2019

summer outlook
winter review
2018-2019

entsoe

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1 Executive Summary

ENTSO-E's Summer Outlook has not identified any specific risk for security of electricity supply for the summer 2019.

In general, the system adequacy assessment for this summer has even improved compared to the same period last year. A detailed probabilistic assessment of week 30 (the most constrained week), from 22 to 28 July, confirms these findings.

Total net generation capacity increase in Europe more than doubled between what was recorded in the Summer Outlook 2018 (+/- 11GW) and what is recorded in this year's edition (+/-23 GW). This is explained by increased growth of renewable generation capacity and growth of some thermal technology. Coal generation capacity shows a continuous decrease.

Hydro reservoirs levels are close to the historical average in the majority of the countries assessed. In France and Italy, reservoir levels are between historical average and minimum levels. Normal hydrological conditions are expected this summer because of the accumulation of snow in the Alps. Switzerland saw higher than normal precipitations and mild weather in the winter 2018/2019, and the level of its reservoirs are above average.

As usual, the Summer Outlook is combined with a review of Winter 2018/2019 that was overall marked by mild weather conditions Despite concerns due to delayed

nuclear maintenance and slightly lower temperatures than average, no adequacy issues were recorded in Belgium last winter.

2 Introduction

2.1 Purpose of the Seasonal Outlooks

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

System adequacy is the ability of a power system to meet demand at all times and thus to guarantee the security of the supply. The ENTSO-E system adequacy forecasts present the views of the TSOs not only on 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 the past report analysis to be checked against 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 Summer Outlook were performed for each week between 27 May 2019 and 30 September 2019. The Winter Review examines the system adequacy issues registered between 28 November 2018 and 31 March 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 regional security coordinators (RSCs).

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

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

2.2 The European Generation Landscape

A pan-European generation capacity analysis reveals generation capacity expansion acceleration. Renewable Energy Sources' (RES) capacity expansion slightly increases, while some conventional capacity expansion is recorded after shrinking last year. Nevertheless, coal generation capacity continues to decrease in the European power system.

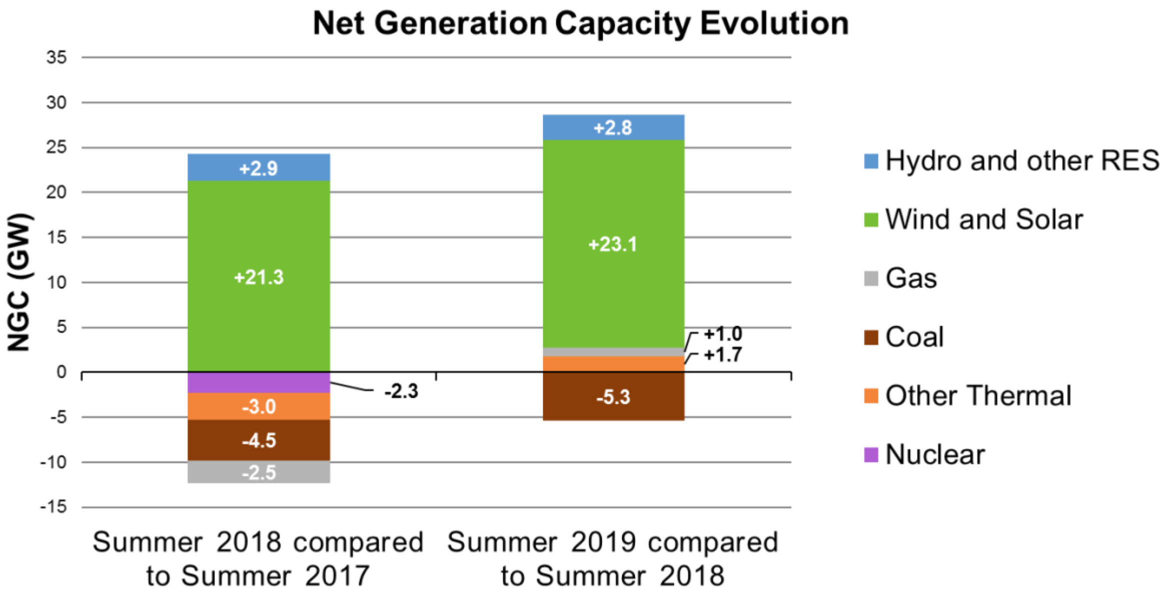
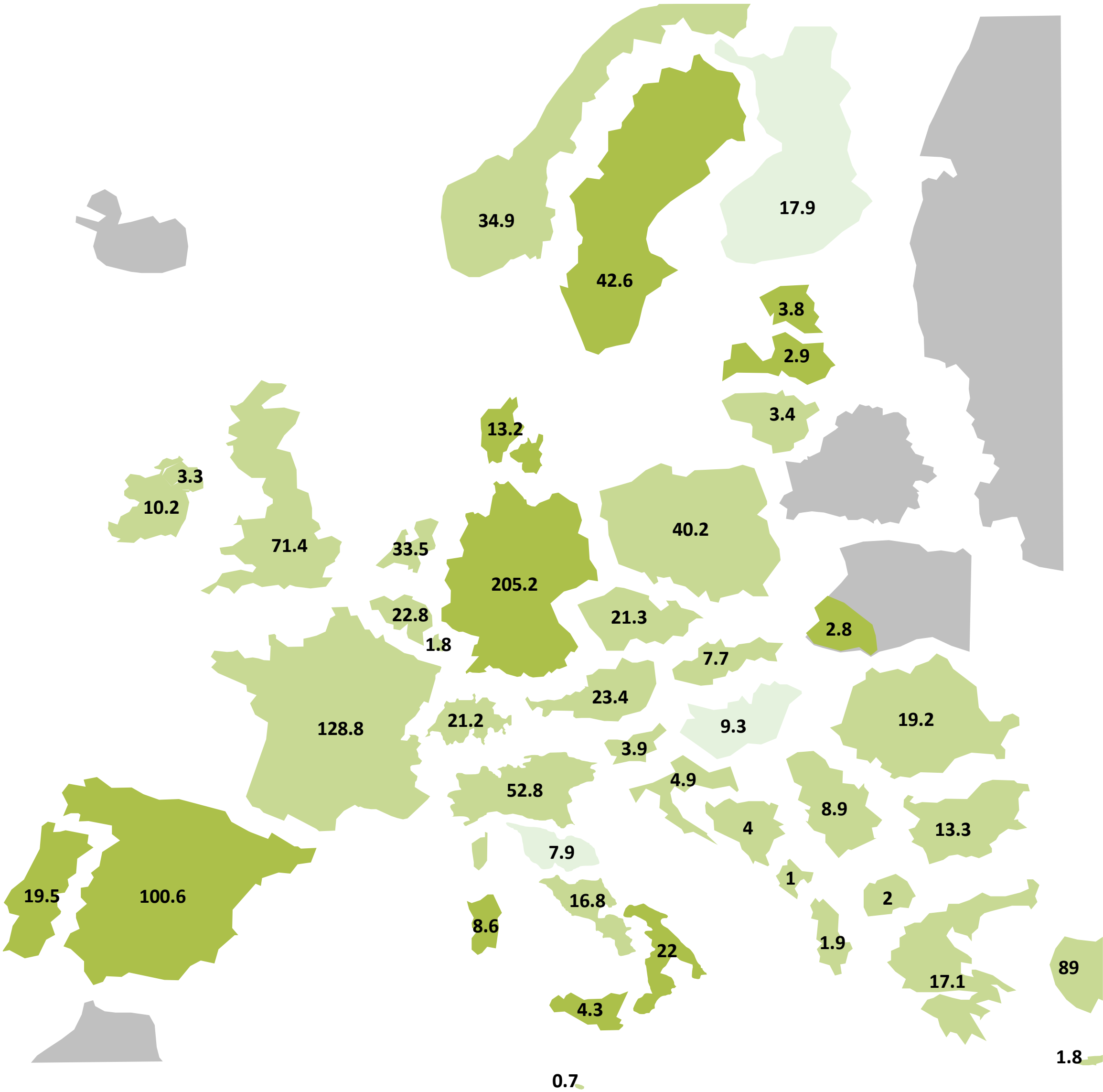


Figure 1: Evolution of net generating capacity per technology.

In the map given in Figure 2, net generation capacities (NGC) are displayed in absolute values (GW) for each study region. To ease comparison at the Pan-European level, a ratio of net generation capacity to expected highest demand (under normal conditions) in a respective region at a Pan-European synchronous peak hour has been derived. Countries are coloured according to this ratio; countries with a higher ratio appear in darker colour shades.



Map Colour Code	Values on map
Ratio of NGC to Season Peak Demand (19:00)	NGC (GW)
100% – 200%	
200% – 300%	
above 300%	

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

3 Summer outlook 2019 – Upward Adequacy

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

3.1 How to Read the Results

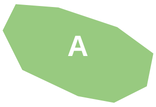
Results in figures displaying maps in Section 3 present reliably available generation capacity capability to supply peak load in the coming season under study (normal or severe condition). If reliably available capacity (RAC) in the country is sufficient to supply expected demand throughout the whole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

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

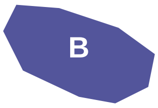
In addition, a simplified merit-order approach[4] is considered. Countries in specific weeks that do not require imports from an adequacy perspective, but could import from a market perspective, are coloured in light blue.

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

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 coming season, with only some countries requiring an import contribution.

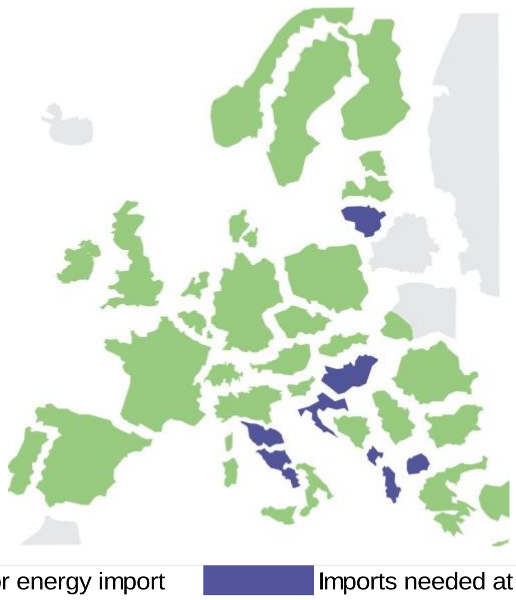


Figure 3: Adequacy under normal condition.

Further insight is provided in Table 1 presenting results in weekly resolution – no adequacy risks are identified during the coming season at Pan-European synchronous peak time (19:00 CEST). Albania, Hungary, Central-Northern Italy (IT02) and Lithuania depend on imports throughout the coming season.

See Section 3.1 for details on how to read the results

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

- Country self-sufficient and prone to export from market perspective
- Country self-sufficient but prone to import from market perspective
- Country required to import from an adequacy perspective
- Part of deficit cannot be convered with imports

Week	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
AL	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
AT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
BA	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
BE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
BG	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
CH	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
CY	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
CZ	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
DE	I	I	I	I	I	I	E	I	I	E	I	I	I	I	I	I	I	I
DK	E	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
EE	I	I	I	I	I	I	I	I	I	I	E	I	I	I	I	I	I	E
ES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
FI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
FR	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
GB	E	E	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
GR	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
HR	R	I	I	I	I	R	R	R	R	R	I	I	R	R	R	R	R	R
HU	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
IE	E	E	E	E	E	E	E	E	E	I	E	E	E	E	E	E	E	E
IT01	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
IT02	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
IT03	R	R	R	R	R	I	I	I	I	I	E	I	E	E	I	I	I	I
IT04	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
IT05	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
IT06	E	E	E	E	E	E	E	E	E	E	E	E	E	I	I	E	E	E
LT	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
LU	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
LV	E	E	E	I	I	I	I	E	E	E	E	E	E	E	E	E	E	E
ME	E	E	E	E	E	E	E	E	E	E	R	R	E	E	E	E	E	E
MK	E	E	E	E	E	R	R	R	R	R	R	R	R	R	R	R	R	R
MT	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
NI	E	E	E	E	E	E	I	I	E	E	E	E	E	E	E	E	E	E
NL	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
NO	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
PL	E	E	E	E	E	I	E	E	E	E	I	I	E	E	E	E	E	E
PT	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
RO	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
RS	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
SE	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
SI	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
SK	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
TR	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
UA_W	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

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 of 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 Summer Outlook uses the same approach; hence, severe conditions could be seen as a deterministic stress test for Europe's electricity system. In the future, implementation of a probabilistic approach for Seasonal Outlook with hourly resolution will improve the accuracy for assessing the global probability of adequacy issue, with both temporal and spatial correlation.

