario, with mild temperatures, resulted in demand lower than that forecasted in SOR 2019.

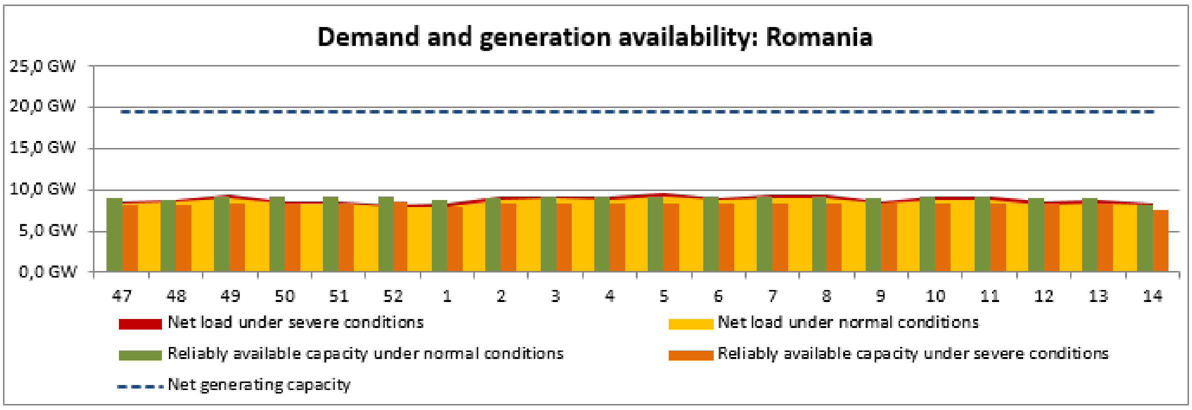
Renewable generation performed more poorly than expected. Hydro inflows were very low and wind generation was slightly below the average. Nevertheless, in summer 2019 a PV generation record (500 MW) was recorded with an installed capacity of 650 MW.

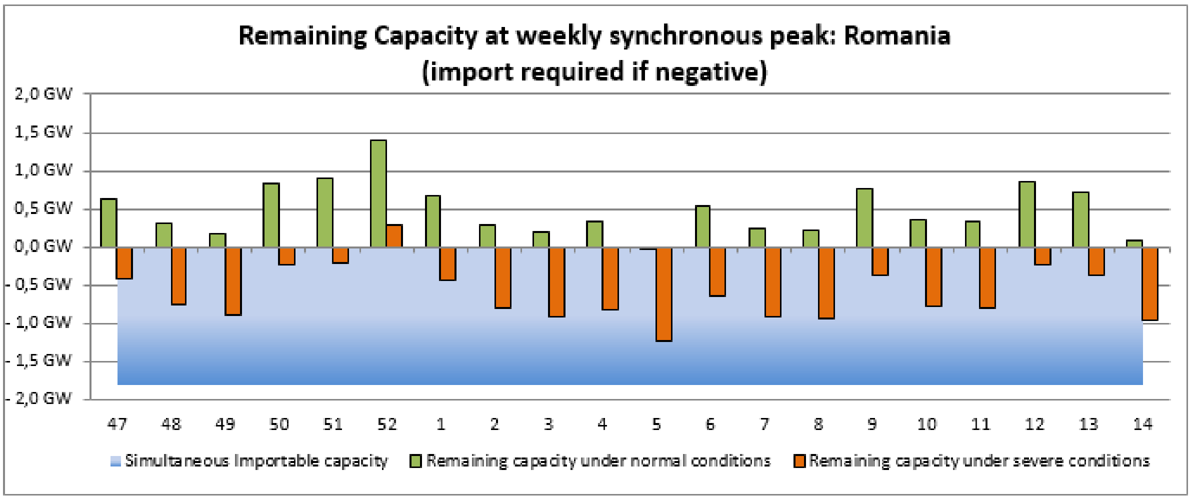
However, lower renewable generation did not result in a substantial increase of thermal generation—combined cycles power plants were utilised more than in recent years, but coal power plants generation was more than 90% below the average values. Nineteen consecutive days were registered when demand was supplied without dispatching coal power plants. Driven by market conditions, demand was met with a significative contribution from imports. On 27 July, imports reached a historical maximum of 3680 MW.

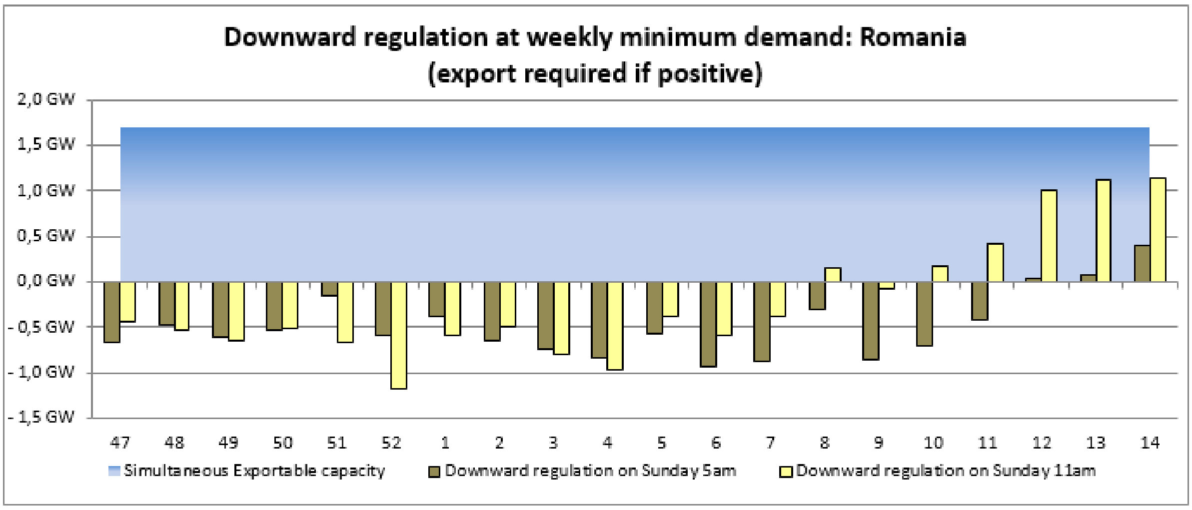
Romania: Winter Outlook 2019/2020

Under normal conditions, the balance forecast does not indicate a problem which could affect the Romanian Power System adequacy during the winter 2019/2020.

Under severe conditions (considering extreme weather conditions with very low temperature values and very small wind generation), generation in Romania might not be sufficient to supply demand. During these periods, the remaining available capacity could be negative, with values up to 1.13 GW at high peak time. Nevertheless, imports should be sufficient to supply demand.