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

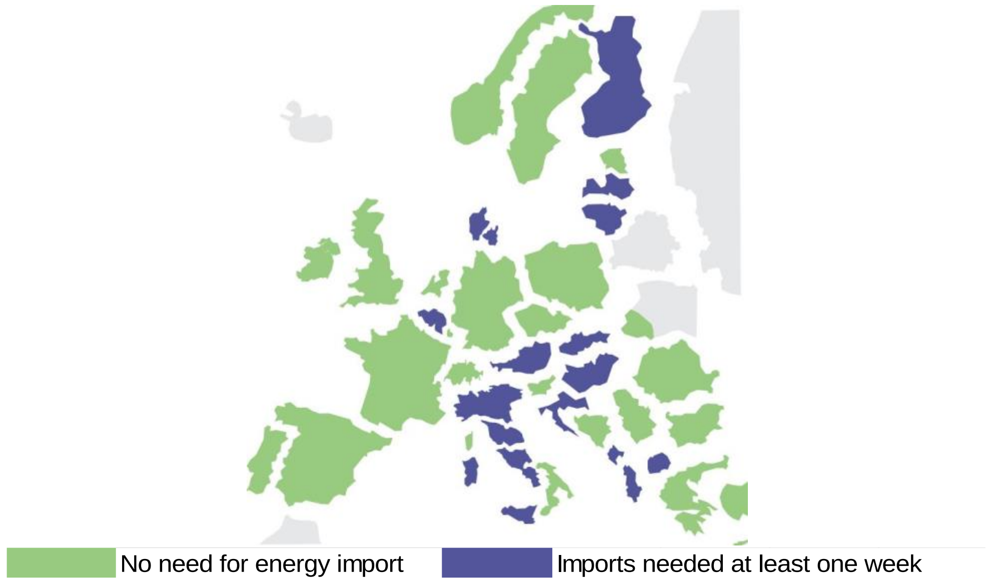


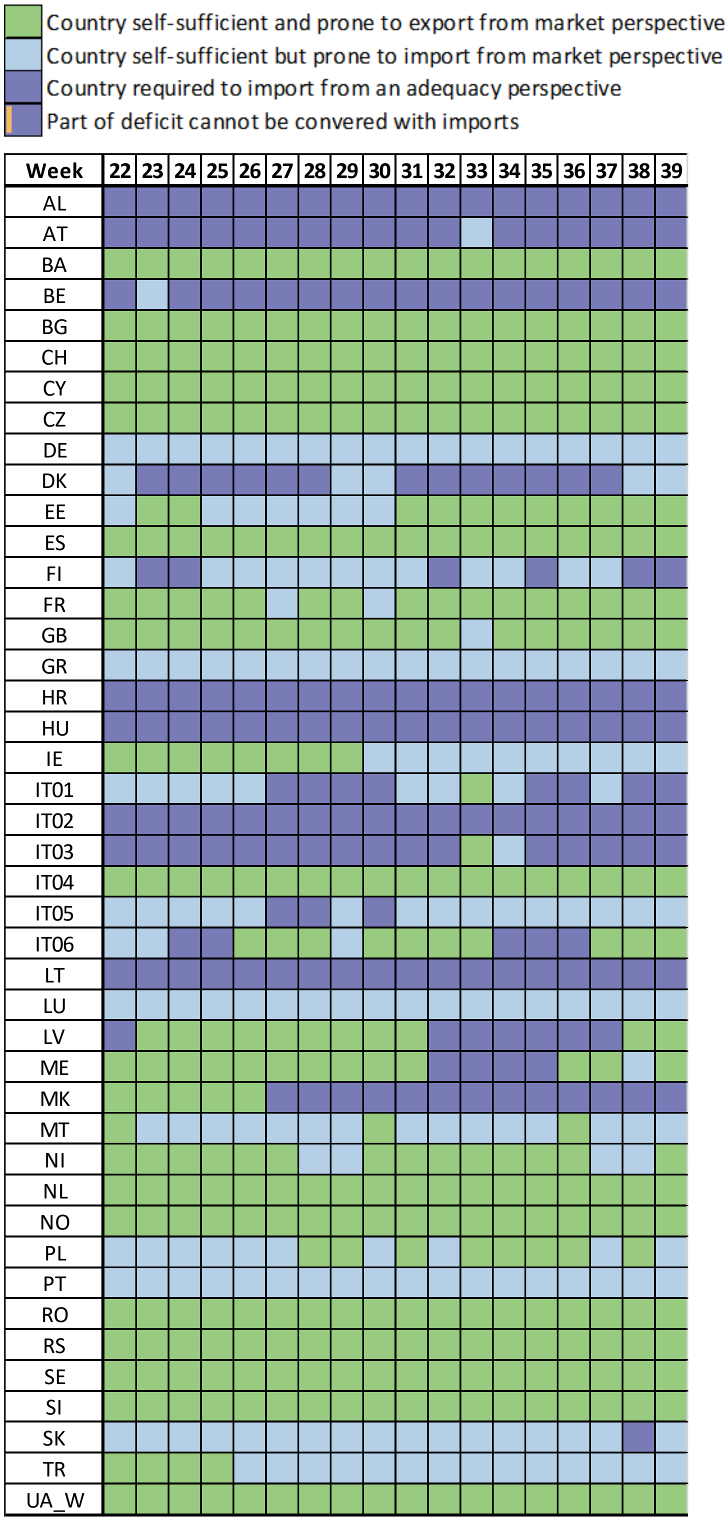
Figure 4: Adequacy under severe conditions.

Results on a weekly basis presented in Table 2 indicate that no adequacy risk is identified for the coming season at pan-European synchronous peak time (19:00 CEST). However, Albania, Croatia, Hungary, Central-Northern Italy (IT02) and Lithuania would rely on imports under severe conditions throughout the coming season. Moreover, Austria, Belgium and Central-Southern Italy (IT03) would need to rely on imports in the coming season under severe

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

conditions with only some weeks being the exception. Nevertheless, resource availability in Europe is expected to ensure adequacy throughout the coming season.

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



See Section 3.1 for details on how to read the results

3.4 Probabilistic Sensitivity Analysis

No adequacy risk has been identified even under severe conditions in any of the studied countries, however, adequacy in summer is typically a concern in Italy. Therefore, a probabilistic analysis has been performed for week 30, identified as the most constraining in 2019 for Italy, to assess if there are any particular circumstances that raise an adequacy risk.

Figure 5 incorporates the results of all bidding zones in a single graph. It suggests that generation capacities and market based DSR in Italy would be sufficient to ensure supply of demand in most of the cases. A combination of high temperature with low wind and photovoltaic (PV) generation may lead to the need for energy import; however, available resources abroad and interconnection availability would be sufficient to ensure adequacy in Italy on a country level.

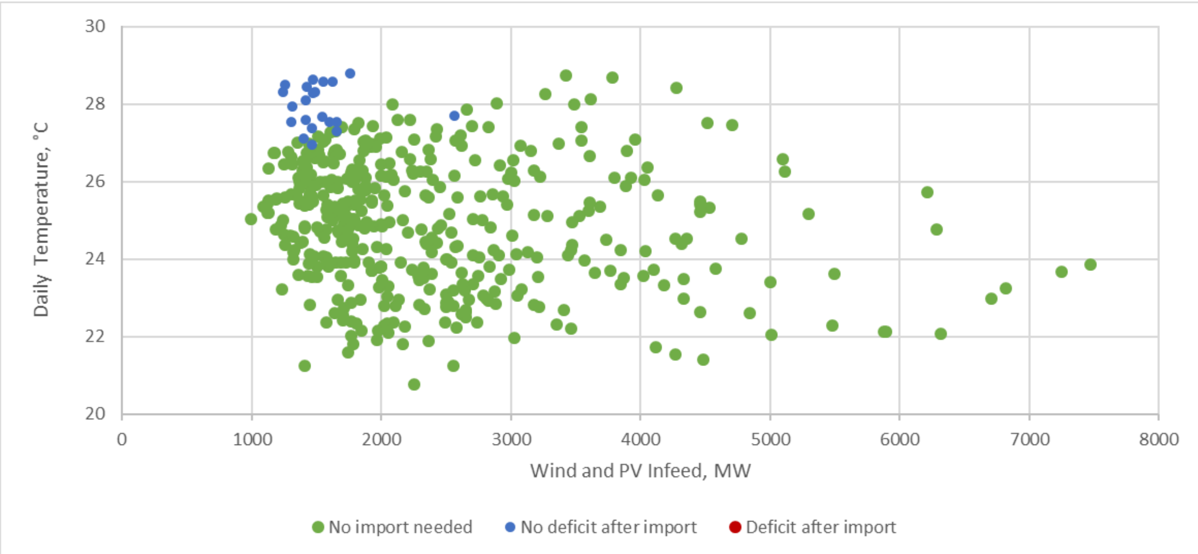


Figure 5: Probabilistic sensitivity analysis – week 30 in Italy

Despite the fact that imports from neighbouring countries would be required only in very limited cases, congestions of interconnections between southern and northern Italy can be the reason for additional import necessity from abroad in additional cases. In Figure 6, probabilistic results for the area composed of Northern Italy (IT01) and Central-Northern Italy (IT02) bidding zones are shown. These results suggest that the adequacy situation in this area is linked to temperature and RES generation:

- area of IT01 and IT02 requires imports from neighbouring Italy bidding zones when average daily temperature reaches 24°C. The lower the RES generation is, the more likely it is that imports will be needed. Nevertheless, imports available from the southern part of Italy are expected to be sufficient to cope with these situations;
- area requires additional imports from neighbouring countries when average daily temperature exceeds the 27°C threshold and RES generation is low.

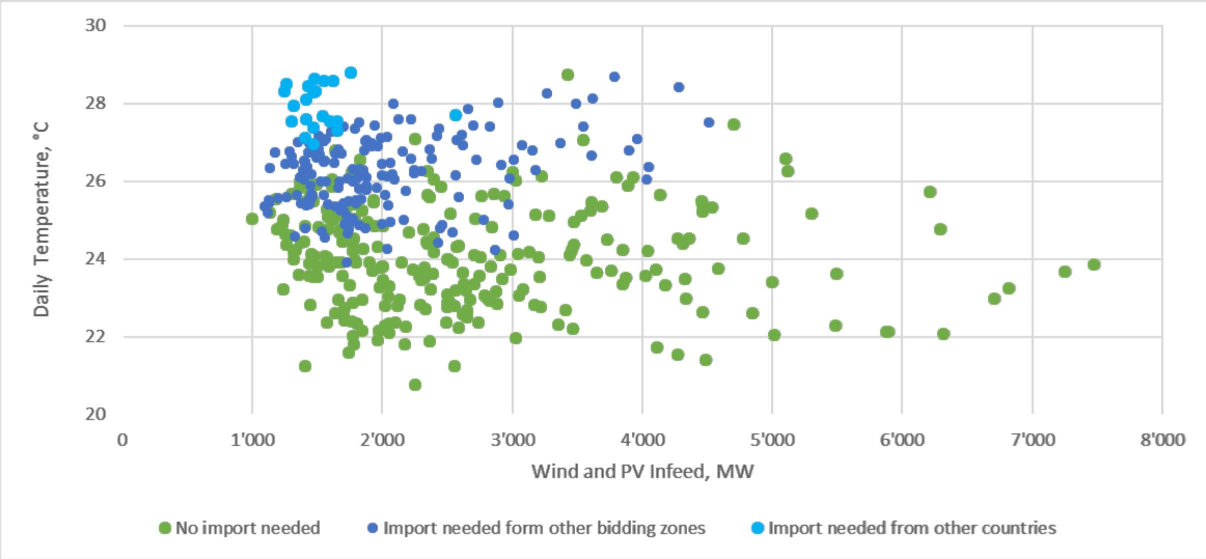


Figure 6: Probabilistic sensitivity analysis – week 30 in Italy (IT01 and IT02)

Further on, results for each bidding zone in Italy are summarised in Figure 7. This indicates that no adequacy risk is expected in any of the bidding zones in Italy in week 30, 2019 and represents the importance of interconnection availability for each bidding zone.

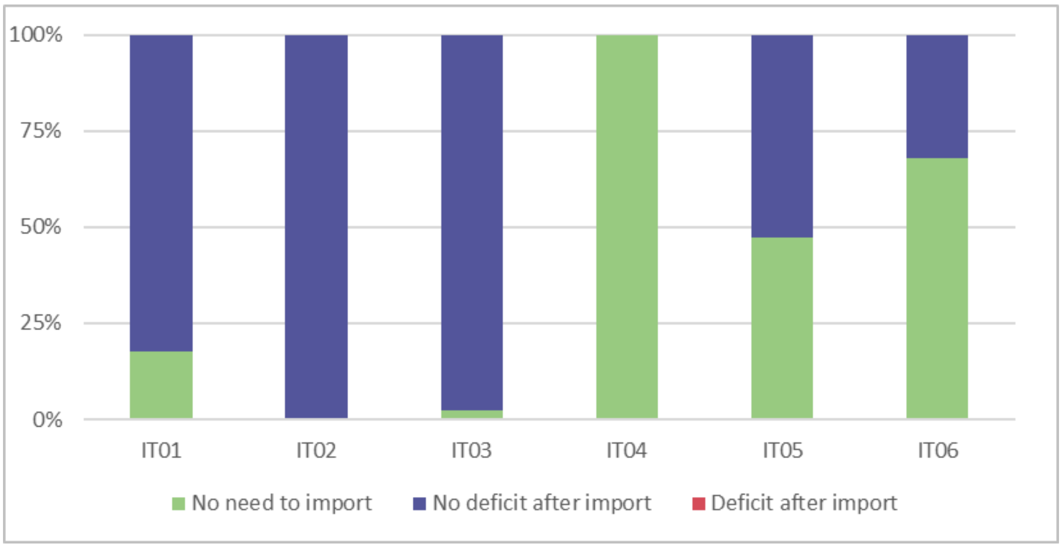


Figure 7: Probabilistic sensitivity analysis – week 30 in Italy (IT01 and IT02)

4 Summer outlook 2019 – 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 required 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 95^{th} percentile values of data samples taken from the PECD (cf. Appendix 2:).

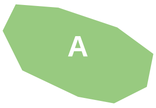
The results in Table 3 and Table 4 should not be read as a representation of forecasted summer curtailment. They only indicate a potential risk in the event of very high wind and PV generation; and very low demand in all of Europe at the same time at a given day. Furthermore, wind and PV generation curtailment should not be perceived as a negative action. The practice of it enables the integration of high rates of renewable generation in the power system and also indicates business opportunities for emerging technologies such as batteries and DSR.

4.1 How to Read the Results

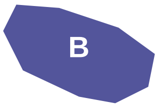
Results in figures displaying maps within Section 4 present the off-peak demand capability to absorb energy from inflexible and variable generation. Countries are coloured green if the expected demand at the reference point is sufficient to absorb all energy from variable and inflexible generation throughout 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 results



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



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

Weekly results table

- Demand is sufficient to absorb Inflexible and variable generation
- National demand is insufficient to absorb inflexible and variable generation – need to export
- National demand 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 8 confirm that demand is sufficient to absorb the energy generated from variable and inflexible generation in most of Europe throughout the summer season.

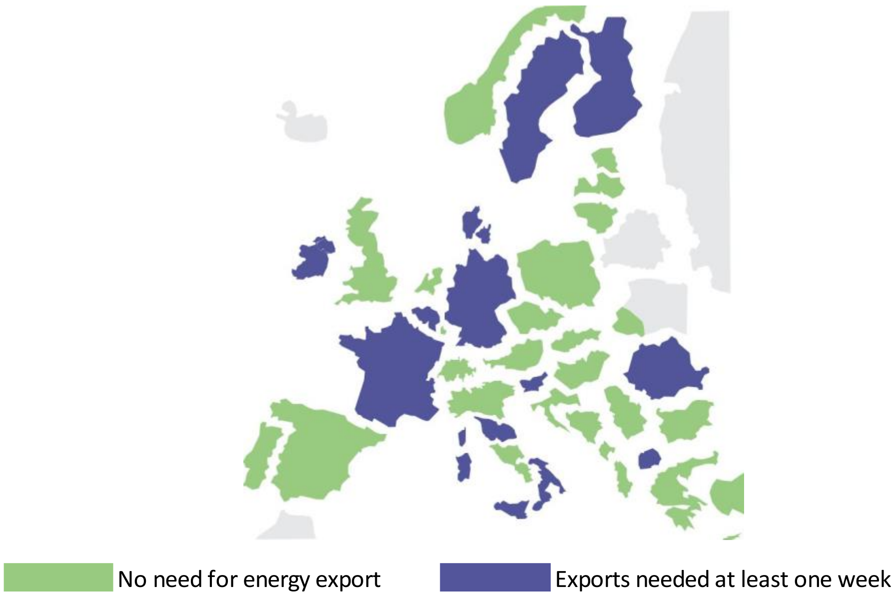
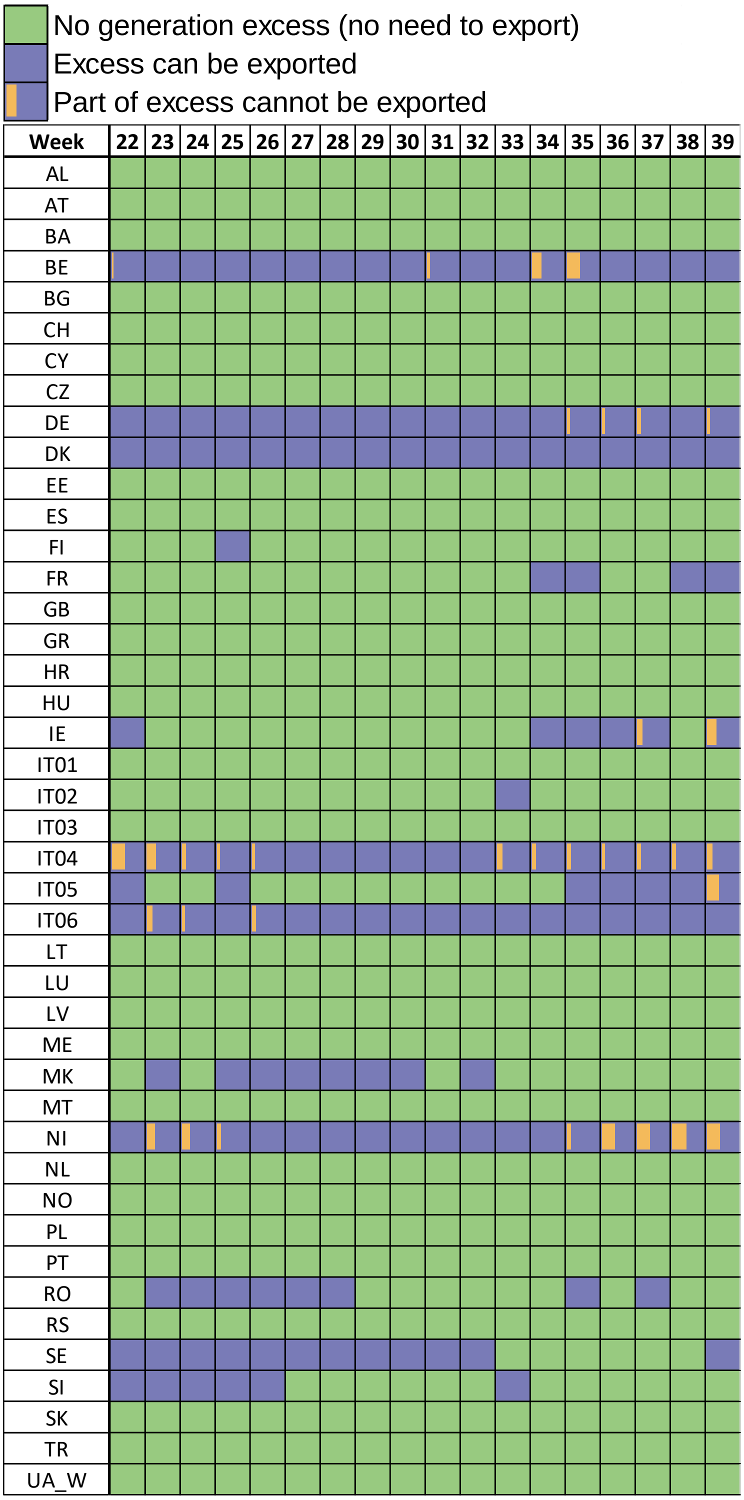


Figure 8: Daytime national downward regulation adequacy.

The weekly results in Table 3 indicate that there are more countries which would be able to export an excess of variable and inflexible energy than countries which would need to curtail some of the excess electricity. This is more likely to happen at the beginning and end of season. This is a result of lower demand (e.g. cooling) due to lower temperatures at the beginning and end of season.

Table 3: Daytime downward regulation adequacy.



See Section 4.1 for details on how to read the results

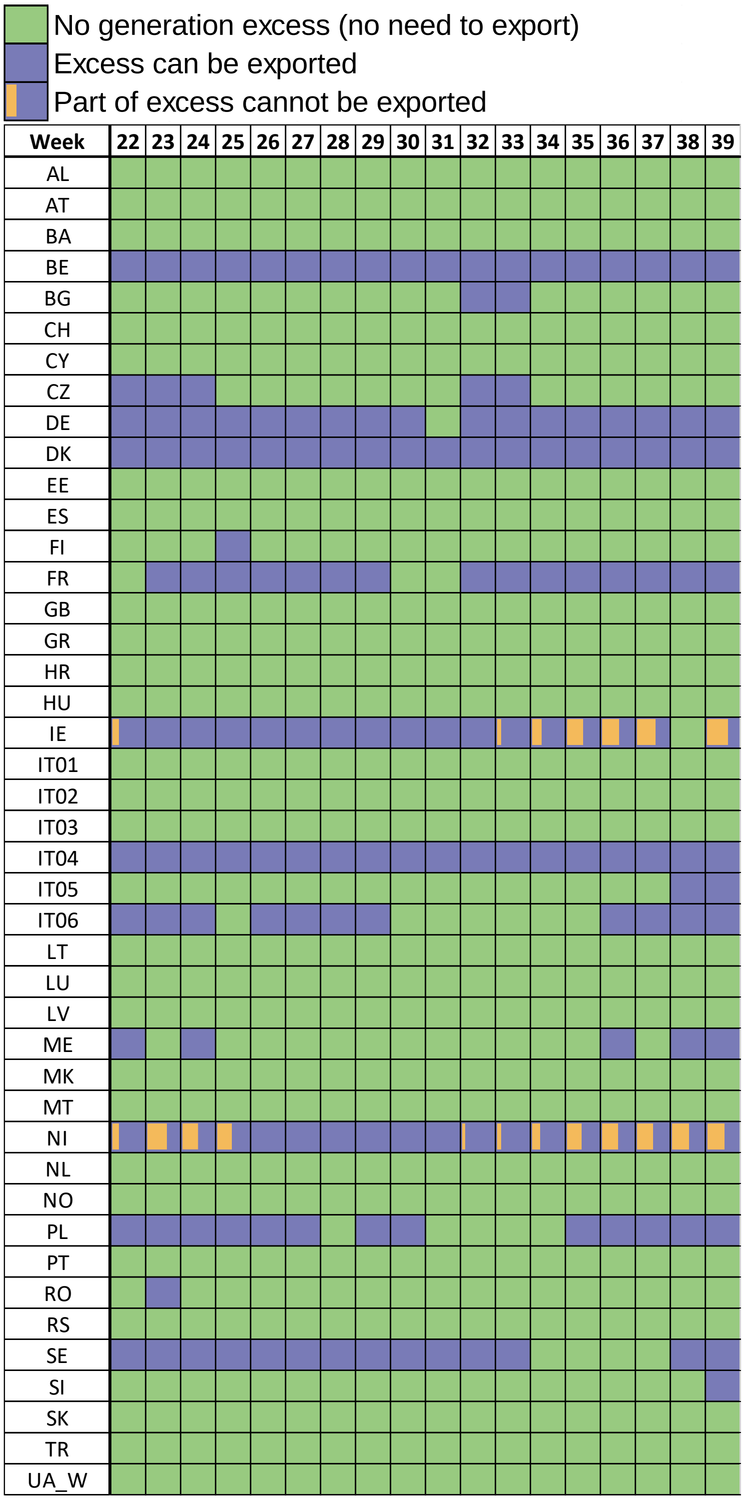
4.3 Night-time Downward Regulation

The night-time downward regulation adequacy corresponds to Sunday early morning (5:00 CEST). Curtailment mostly relates to wind generation, as no PV generation is expected at that time. The results presented in Figure 9 show that all countries exposed to a possible excess of energy during daytime would have excess during night-time as well. However, one of the bidding zones in Italy (Central-Northern Italy, IT02) is an exception. Some additional countries would need to export an excess of electricity as well: Bulgaria, Czech Republic and Poland.

Figure 9: Night-time national downward regulation adequacy.

The weekly results in Table 4 suggest that most of the countries would have the capability to export energy throughout the season, though some excess electricity curtailment could be required in Ireland and Northern Ireland.

Table 4: 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 provide 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 the first half of 2019 remain around historical average levels across Europe. Italy reservoir levels are recovering since beginning of year when it was historically low. Snow levels in mountains suggest that hydrological conditions in Italy should be normal in summer 2019. Reservoir levels in France dropped in January and February due to tight supply margins in the region and settling between historical minimum and average levels in March. Meanwhile, reservoir levels in Switzerland have climbed above historical average levels since the beginning of 2019 as a result of high precipitation combined with mild and sunny days in winter 2018/2019. On a pan-European scale, reservoir levels are considered to be on average, with some reservoir levels in some countries deviating slightly from average.

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

In Italy, the reservoir levels slightly recovered after reaching historically low levels at the beginning of 2019. High amounts of snow suggest that hydrological conditions this summer should be normal.

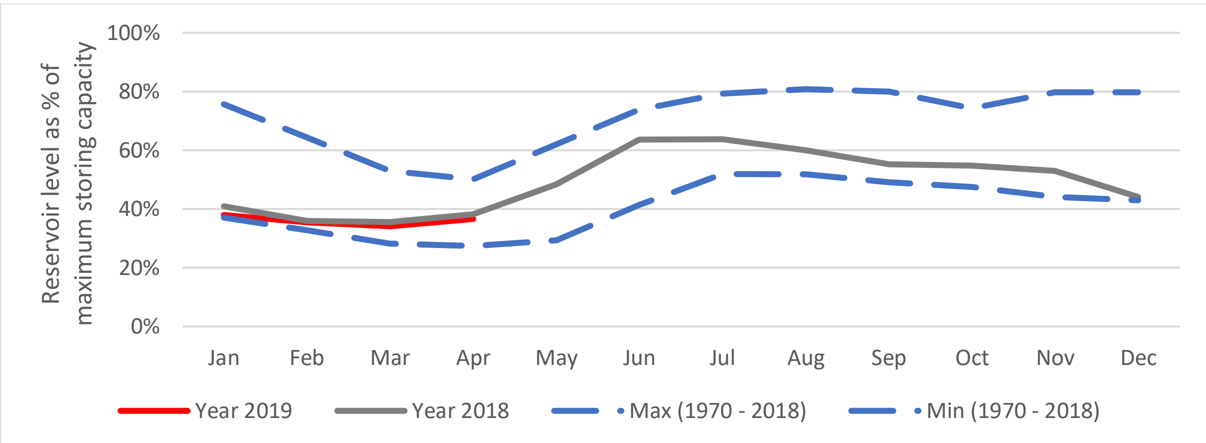


Figure 10: Reservoir levels in Italy.[6]

[6] *Based on data published by Terna*

In France, the reservoir levels are well above last year's levels, though remaining below historical average levels. In the beginning of 2019, reservoir levels were approaching the reservoir levels of 2018, which were characterised by low reservoir levels. However in March it detached, settling in between historical average and historical minimum levels (recorded 2018).

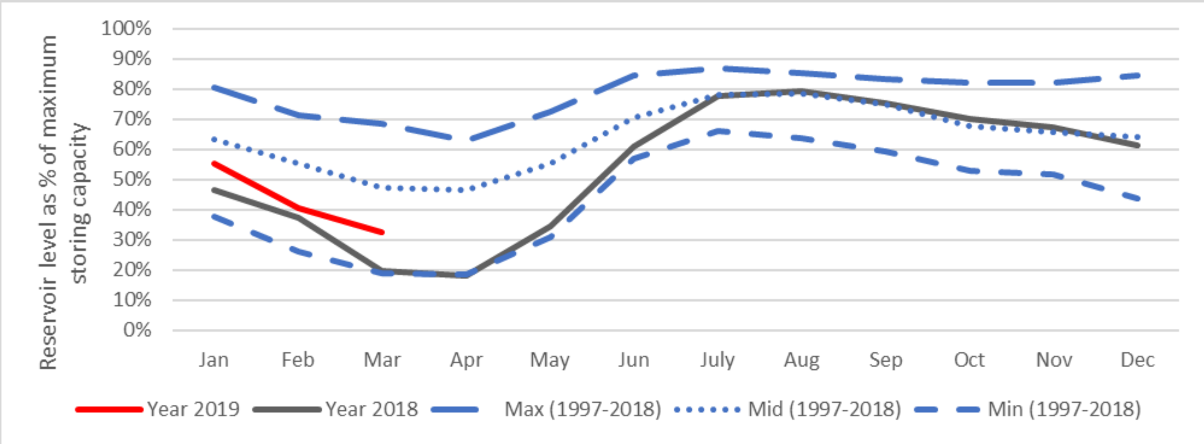


Figure 11: Reservoir levels in France.[7]

Hydro reservoir levels in Spain have remained around average for the last few months, however ending slightly below historical average levels in 2019.