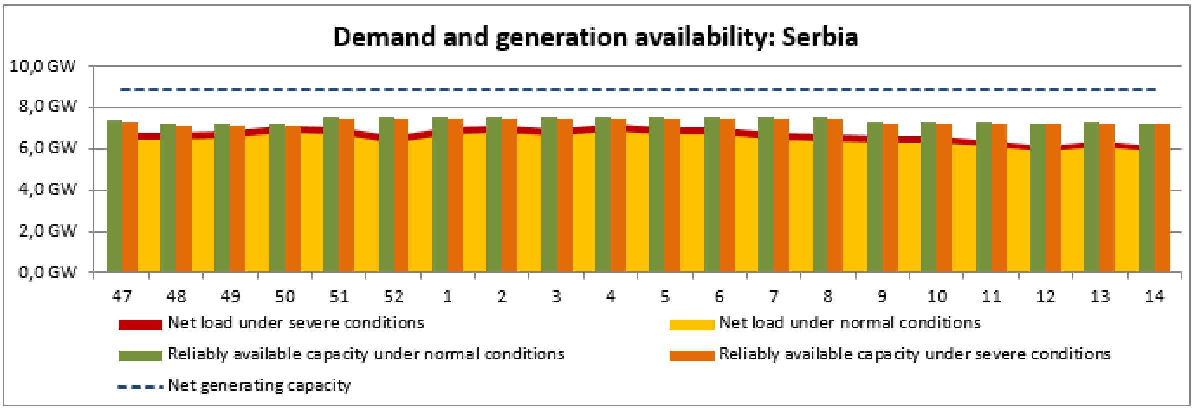


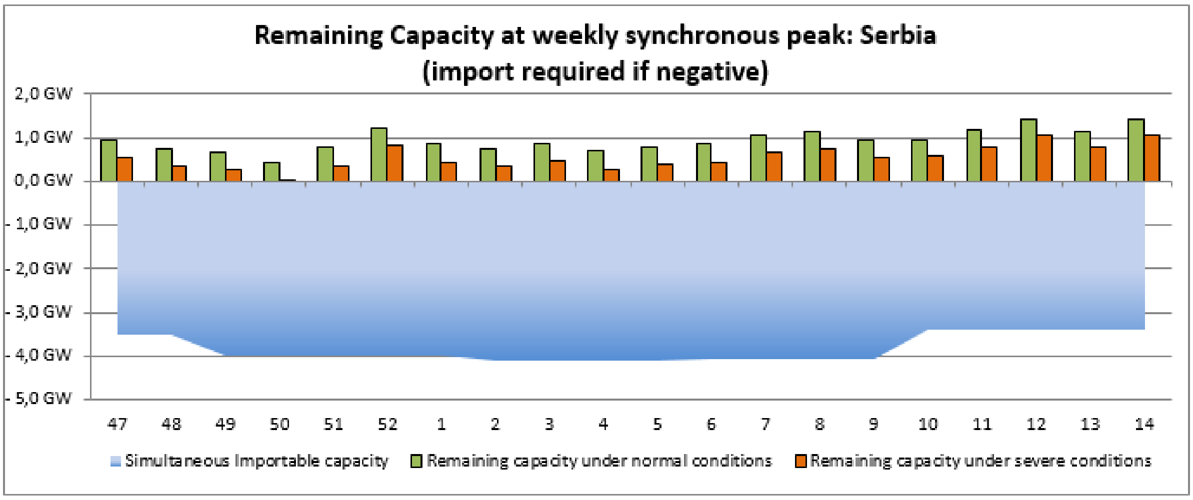
Romania: Summer review 2019

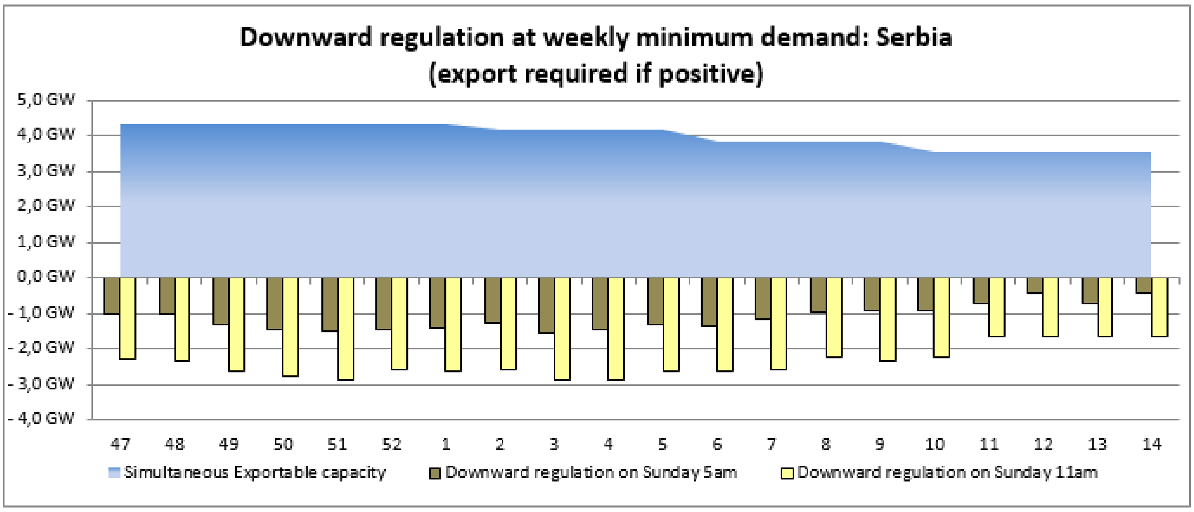
No adequacy or downward regulation issues were identified during the past season.

Serbia: Winter Outlook 2019/2020

In the coming winter there are no expected problems in the supply of final consumption in Serbia. Consumers in Serbia are expected to be supplied mostly by local generation as coal fuel reserves are in good shape and hydrological conditions are expected to be favourable. Wind generation is expected to contribute significantly as well.







Serbia: Summer review 2019

No adequacy or downward regulation issues were identified during the past season. The summer period passed without major problems. There were no major purchases or sales of energy in peak hours.

Problems from the last year related to the lack of energy in the sub-area KOSTT, which operates within the EMS control area, continued throughout the summer. KOSTT energy shortage on average is low but the compensation programme (exchange programme for additional KOSTT export of energy in order to return the energy it already took from the interconnection in the previous period) is gradually rising and in some tariff periods is closing to 150–200 MW.

Slovakia: Winter Outlook 2019/2020

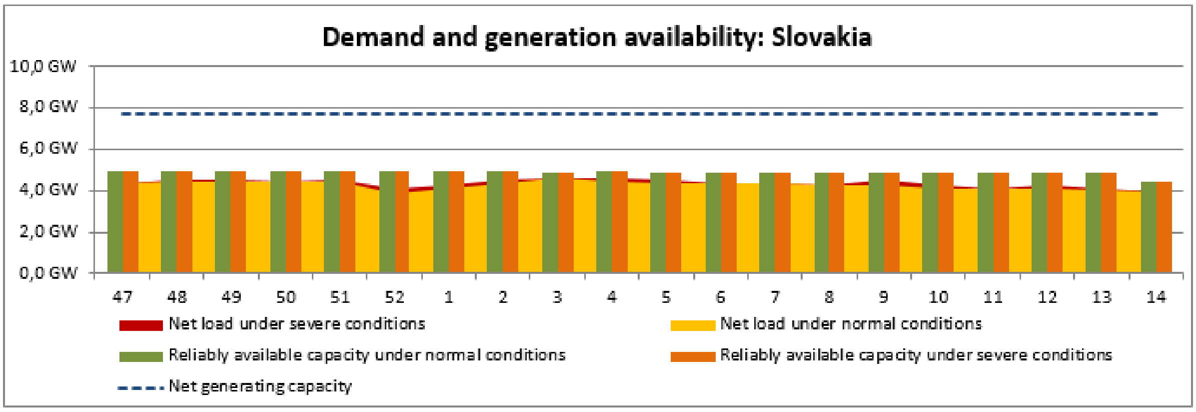
Potential critical periods and foreseen countermeasures

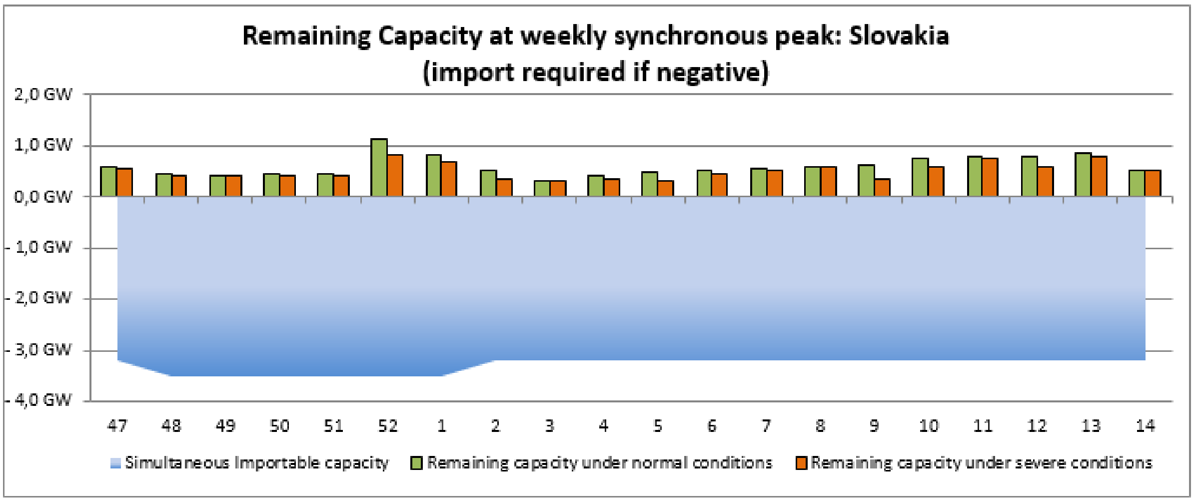
No adequacy risk was identified in the Winter Outlook 2019/2020 for Slovakia. Usable generation capacity was increased by recommissioning mothballed CCGT Malženice (419.6 MW). Expected generation capacity for the winter of 2019/2020 should be sufficient to meet expected peak demands and to ensure the appropriate level of security of supply under normal and severe conditions. Forecasted demand peaks for the winter 2019/2020 are expected to be similar to the winter 2018/2019.

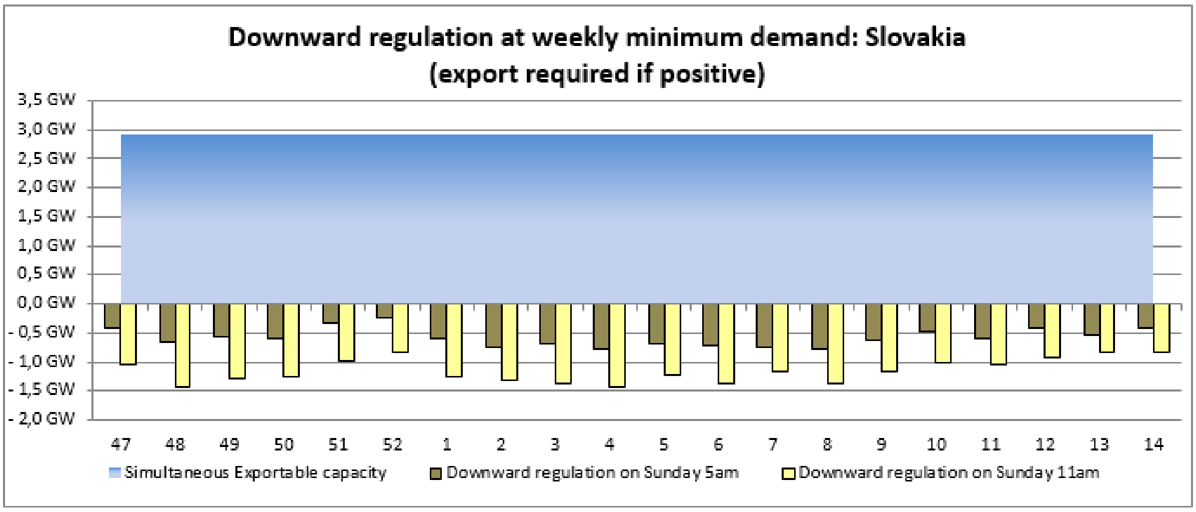
During the winter of 2019/2020, the expected maximum weekly peak demand is expected to be 4600 MW under severe conditions in January—slightly higher than in the Winter Outlook of 2018/2019, which was 4550 MW. The peak demand in winter 2018/2019 was in January (4571 MW).

During the winter period, the maintenance is minimised. The cross-border capacities for electricity import are sufficient.

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







Slovakia: Summer review 2019

The average temperature in summer 2019 was 20.1°C (19.9°C in summer 2018). June 2019 was much warmer than June in 2018 (+2.6°C) and the average temperatures in the months July, August and September 2019 were lower than in 2018 (-0.5, -0.7 and -0.9 °C, respectively).

Compared to summer 2018, the production of electricity in Slovakia during summer 2019 was much higher (index 105.5%). In particular, production of hydro power plants (130.7 %), fossil gas power plants (161 %) and nuclear power plants (104.0 %) increased significantly. Decreased production of hard coal (45.7%) and coal-derived gas power plants (60.1%) was balanced by the increased production of fossil gas power plants (161%) from the fossil fuels perspective. In the RES sector, a drop in electricity production was noted (96.6%).

The electricity consumption was noticeably lower compared with summer 2018 (index 97.7%). A consumption decrease in all months of summer was observed, mainly in June (index 96.8%) and August (index 96.5%). The summer peak demand of 3,895 MW was recorded on 19 June 2019 at 13:00, and during summer 2018 it was 3,878 MW on 24 August 2018 at 12:00. Weekly peaks were mostly lower except for six weeks.

The electricity was imported in all summer months into the power system of Slovakia. The total import of electricity in summer 2019 decreased by half compared to summer 2018. In summer 2019, the share of import in the electricity consumption of Slovakia decreased to 7.2% compared to 14.1% in summer 2018, due to higher electricity production and also lower consumption. Cross-border capacities were sufficient to ensure such a level of import. No remedial actions were necessary to solve the overloading of transmission lines.

Metered cross-border flows of electricity revealed an increase in the export (index 122.6%), while import stayed at the same level (index 99.7%) compared to the electricity exchanges of summer 2018.

Specific events and unexpected situations that occurred during the past summer

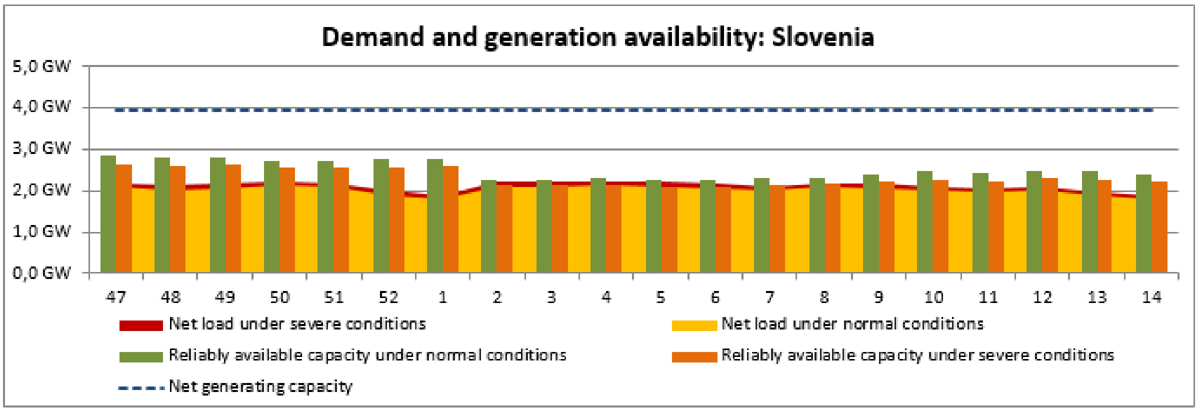
There was no specific event or unexpected situation worth mentioning.