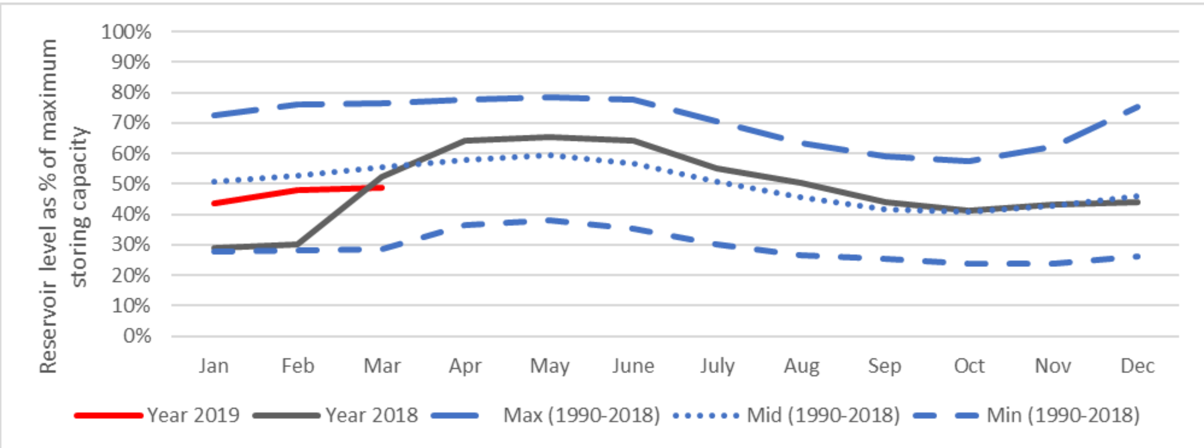


Figure 12: Reservoir levels in Spain.[8]

Reservoir levels in Switzerland are above the historical average. In the second half of 2018, reservoir levels were close to the historical average. Since December 2018, reservoir levels have shown a positive trend and from then until March they have remained in between the historical average and historical maximum values.

[7] *Based on data published by RTE*

[8] *Based on data published by REE*

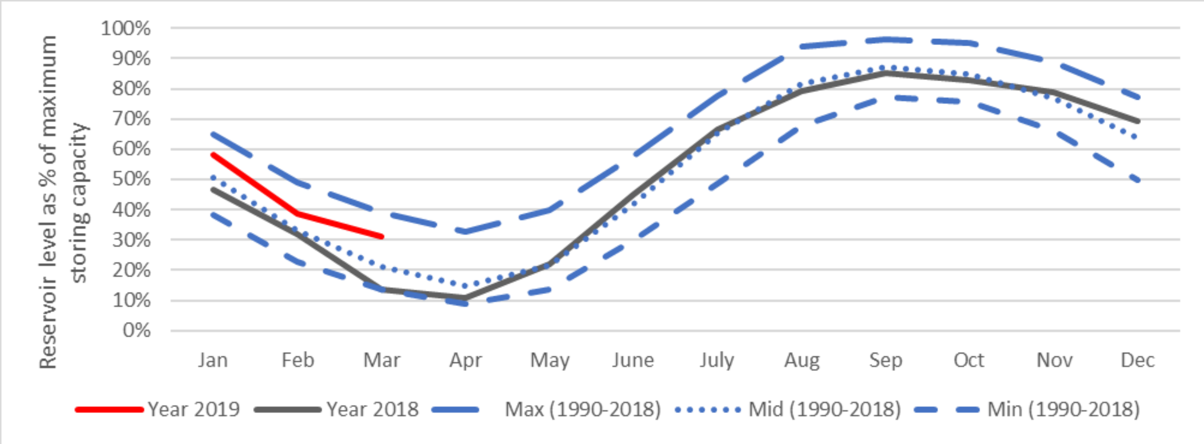


Figure 13: Reservoir levels in Switzerland.[9]

Austria's reservoirs levels are in between the historical minimum and maximum values. They remain rather steady compared to the pronounced downward trend recorded in 2018.

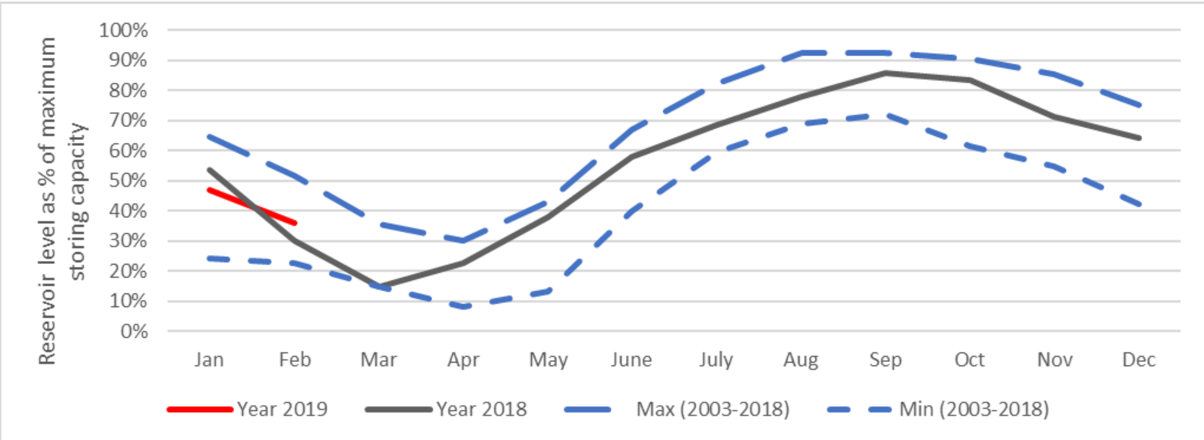


Figure 14: Reservoir levels in Austria.[10]

Hydro reservoir levels in Norway reached levels close to the historical average in October 2018 and remained so until March. Reservoir levels at the beginning of 2019 were close to the levels recorded in 2018.

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

[10] *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'.*

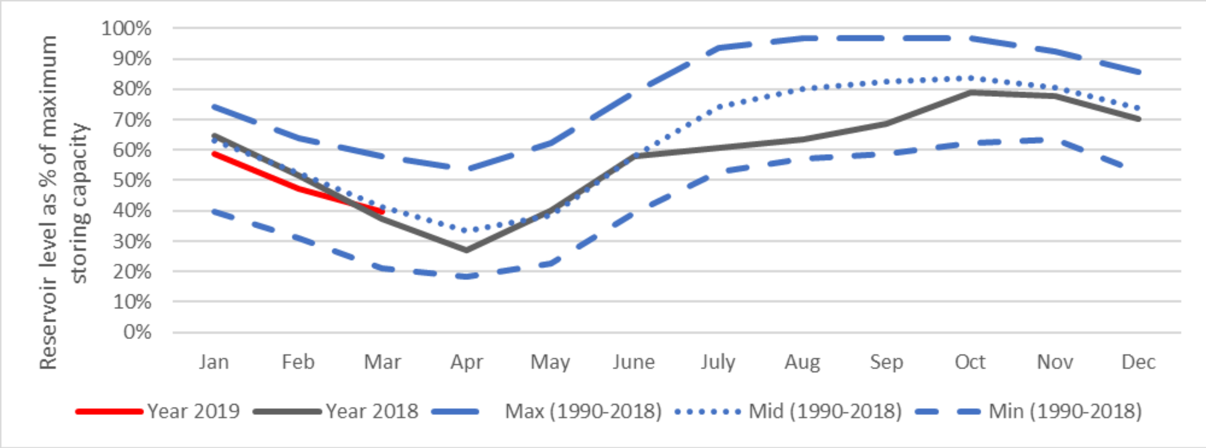


Figure 15: Reservoir levels in Norway.[11]

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

6 Winter 2018/2019 review

The winter review is based on the qualitative information submitted by ENTSO-E TSOs in April 2019 to represent the most important events that occurred during winter 2018/2019 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 winter review by country is shown in Appendix 1:.

6.1 General Comments on the Past Winter Climate

Last winter was generally mild, with above average temperatures throughout most of the season. January was the exception, with slightly below average temperatures and a concentration of most of the severe weather occurrences. The eastern part of Europe experienced higher than average snow, as well as the Alps region, and the season was dryer than usual in the Balkans. Furthermore, some storms affected transmission system availability.

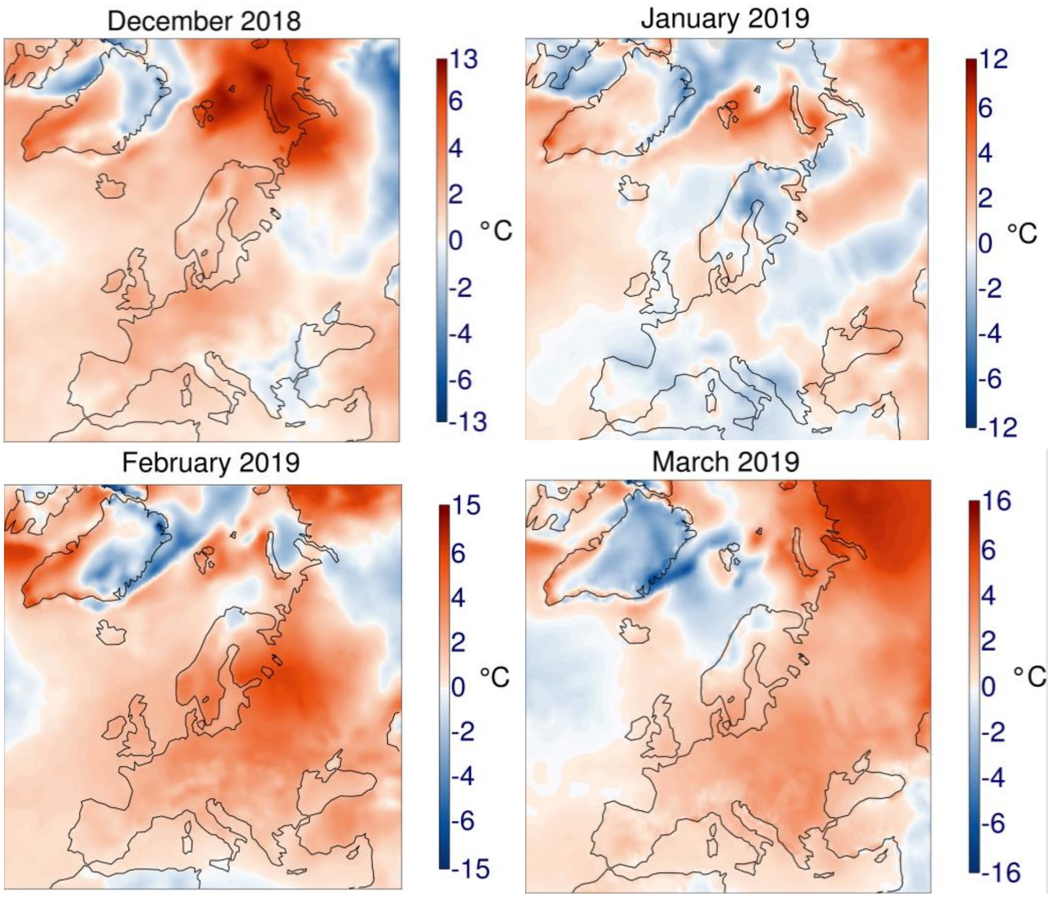


Figure 16: Surface air temperature anomaly in winter 2018/2019 relative to the average for the period 1981-2010.[12]

[12] Copernicus Climate Change Service–Surface air temperature maps

6.2 Specific Events and Unexpected Situations During the Past Winter

This mild winter has helped ease adequacy conditions throughout Europe, but some storms still had impacts on the electricity system, and several local events were monitored:

- An adequacy risk for winter 2018/2019 in Belgium was recognised after nuclear maintenance delays were announced in autumn 2018. 750 MW of additional measures were found by a task force led by the Federal Minister of Energy. Furthermore, coordination with neighbouring TSOs was enhanced to maximise import capability (under flow-based market coupling). The adequacy situation was finally relieved after the return of Doel 4 (1 GW in mid–December) and Tihange 3 (1 GW in early-January); however still requiring careful monitoring;
- Heavy snowstorms in late January 2019 caused roadblocks and power disruption in the southern mountainous parts of Bulgaria. A temporary solution with diesel generators was provided while restoring access to the power system;
- Coal supply to the power plants via the Rhine river was impeded. The main reason for this was low water levels in the Rhine river and limited capability to deliver coal by railroads. Coal stocks in power plants recovered during Christmas and the New Year holiday period, when water levels rose and electricity demand decreased due to holidays;
- A storm in late October–early November damaged the 220 kV Avise-Riddes tie–line between Italy and Switzerland. Line operation was restored on 1 December. The same storm also affected two 380 kV lines in the Albula pass (Switzerland) and the internal grid in northern Italy. Transfer capacity decreased between Italy and Switzerland, but did not pose any adequacy risk;
- In Sweden, several storms occurred which caused some local power shortages;
- In Sweden, Oskarshamn 3 nuclear reactor generation capacity availability dropped from 1400 MW to 450 MW on 23 January. A strategic reserve activation time reduction notification was issued as a response. Oskarshamn 3 returned to normal operations the following day. No strategic reserve generation was ultimately required;

- Energy balance issues in Kosovo*[13], which operates within the Serbian control area, are persisting and creating frequency deviations. However, Continental Europe TSOs are taking action to maintain deviations within limits.