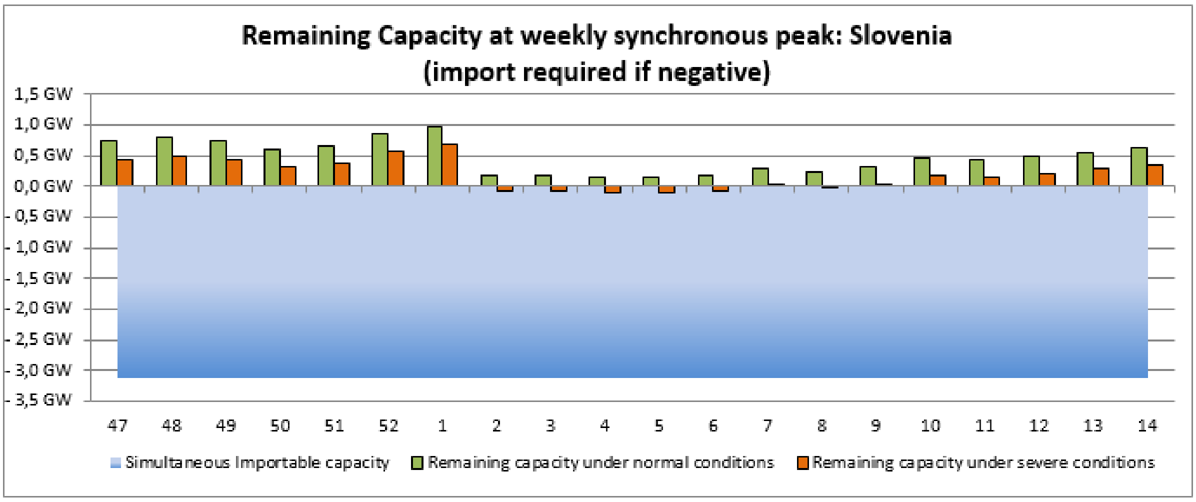
Slovenia: Winter Outlook 2019/2020

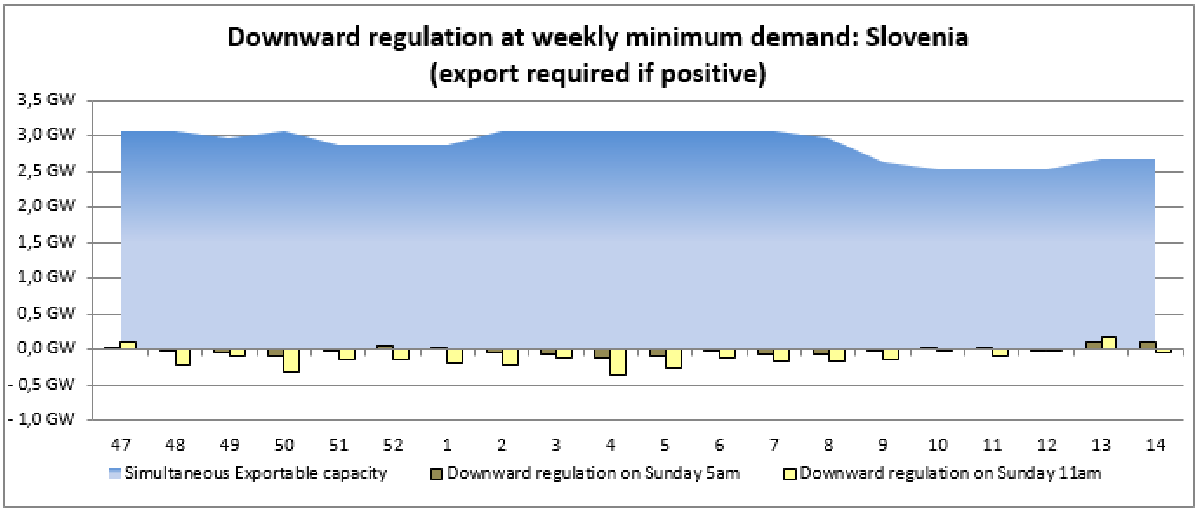
Slovenia might face a negative remaining capacity in weeks 2–6 of 2020 under severe conditions. The reason for a possible occurrence of these negative capacities is a high number of hydro power plants under maintenance in that period in combination with a relatively high demand. However, the expected import capacities are sufficient to cover all energy shortages and consequently no adequacy issues are expected during the upcoming winter.

A 539 MW unit in thermal power plant Šoštanj will be stopped for four days in march, whenever the conditions will be most favourable. No adequacy issues are therefore expected in March.

In the weeks 13–14, the only pumping hydro power plant in Slovenia of nominal power 180 MW will be under revision so an export of maximum 100 MW will potentially be required during the low consumption periods.







Slovenia: Summer review 2019

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.

From 17 August to 16 September, a 539 MW unit in the Thermal power plant Sostanj was unavailable due to unplanned outage as a result of error on the ash silos.

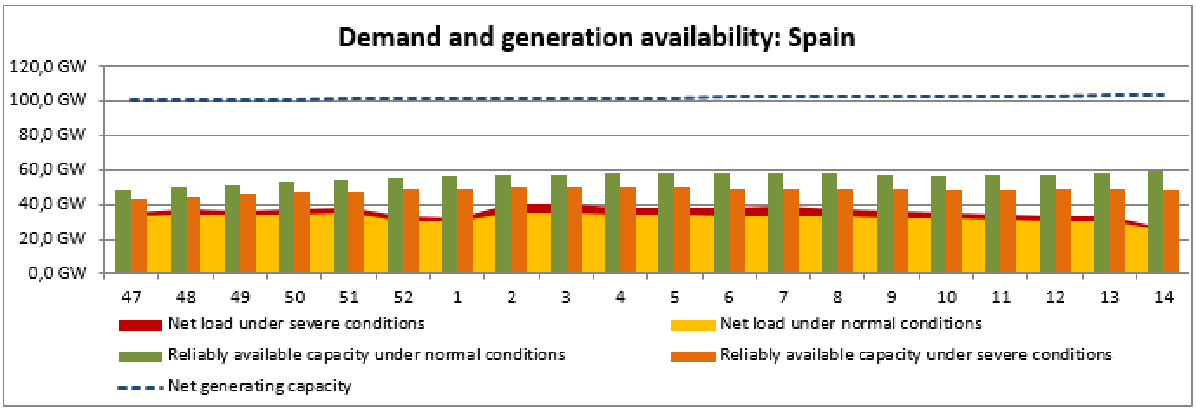
Spain: Winter Outlook 2019/2020

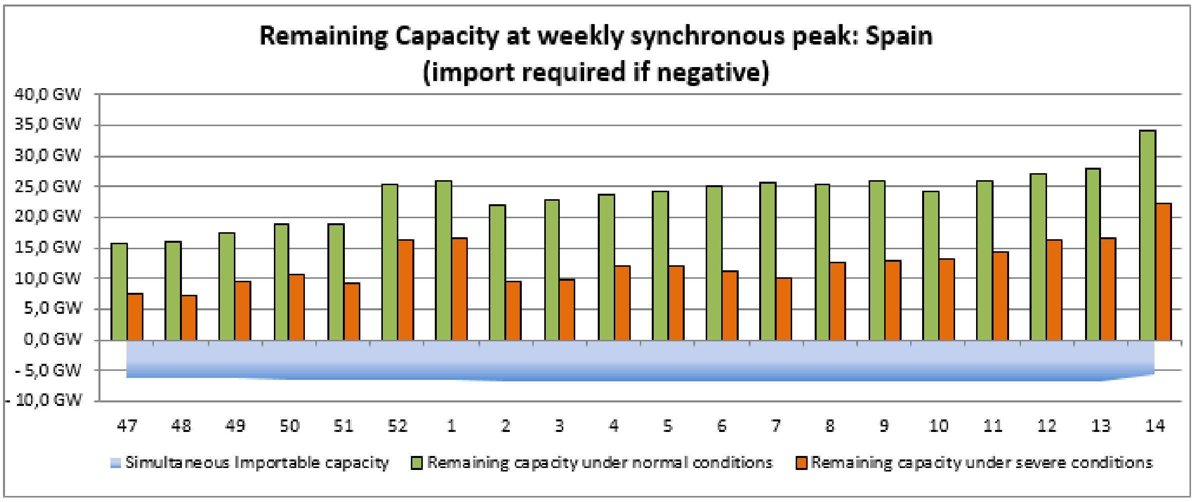
Potential critical periods and foreseen countermeasures

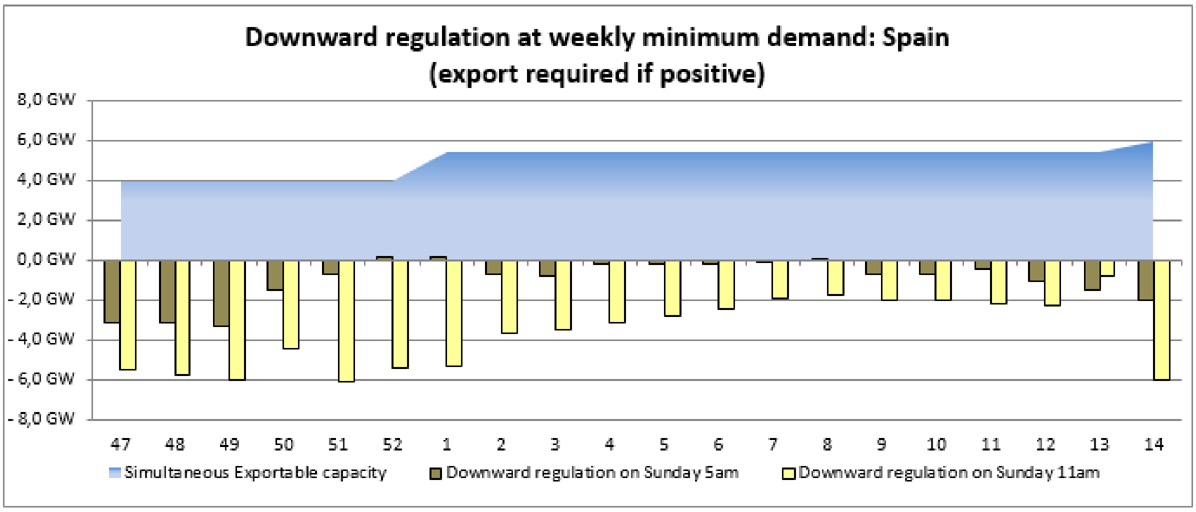
From the perspective of upward adequacy, there is no adequacy risk detected in the Spanish peninsular system for the upcoming winter. Good generation/demand adequacy can be expected regardless of imports from neighbouring countries. Furthermore, capacity margins for Spain are higher in the reference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

The factors which could reduce upward capacity during the next winter in the Spanish system would be the sensitivity of the demand to temperature in extreme weather conditions and gas availability to combined cycle thermal plants during situations of low RES infeed. It is worth mentioning that the hydro reservoir levels are slightly below the historical average (10% below), and persisting drought conditions could also reduce the upward capacity.

Low downward regulation margins are forecasted in the quantitative analysis, mainly at 05:00—also at some weeks at 11:00 due to the high RES infeed considered. The export capacity of interconnectors is a key factor in order to avoid the curtailment of renewable energy. Besides, as part of the RES capacity participates in balancing actions, the risk of RES spilling is low. Another point worth mentioning is the importance of energy storage—mainly pumped storage plants—in order to properly manage the excess of inflexible power.







Spain: Summer review 2019

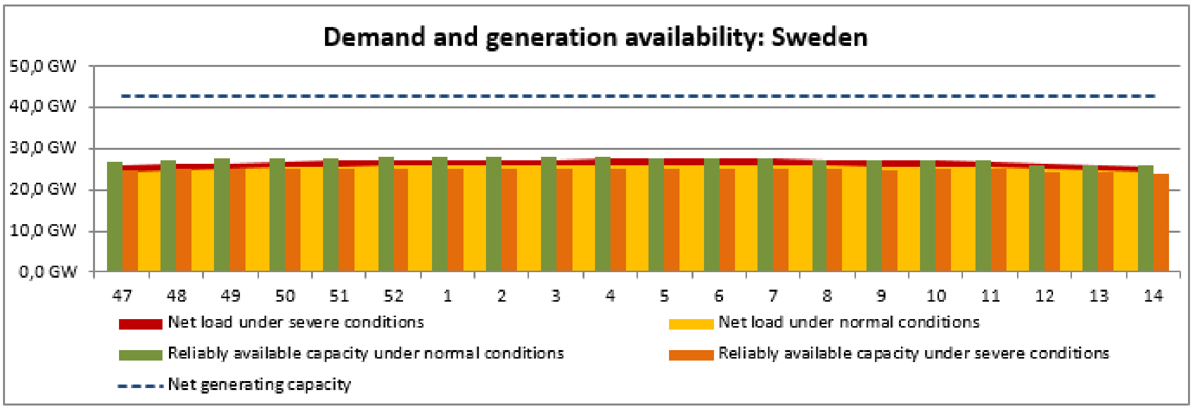
No adequacy or downward regulation issues were identified during the past season.

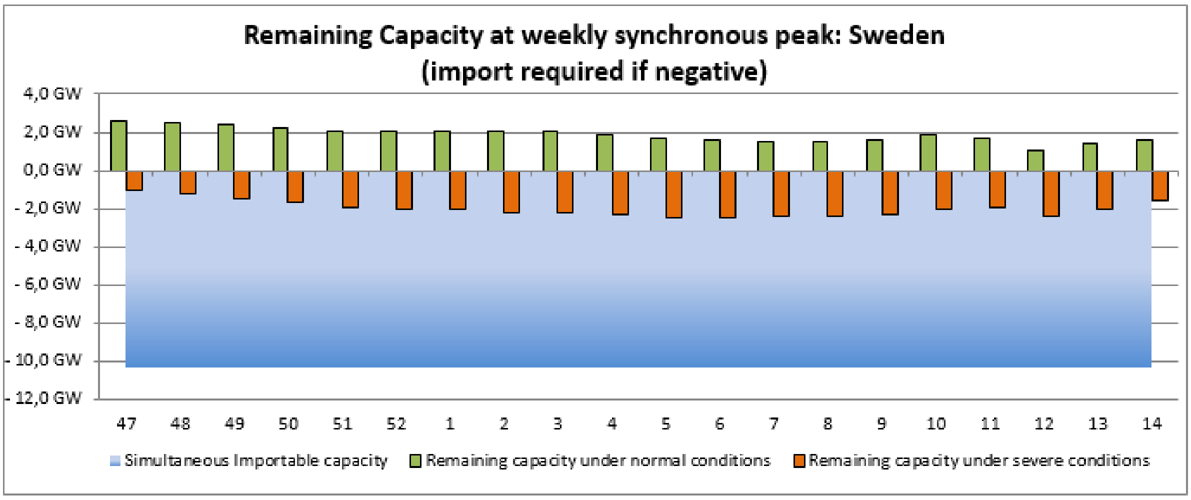
Sweden: Winter Outlook 2019/2020

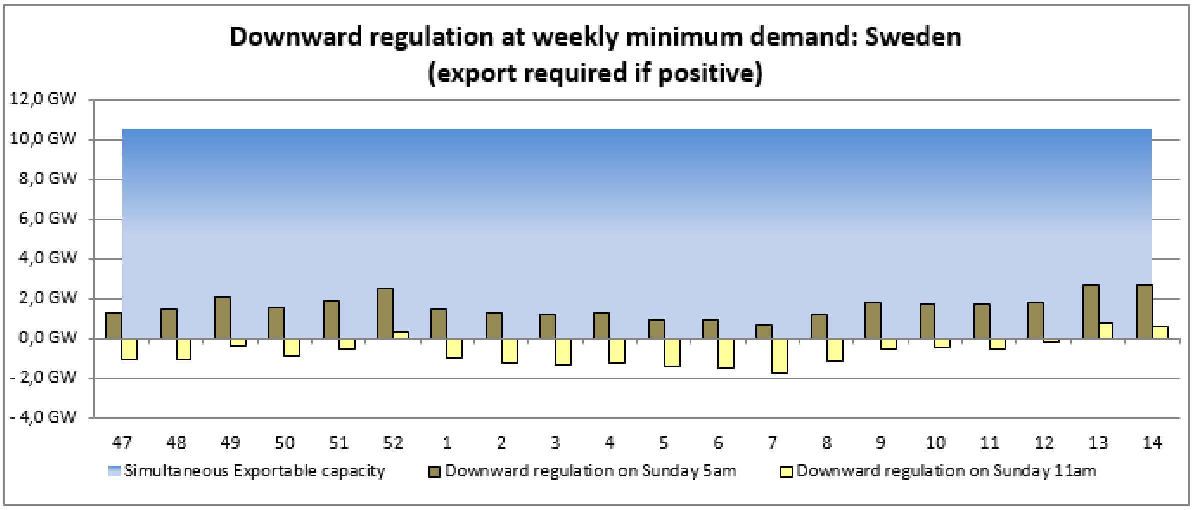
The winter period is the most critical period for maintaining adequacy in Sweden and the demand peaks strongly correlate with the coldest periods. At such times, interconnections are expected to play an important role in maintaining adequacy, and the local power balance (balance before imports) is expected to be negative.

There is a risk that adequacy margins are somewhat overestimated, since internal congestions are not accounted for in the adequacy analysis.

To secure power adequacy at peak demand, Svenska Kraftnät contracts a strategic reserves (‘peak load reserve’). For winter 2019/2020, the strategic reserve is 752 MW in total, of which 562 MW is thermal production capacity and 190 MW is demand reduction.