[13] *Kosovo (*)–This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ opinion on the Kosovo declaration of independence.*

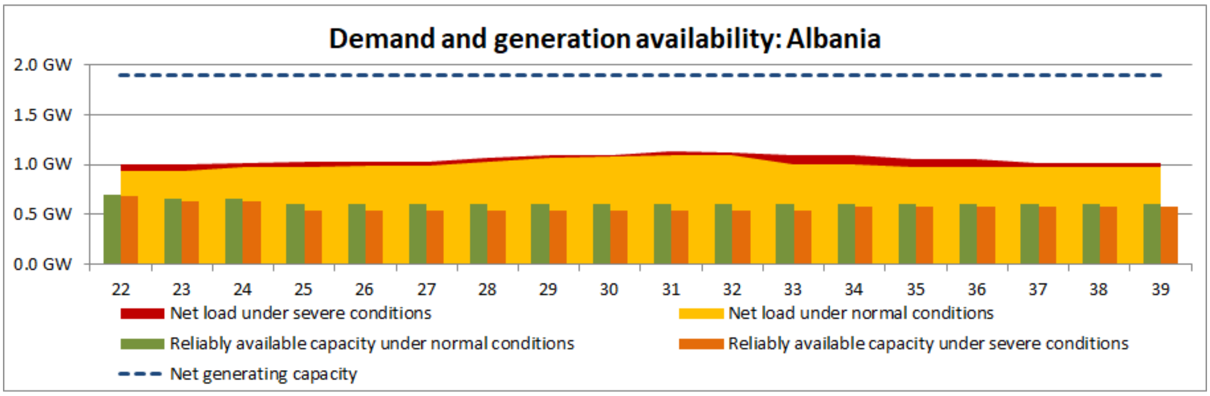
Appendices

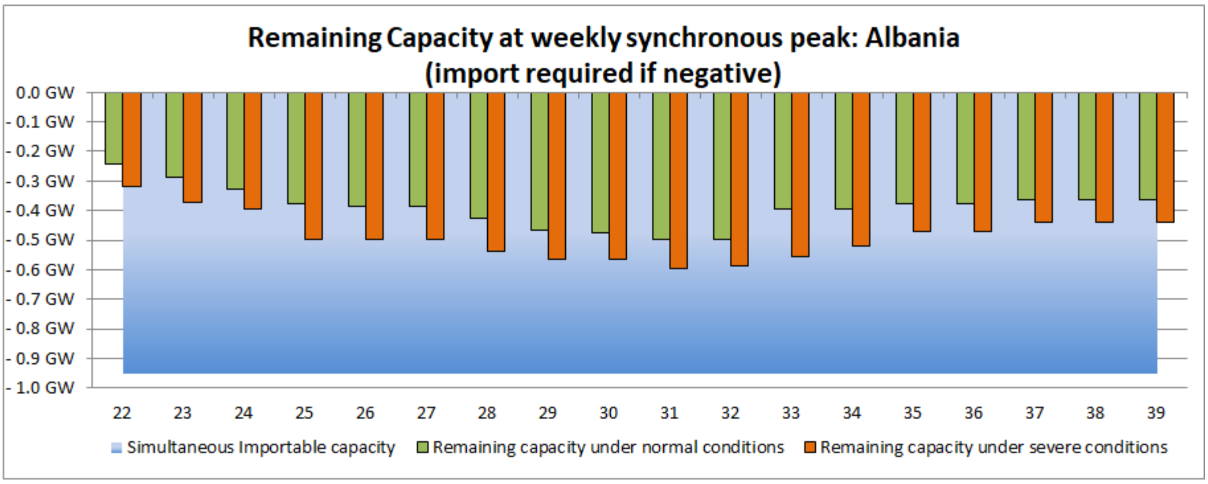
Appendix 1: Individual Country Comments on the Winter Outlook and Summer Reviews

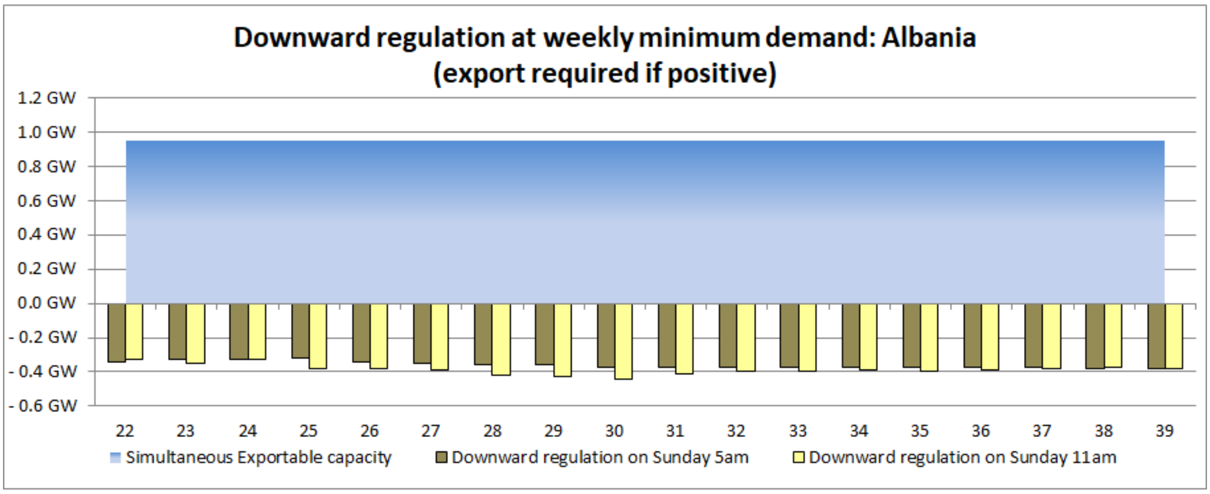
Albania: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Albania: Winter review 2018/2019

System adequacy was not endangered in winter 2018/2019.

Demand was slightly lower compared to previous years, since temperatures were above average. However, a dry winter was recorded in Albania and system adequacy was mainly fulfilled by firm import contracts arranged by the DSO. No deviations from system operational standards were recorded.

In recent years, there has been an increase in installed generation capacity and, at the same time, a small decrease in country consumption. Consequently, Albania’s dependency on imports slightly fell, but weather conditions are still a determinant factor for import needs. The network maintenance was optimised to ensure sufficient import capacities.

Austria: Summer outlook 2019

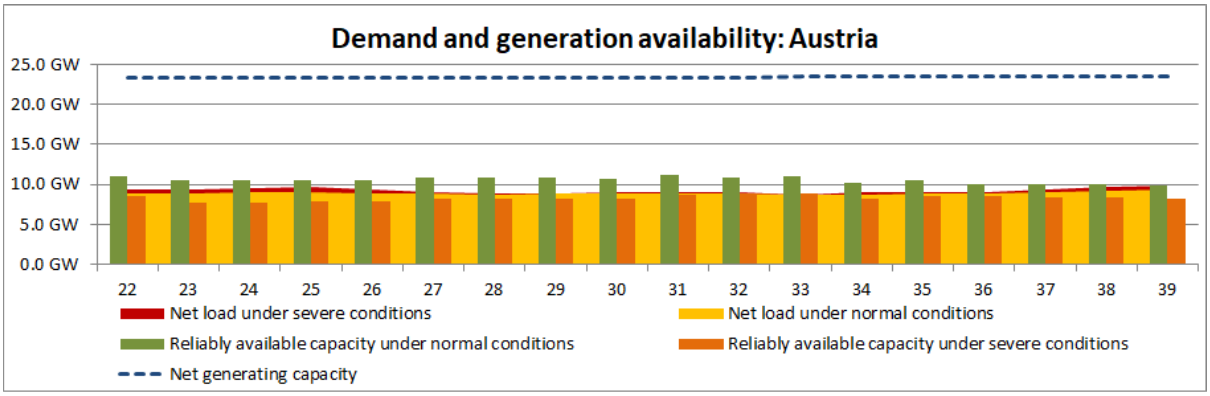
Potential critical periods and foreseen countermeasures

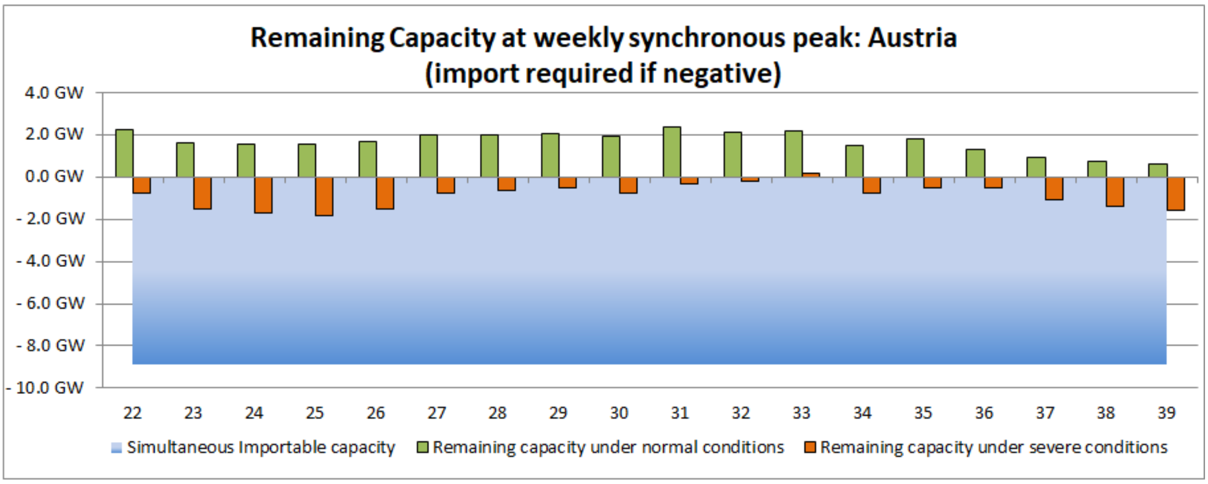
No adequacy or downward regulation issues are expected for the coming season.

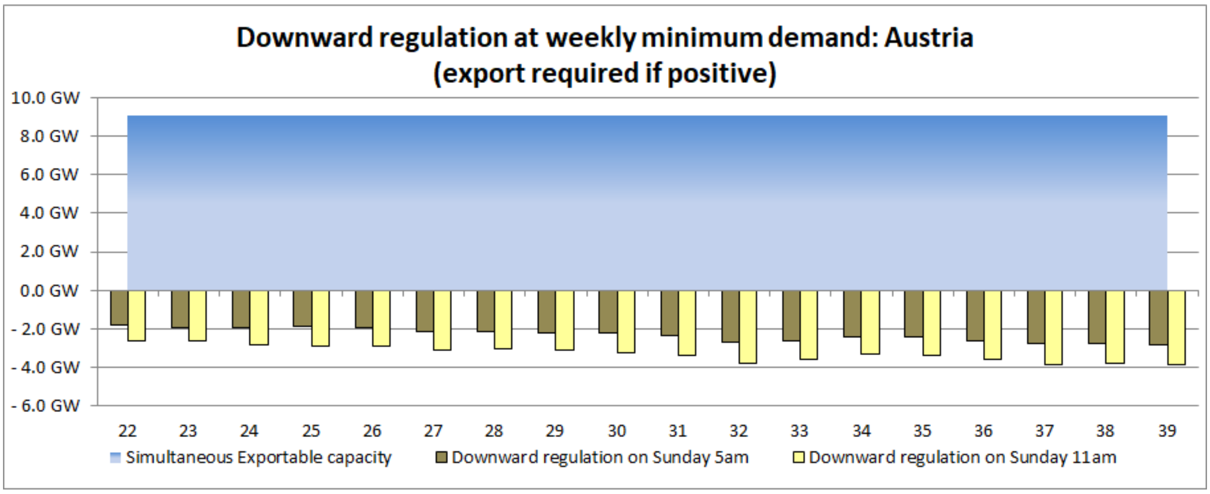
For the summer 2019, APG (Austrian TSO) assumed an 0.56% demand increase compared to summer 2018. The tool “Trapunta” was used to estimate the demand for the Summer Outlook 2019. The tool estimated demand profiles given weather conditions of the last 36 climate years (1981–2016). The mean values were taken for demand under normal conditions, whereas the 95th percentile values were taken for demand under severe conditions.

Concerning the NGC, it is worth mentioning that the net generating capacities of the “Kraftwerksgruppe Obere Ill-Lünersee” (turbine: 2.1 GW; pumping: 1.4 GW) and of “Kühtai/Silz” (turbine: 0.8 GW; pumping: 0.25 GW) are assigned to the German control block and thus are not considered for Austria.

The reliable available power of pumped storage powerplants (PSPs) was calculated considering the statistical data of generated energy by Austrian Pumped Storage Power Plants (PSPs) in a normal year and in a dry year (normal and severe conditions respectively). These energies were divided by 60 h for each week in order to account for the energy constraints of this type of power plant, seasonal inflows and the sustainable exploitation of a PSP. This approach assumes that the plants only generate during peak time (Mo.–Fr. 8:00– 20:00), which leads to a time frame of 60 h/week of generation.







Austria: Winter review 2018/2019

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

General comments on past winter conditions

Temperatures in winter 2018/2019 (December, January, February) were significantly above the average. In the lowland areas–where the majority of the Austrian population lives–it was warmest in the last 15 winters (1.2°C above the average); and in the mountain regions it was average.

High precipitation of snow (50–200 % above the average) was recorded in the northern Alps region. However, precipitation levels were one of the historically lowest in the southern Alps region.