Sweden: Summer review 2019

No major outage or other serious event occurred during the summer, and the period passed relatively calmly for the operators at Svenska kraftnät.

The testing of the *South-West Link* (an internal grid-reinforcement project) has been running all through the summer, which has affected operations. Erroneous temperature measurements caused some lines and other components to be disconnected needlessly. Although not critical for system operation, such events lead to less efficient usage of the power system, and these reoccurring summer issues should be addressed in the future.

In general, low system inertia is a concern in Sweden during summer due to some large generators being offline. If the system inertia is too low, the system operator typically down-regulates the largest nuclear reactor (Oskarshamn 3) to lessen the largest fault. This measure was never needed during the summer and the system frequency was never allowed to drop below 49 Hz. A system for FFR (fast frequency reserve) should be in place before the next summer, and would typically replace the down-regulating action for low-inertia situations.

Switzerland: Winter Outlook 2019/2020

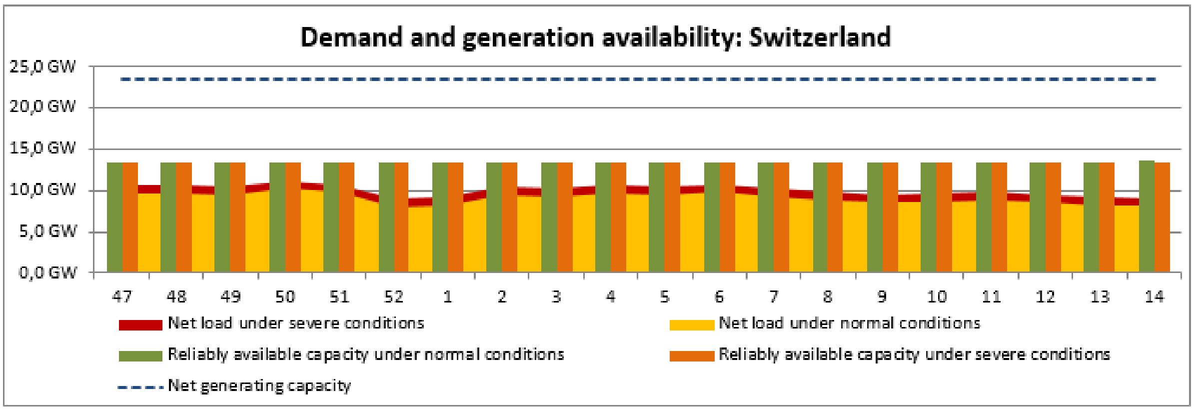
Potential critical periods and foreseen countermeasures

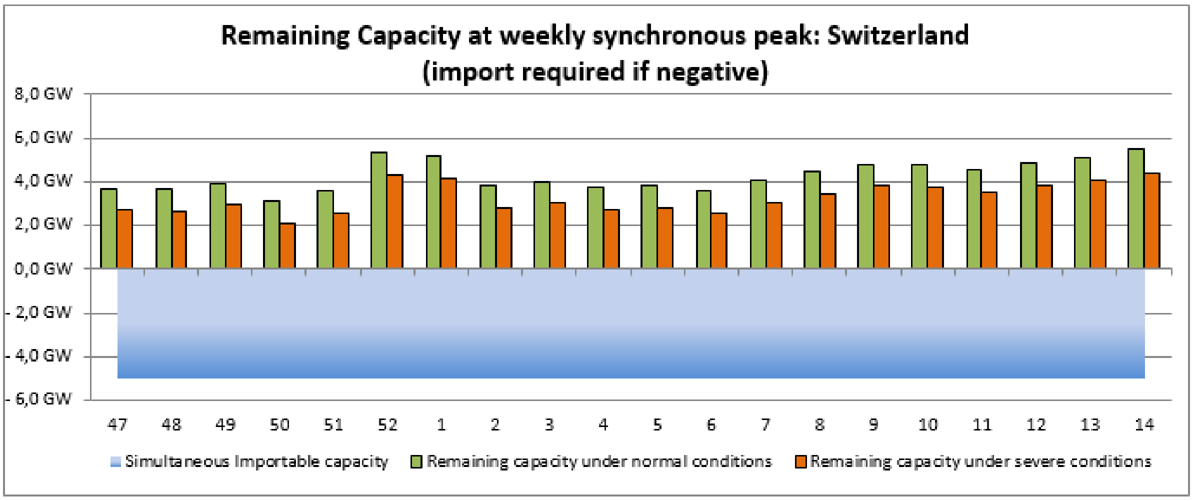
Using the ’conventional modelling’ adequacy methodology, no adequacy or downward regulation issues are expected for the coming season.

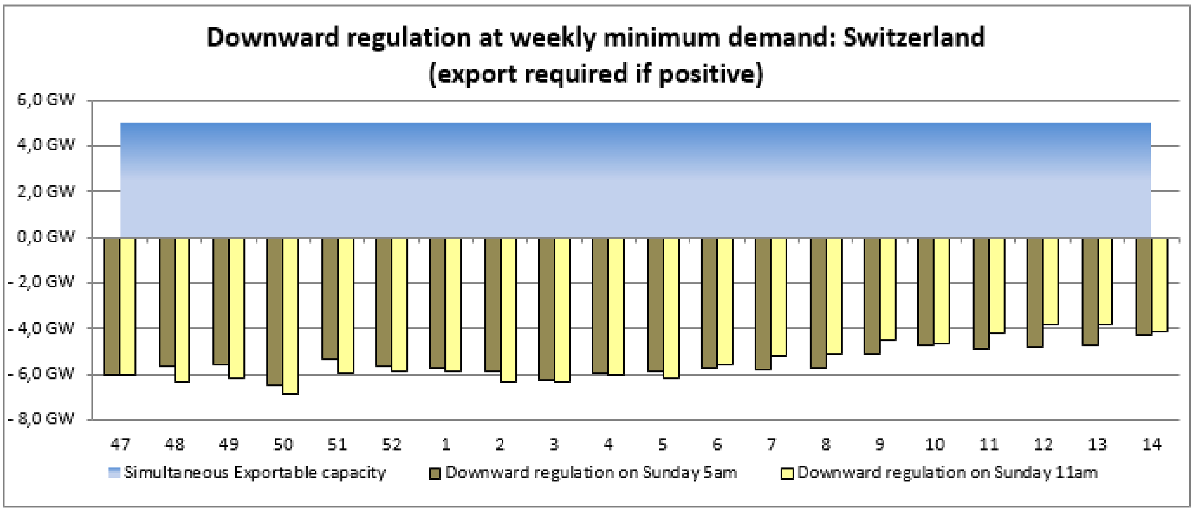
Indeed, deterministic capacity-based assessments (MW) cannot reveal potential problems faced by hydro-dominant countries such as Switzerland. In particular, for Switzerland it is very important to also consider energy constraints (MWh).

This ‘conventional modelling’ methodology does not aim to provide insights on possible overloads and voltage problems which might occur.

In other words, even if the current methodology concludes that no problems are expected in Switzerland, specific problems might still arise (cf. situation of winter 2015/2016).







Switzerland: Summer review 2019

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

General comments on past summer conditions

This summer was the third hottest since the beginning of the measurements (In 2018, 2017 and 2015, the summers were as hot as in 2019). There was sufficient rain in most parts of Switzerland.

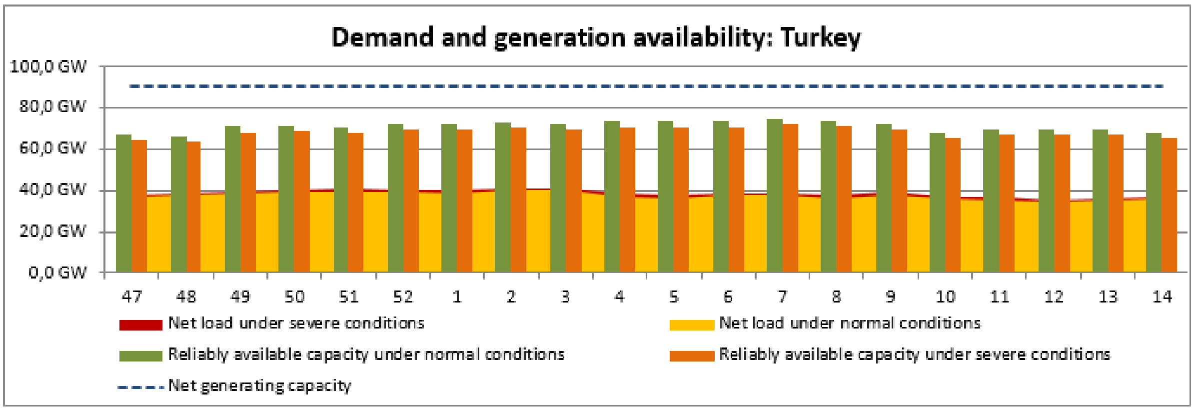
Specific events and unexpected situations that occurred during the past summer

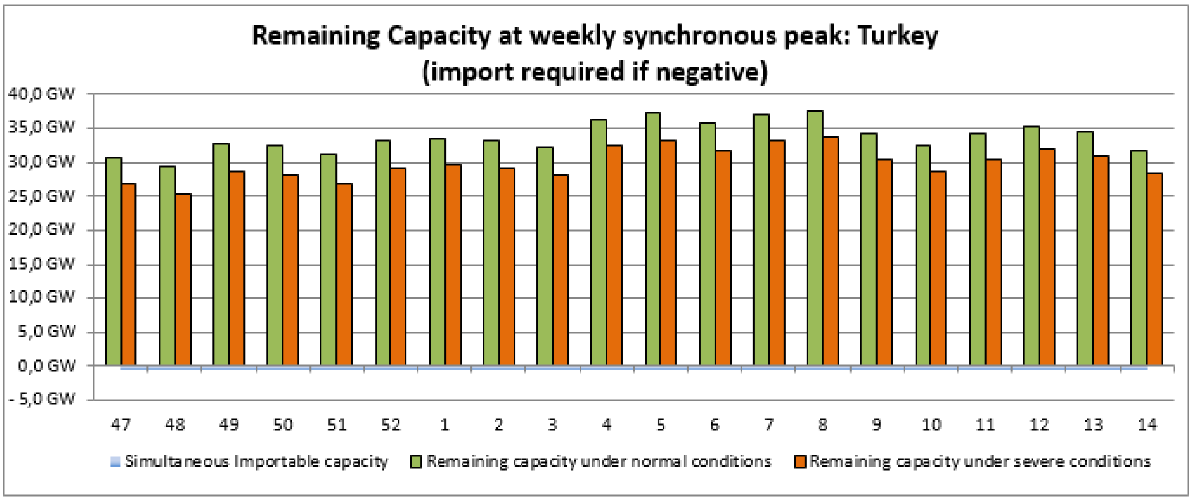
Summer 2019 was challenging for the operation of the transmission grid. A novel situation occurred: exports to the Northern and low exports to Italy compounded with imports from France. This resulted in some constraints in the grid.

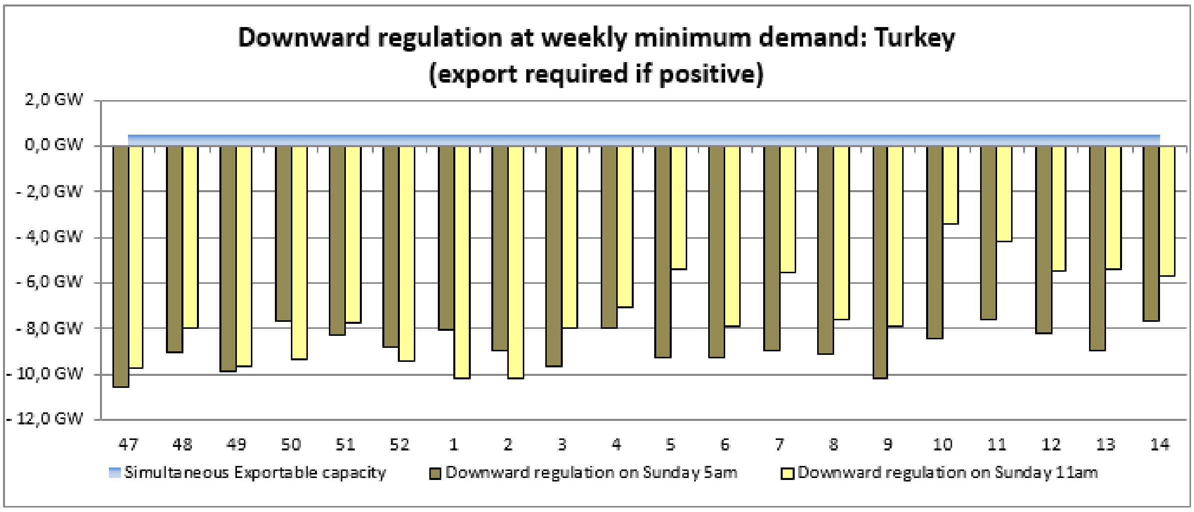
Turkey: Winter Outlook 2019/2020

Potential critical periods and foreseen countermeasures

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







Turkey: Summer review 2019

No adequacy or downward regulation issues were identified during the 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.*[17]

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 devise advanced methodology to overcome limitations, thus providing additional realistic insight into 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

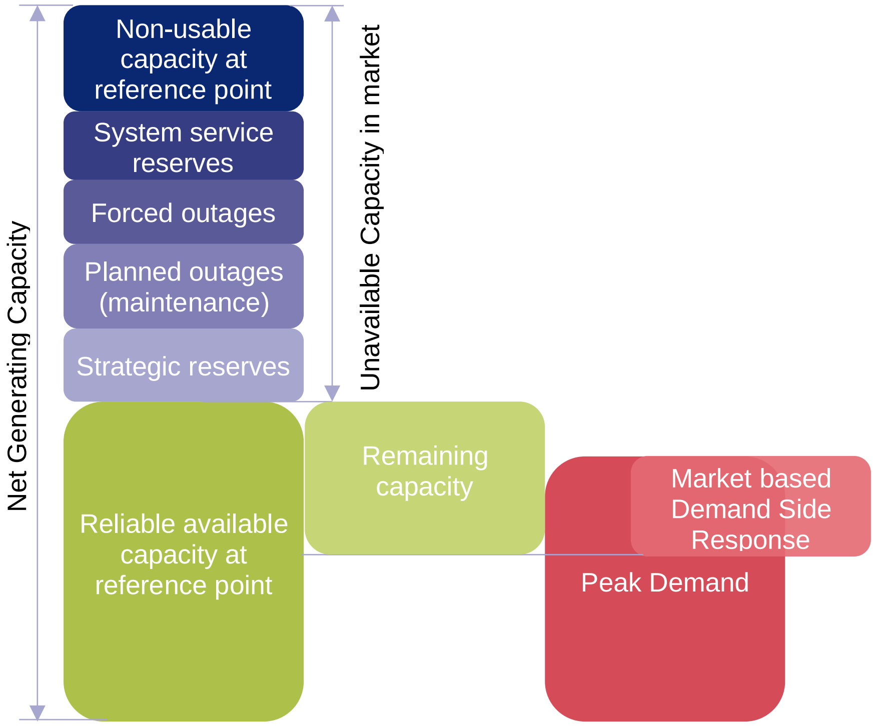
The **upward adequacy analysis** consists of identifying the ability of generation to meet the demand by calculating the 'remaining capacity' (RC) under either normal conditions or severe conditions.

- '**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 occur 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:[18]

17 *ENTSO-E Target Methodology for Adequacy Assessment*

18 *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.