Belgium: Summer outlook 2019

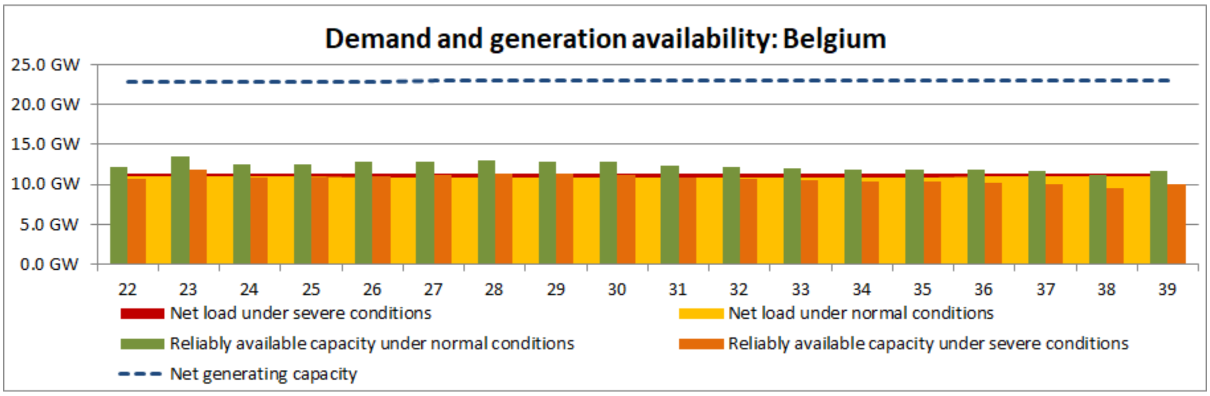
Potential critical periods and foreseen countermeasures

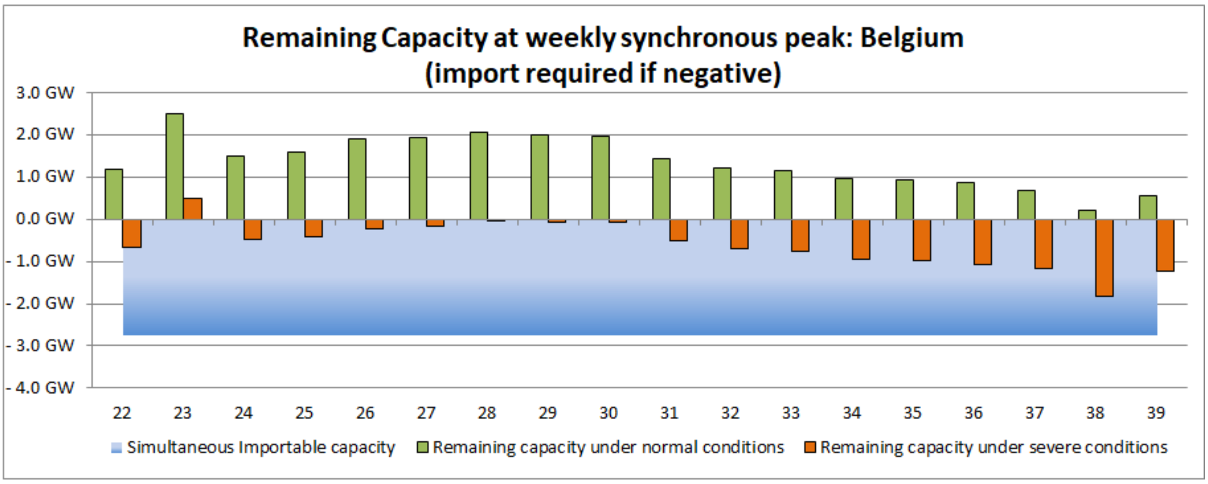
In Belgium, the maintenance profile is reasonable for the season, with no overlap of nuclear maintenance. Import needs stay below 1.8 GW in September under severe conditions. A low risk of structural shortage in Belgium is expected for the period covered in this Outlook Report, since import need does not exceed annual NTC value with all interconnected countries operating in the same synchronous area.

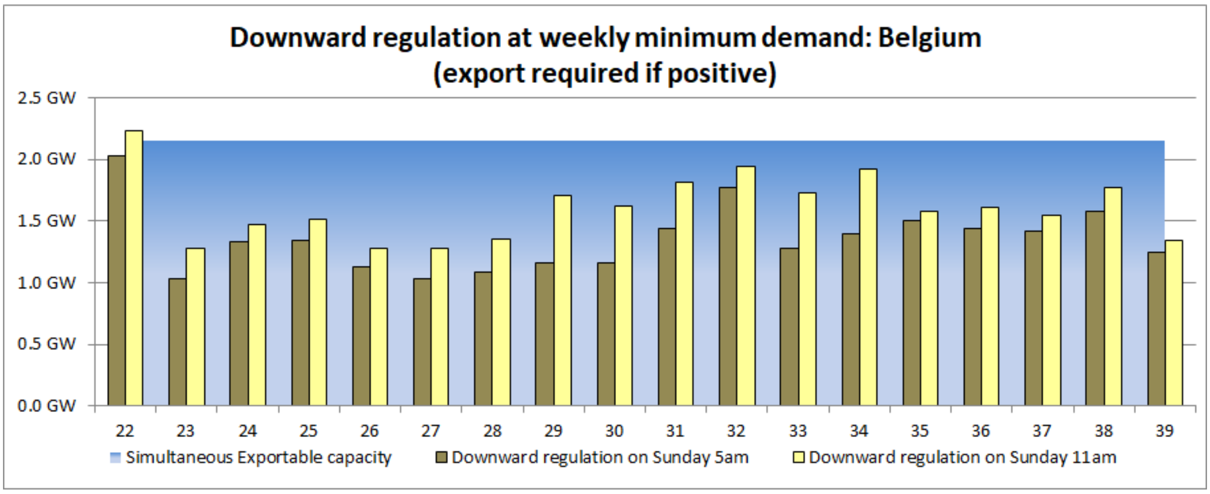
Increasing volumes of installed wind and PV combined with the high availability of nuclear park, as well as the maintenance of basin I of Coo (450 MW of pumping capacity unavailable from end of July until mid-October), leads to relatively high export needs for Belgium during most of the summer.

In the event of normal wind and solar conditions (50^{th} percentile) the excess energy could be expected only during weekends and the holiday periods. On these occasions, the export capacities should be sufficient.

In the event of high wind and solar conditions (95^{th} percentile) the excess energy increases. In most cases, the export capacity should be sufficient, however in some specific cases (mainly during the holiday period and in the afternoon) additional measures may be necessary (for example modulation on nuclear units, optimisation of export capacity). These additional measures (before curtailing the output of renewable energy sources) are not included in the data collection.







Belgium: Winter review 2018/2019

The Belgian control area expected considerable adequacy issues during the second half of 2018, when half of the nuclear units unexpected outages (Doel1, Doel2, Tihange2 and Tihange3) on top of those that were already planned (Doel4, Tihange1). This had never been seen before in Belgium, causing a 3000 MW capacity shortfall until mid-December (i.e. 25% of total installed dispatchable generation capacity in Belgium). In November, only 1 out of 7 nuclear plants were operational and in December, 4 were still out of service. To deal with the crisis, Elia actively participated in a taskforce that was led by the Ministry of Energy, and ran a weekly operational process reviewing the outlook for the upcoming week. Thanks to international support, reshuffled maintenance interventions and market efforts to find additional capacity (+750 MW), security of supply was maintained, despite the critical situation.

On an international level, Elia put a new procedure of "request for coordination" in practice to ensure that the Flow-Based market coupling would work according to the defined rules in case of adequacy problems.

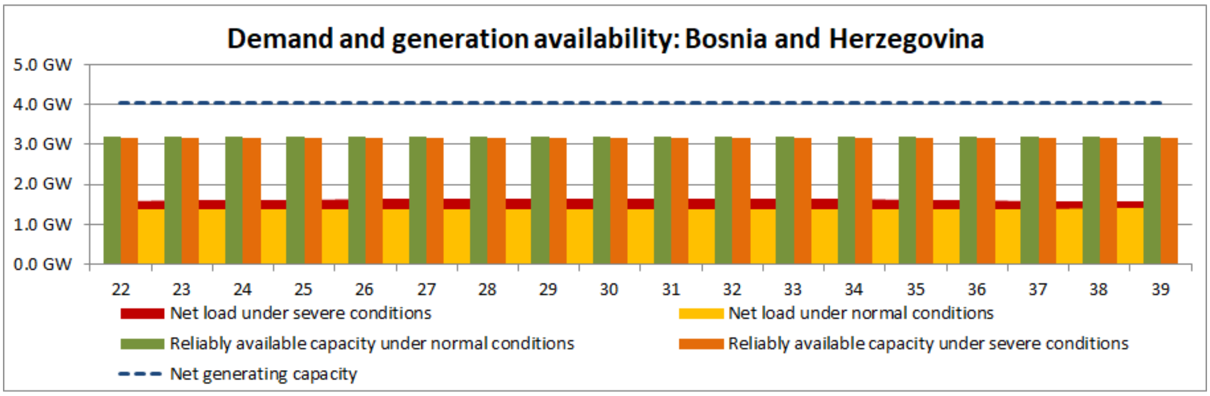
These combined exceptional actions helped Elia pass through the winter with unprecedented import levels up to 5300 MW.

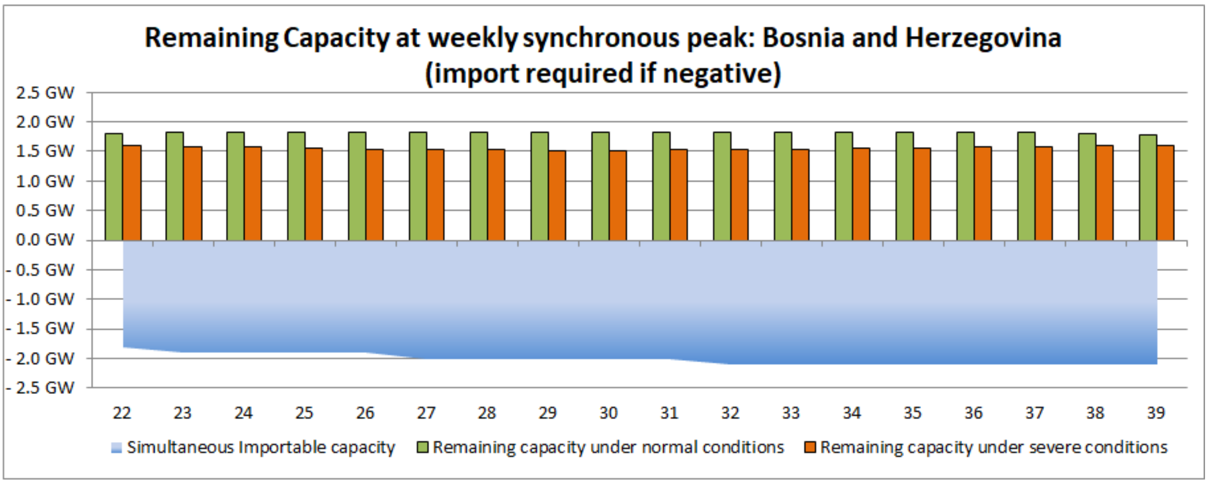
By end of January, it was clear that sufficient generation had returned to the system. Furthermore, Nemo cable with Great Britain started operations, and adequacy issues were deemed to be resolved.

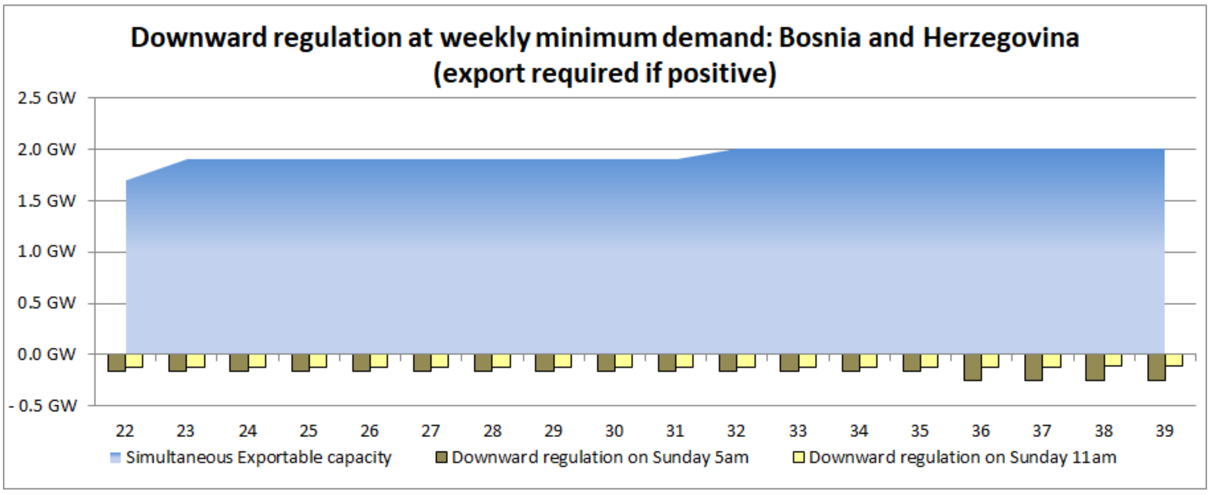
Bosnia and Herzegovina: Summer outlook 2019

Potential critical periods and foreseen countermeasures

No adequacy or downward regulation issues are expected in Bosnia and Herzegovina for the upcoming summer. No increase of demand is expected.







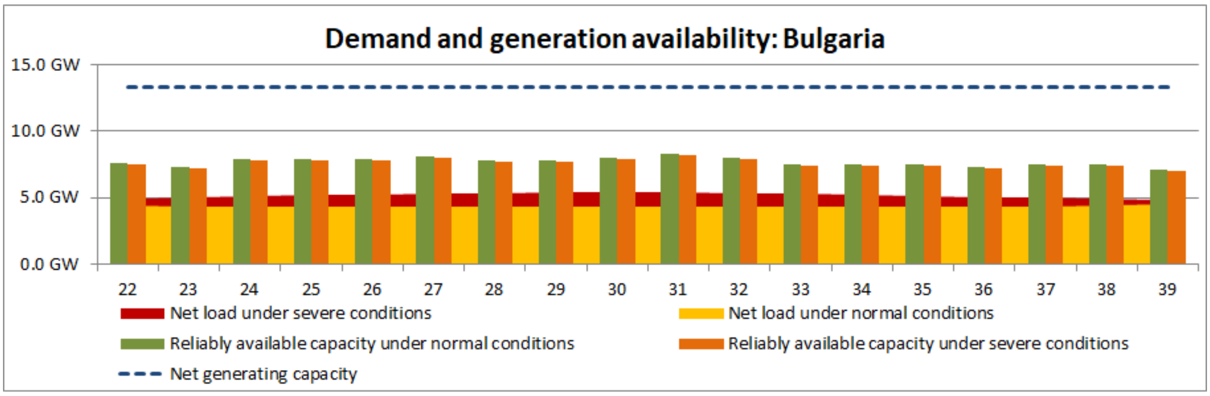
Bosnia and Herzegovina: Winter review 2018/2019

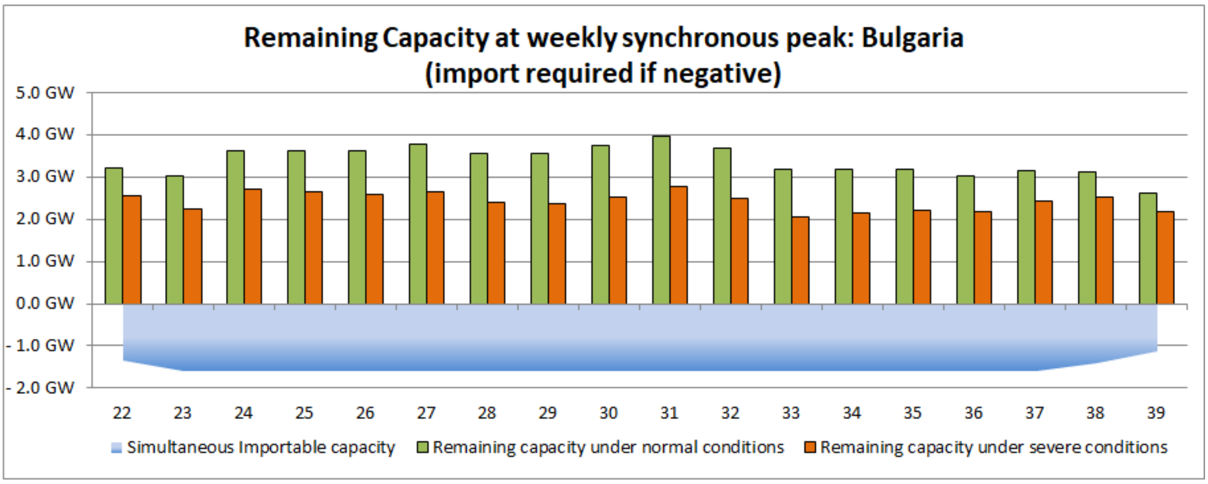
In winter 2018/2019 there were no significant unusual events in the electric power system of Bosnia and Herzegovina. A maximum hourly consumption of 1994 MW was registered on 18 December at 18:00. Total electricity consumption was similar to that of winter 2017/2018, but significantly lower than winter 2016/2017 because of more favourable weather conditions.

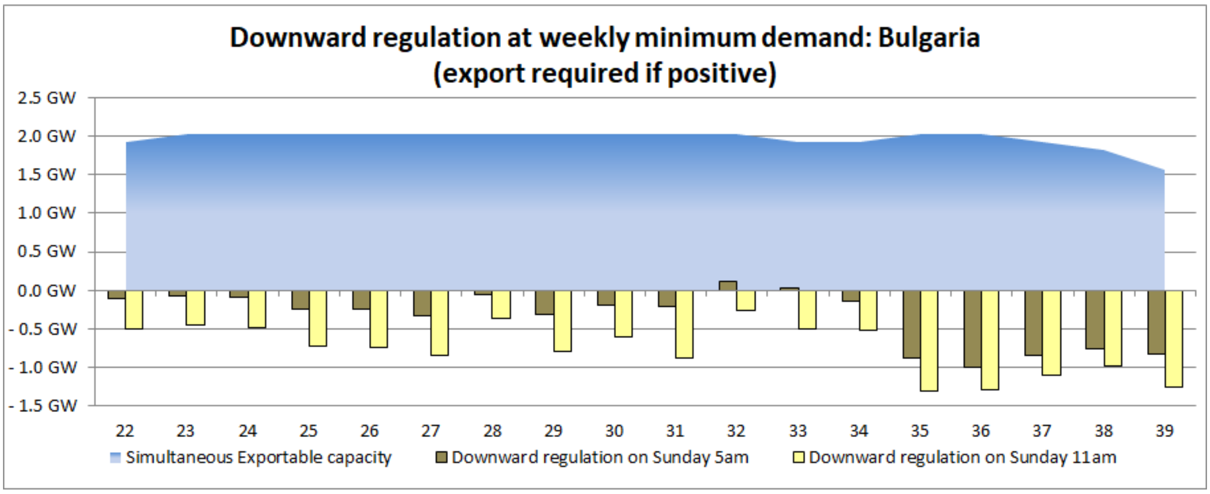
Bulgaria: Summer outlook 2019

Potential critical periods and foreseen countermeasures

As usual, no adequacy or downward regulation issues are expected in Bulgaria for the coming season.







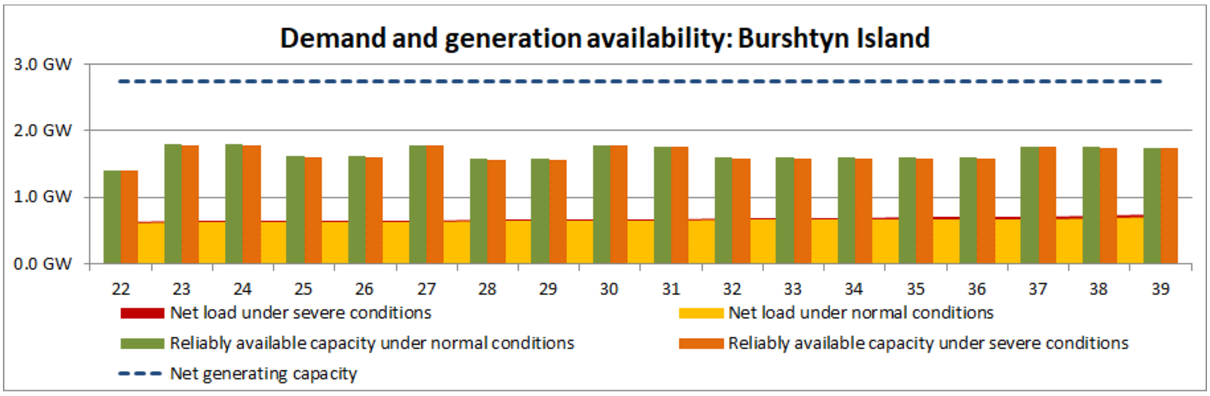
Bulgaria: Winter review 2018/2019

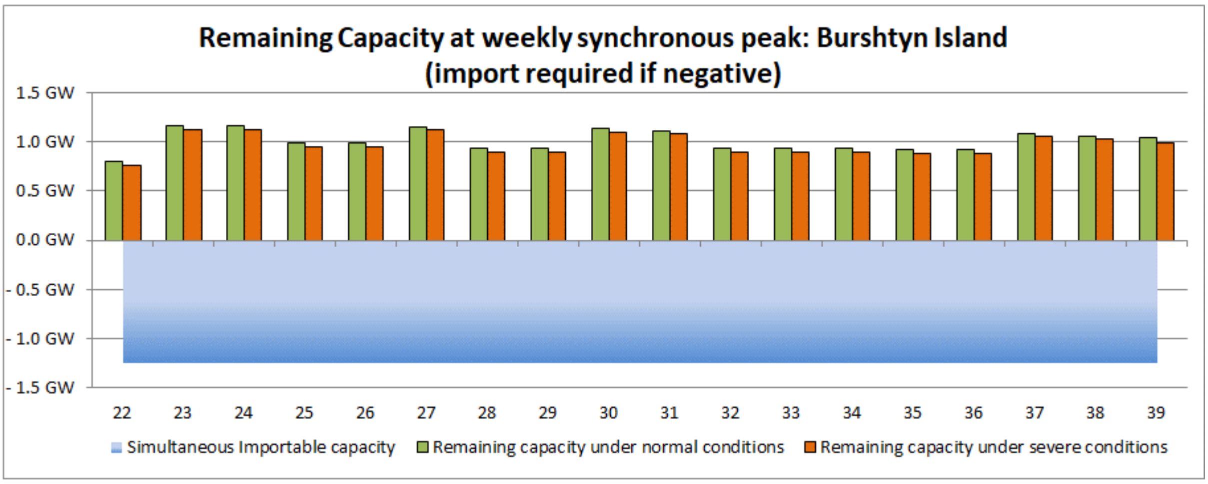
Heavy snowstorms in late January 2019 caused roadblocks and power disruption in the southern mountainous parts of Bulgaria, and a number of small towns and villages. Many power lines, both in distribution and transmission grids, were torn and disconnected. TSO and DSO emergency teams provided a temporary solution with diesel generators in some isolated regions while working intensively to restore connection to the power system.

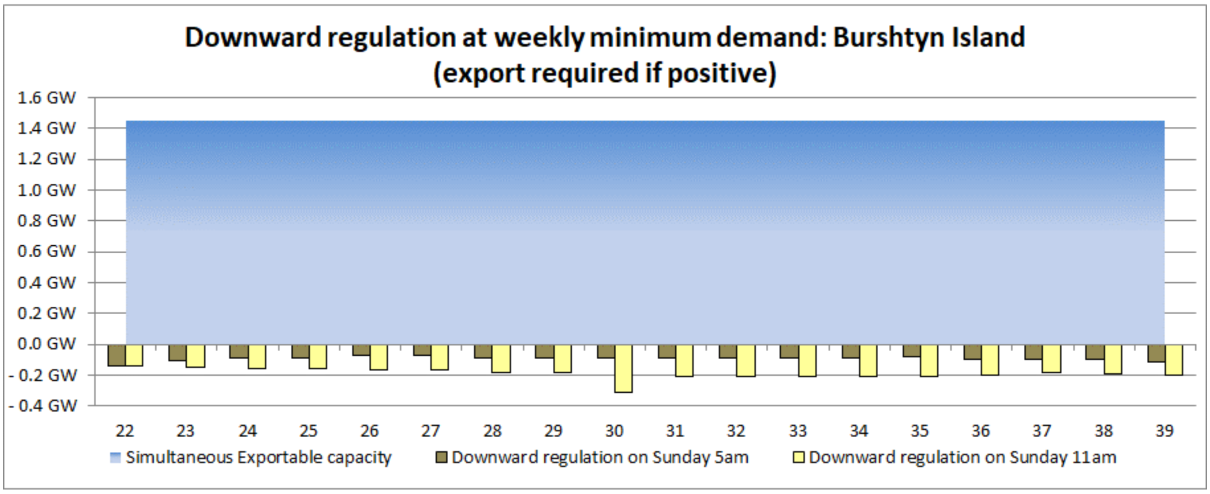
Burshtyn Island: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







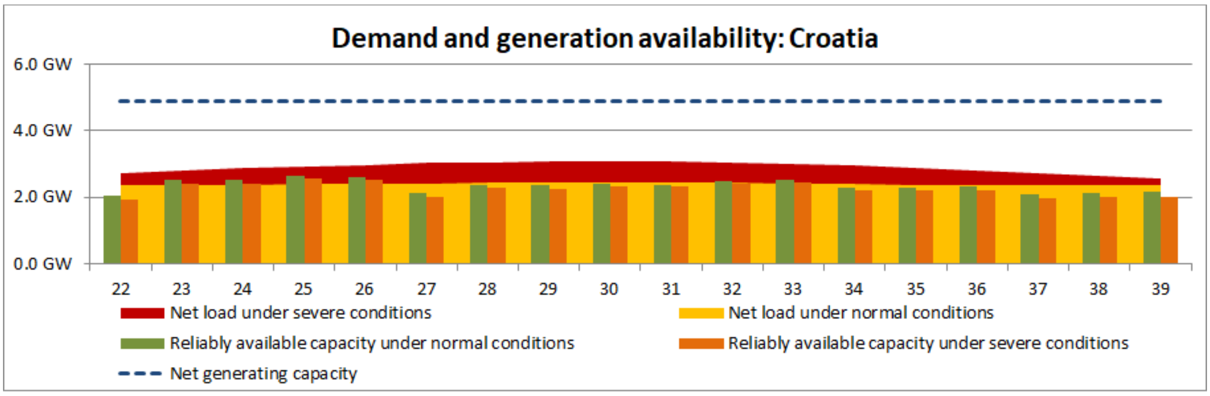
Burshtyn Island: Winter review 2018/2019

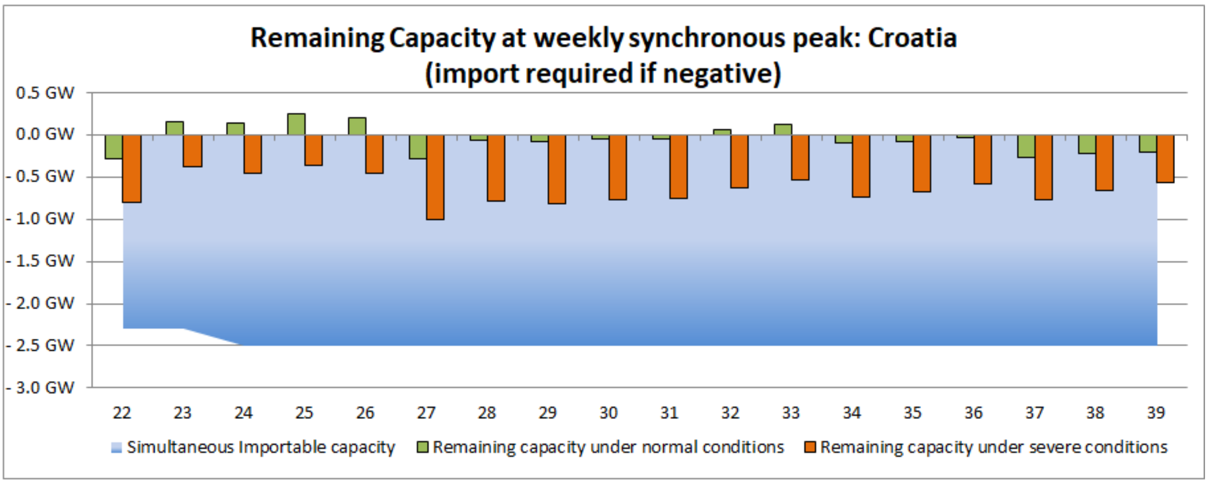
No adequacy or downward regulation issues were identified during the past season.

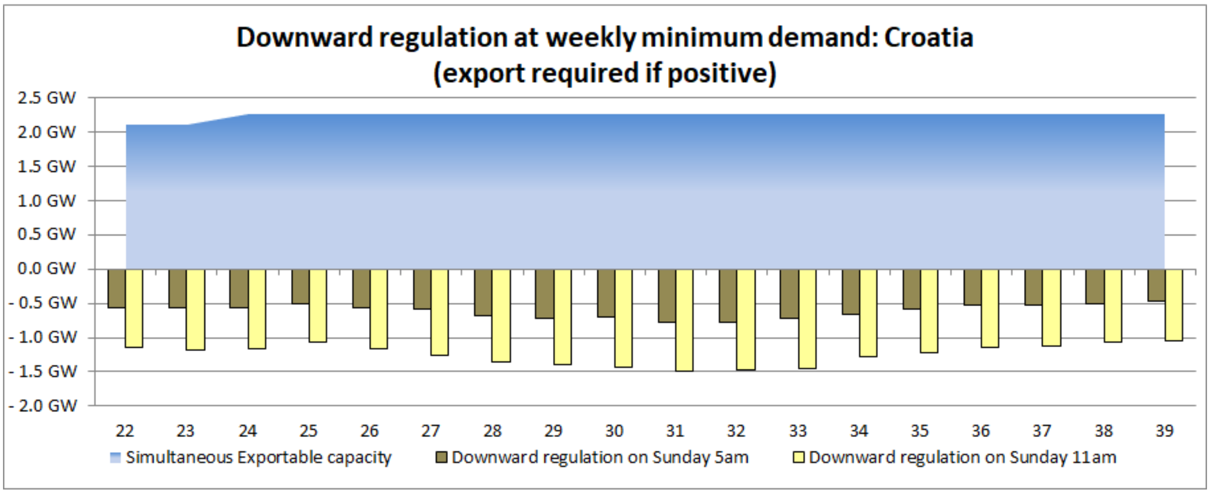
Croatia: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Croatia: Winter review 2018/2019

Winter 2018/2019 in Croatia was rather mild, however, there was little precipitation. The highest demand reached 2783 MW, recorded on 19 December 2018 at 18:00 (local time). Average demand–2064 MW–was 1.6% lower than in winter 2017/2018. Imports supplied between 30% and 60% of demand.