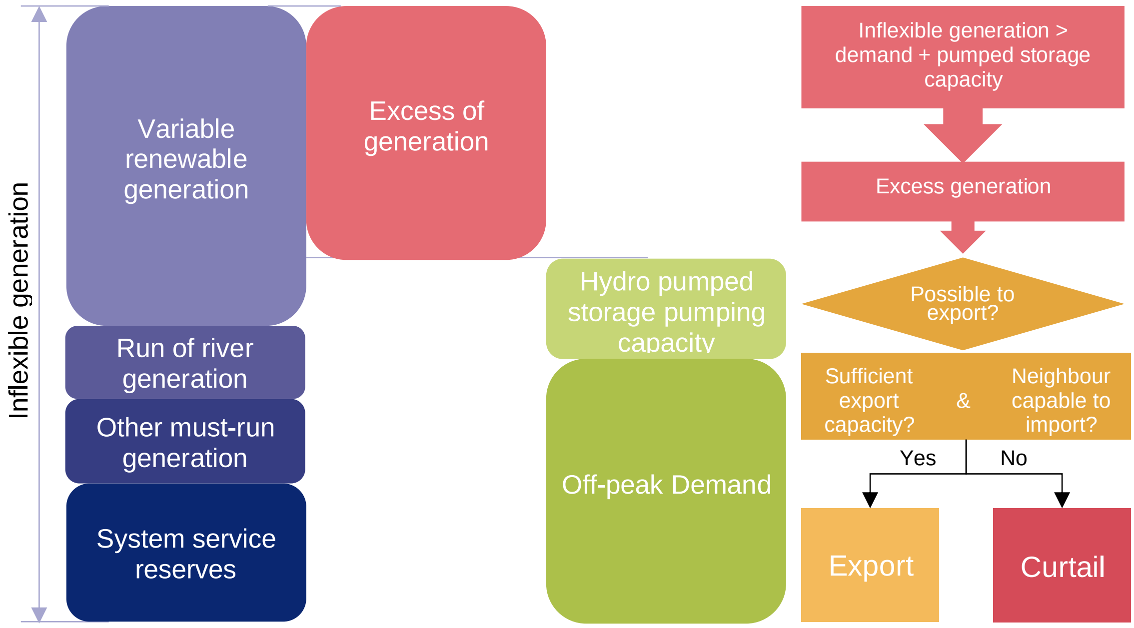
One synchronous point in time is collected for all countries to allow for a meaningful pan–European upward adequacy analysis when determining the feasibility of cross–border flows. The most representative synchronous point in time for the upward adequacy analysis is Wednesday 19:00 CET during wintertime 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 the event 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[19] is used to run numerous simulations. The following high-level methodology is applied to build each one of those simulations:

[19] *For one point in time, a 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.

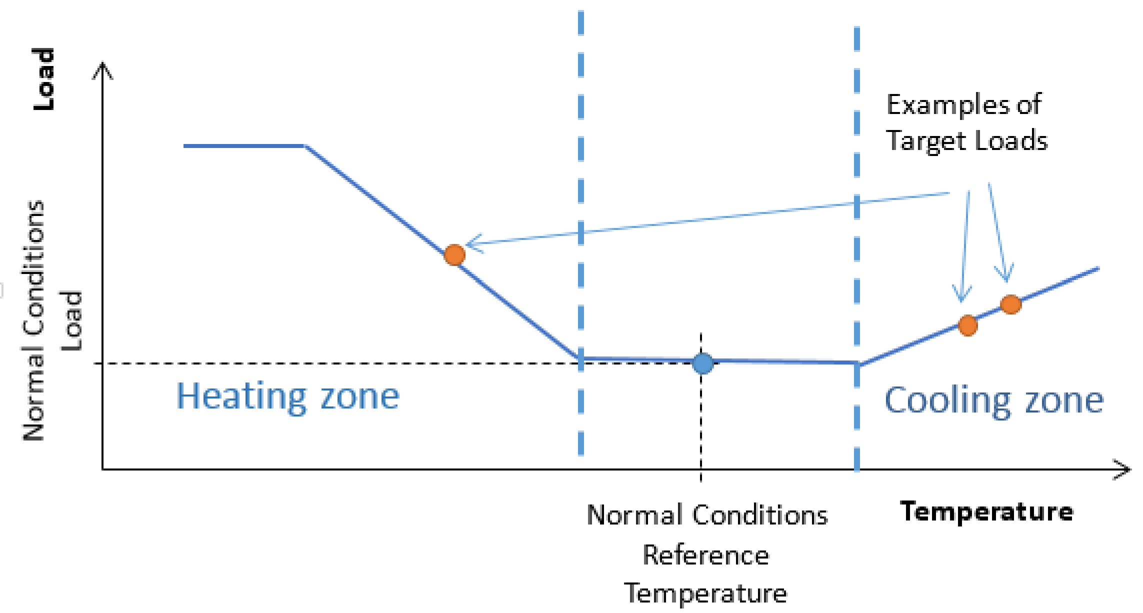
Regarding the downward adequacy analysis, the same approach is used, but using the 95th percentile value (that is exceeded only by 5% of records in collection).

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 and 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. In addition, for the pan–European analysis, simultaneous importable and exportable limits are considered when relevant, capping the global imports or exports of a country.

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.[20]

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:[21]

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

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

[21] *The climatology database of the World Meteorological Organization (WMO) is the source for 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,..)

ND_{imonth}– number of days of month j

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

to the dates corresponding to the middle of each month:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4. Calibrate $CPWNMAT_i$ to reach the equality:

$$AAT_{daily} = AAT_{monthly}$$

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

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

Polynomial 6–th order approximation is applied to the time series of $CPWNMAT_{ij}$ (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.

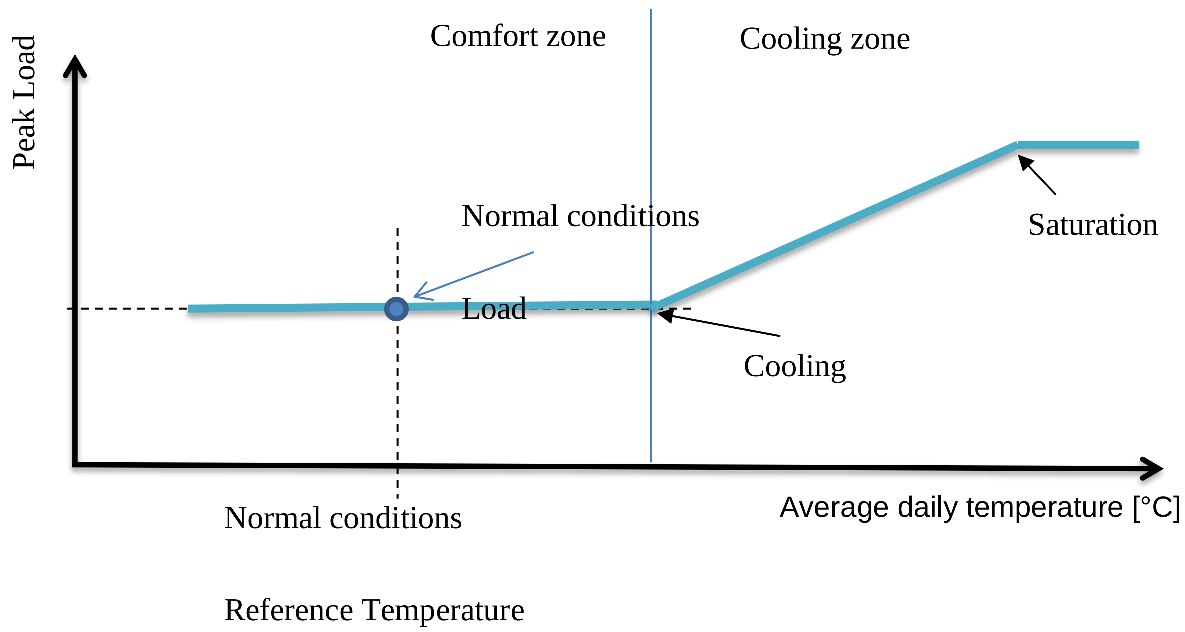
5. Model the relationship between the peak load and the daily average temperature in the range **$T_{start} – T_{satur}$** by simple linear regression:

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

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.*
<u>Most critical periods for maintaining adequacy</u>, counter–measures adopted and expected role of interconnectors.
<u>Most critical periods for maintaining upward adequacy</u>, 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 the 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. In 2016 ENTSO–E produced 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 the 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 Term adequacy (STA): 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 considering 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 RES, mostly wind and photovoltaic, whose output level is dependent on non–controllable parameters (e.g. weather).