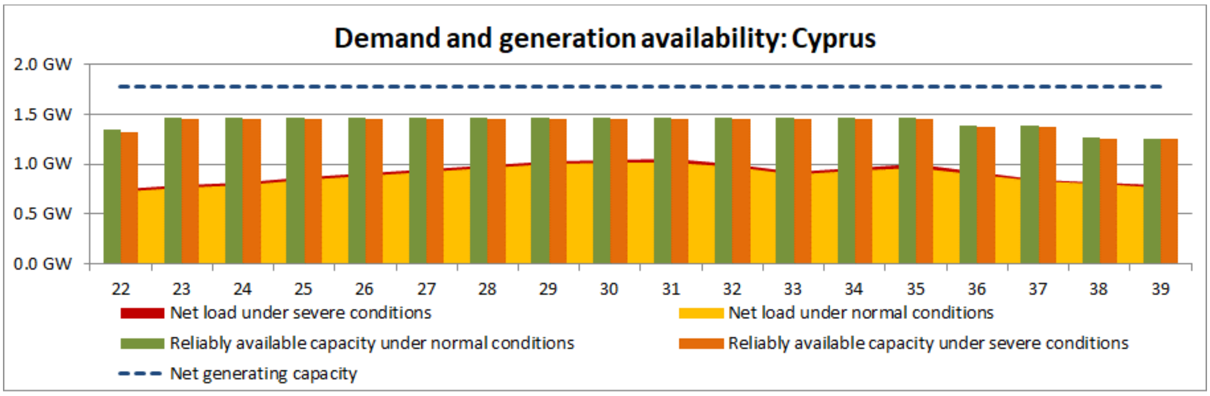
Hydro power plant generation recovered only from the beginning of February 2019. Since then, some periods have been recorded in which Croatia was a net exporter.

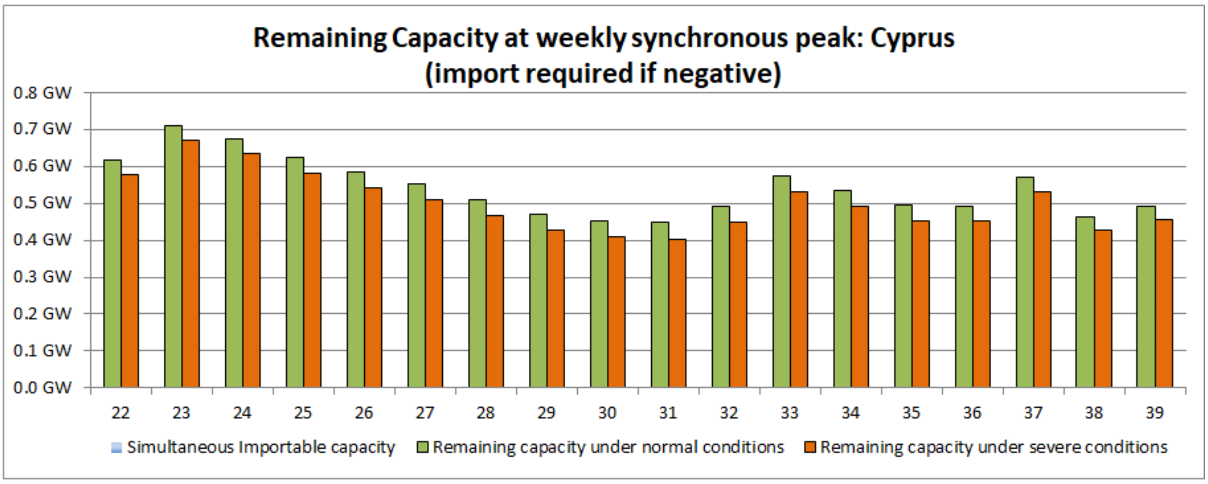
No adequacy or downward regulation issues were identified during the past season.

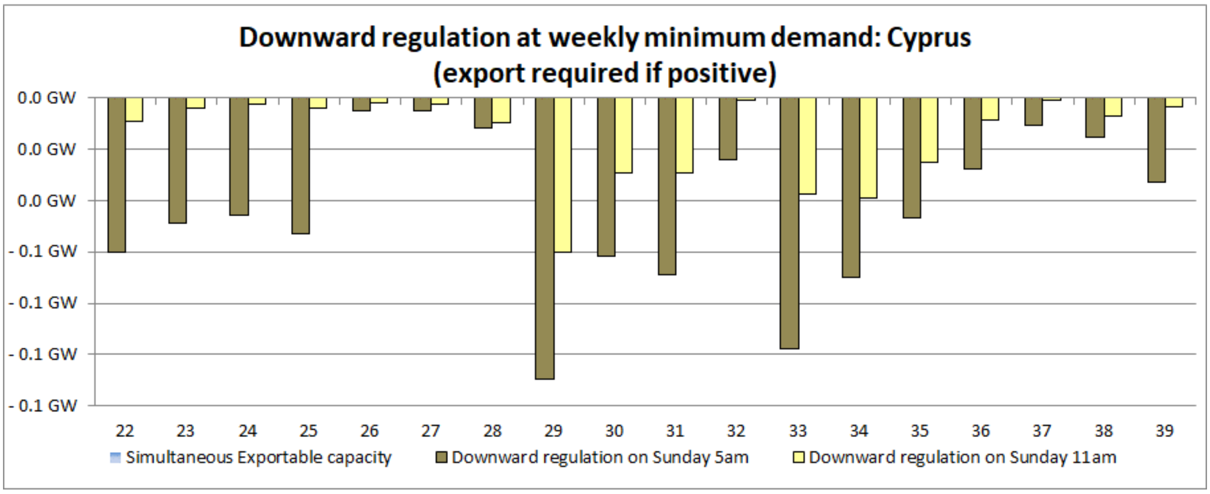
Cyprus: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







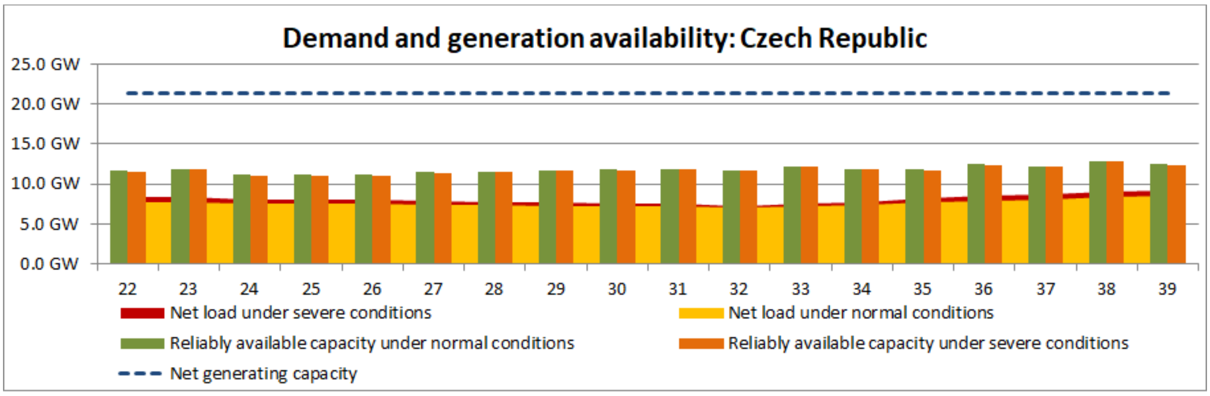
Cyprus: Winter review 2018/2019

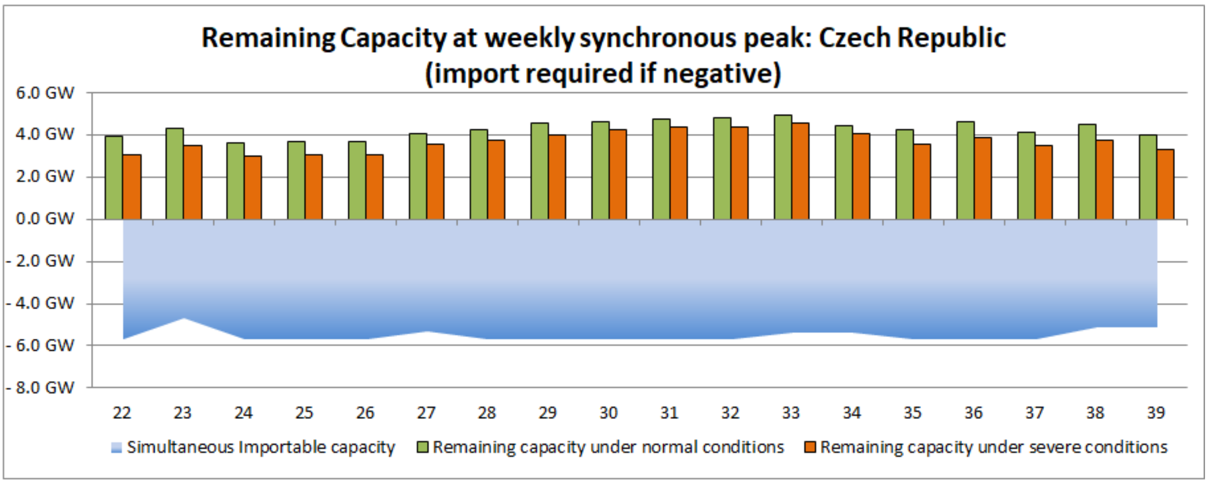
No adequacy or downward regulation issues were identified during the past season.

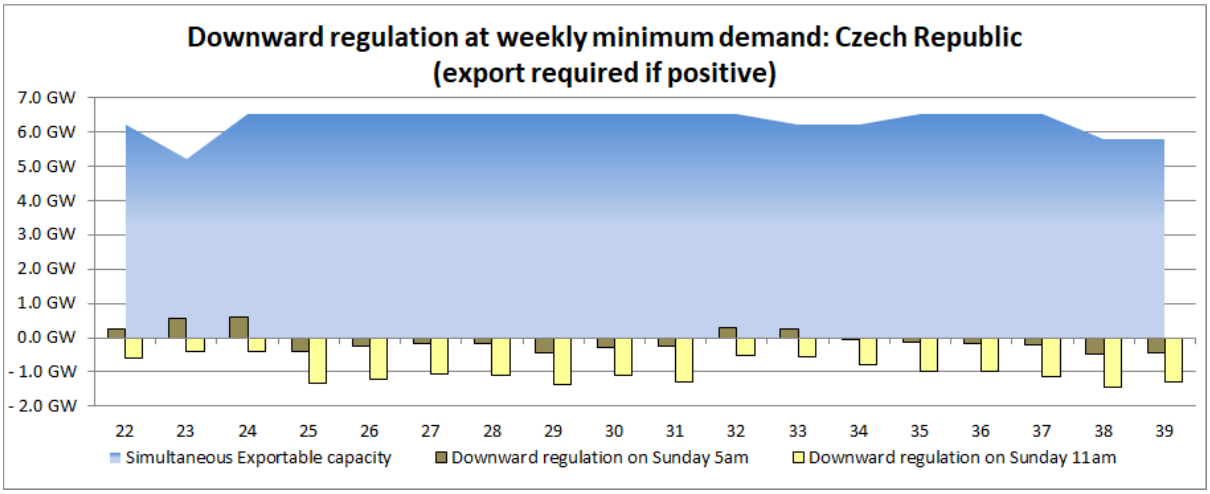
Czech Republic: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Czech Republic: Winter review 2018/2019

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

Denmark: Summer outlook 2019

Energinet (TSO in Denmark) expects no risk for system adequacy. Some maintenance is planned on power plants and some grid elements that affect the capacity but should not pose any risk for system adequacy under normal conditions. Under severe conditions, some import may be required.

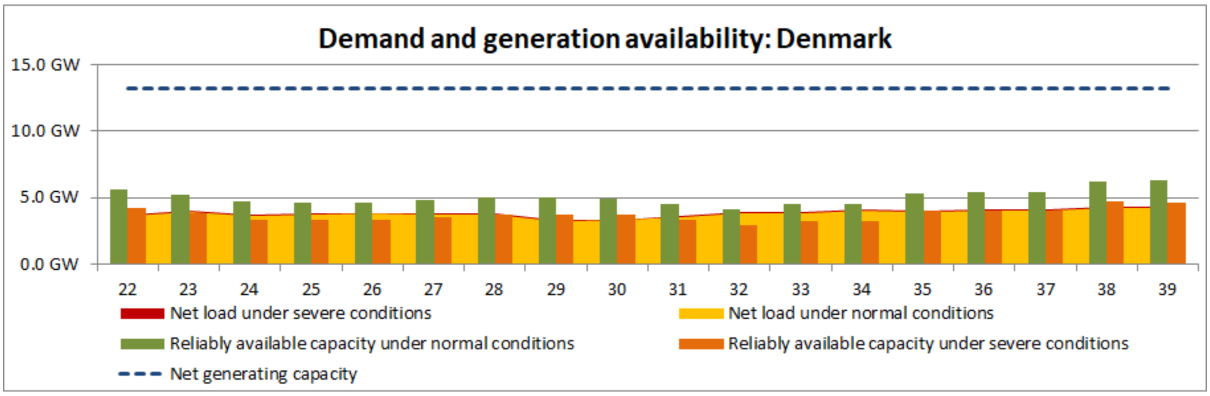
Potential critical periods and foreseen countermeasures

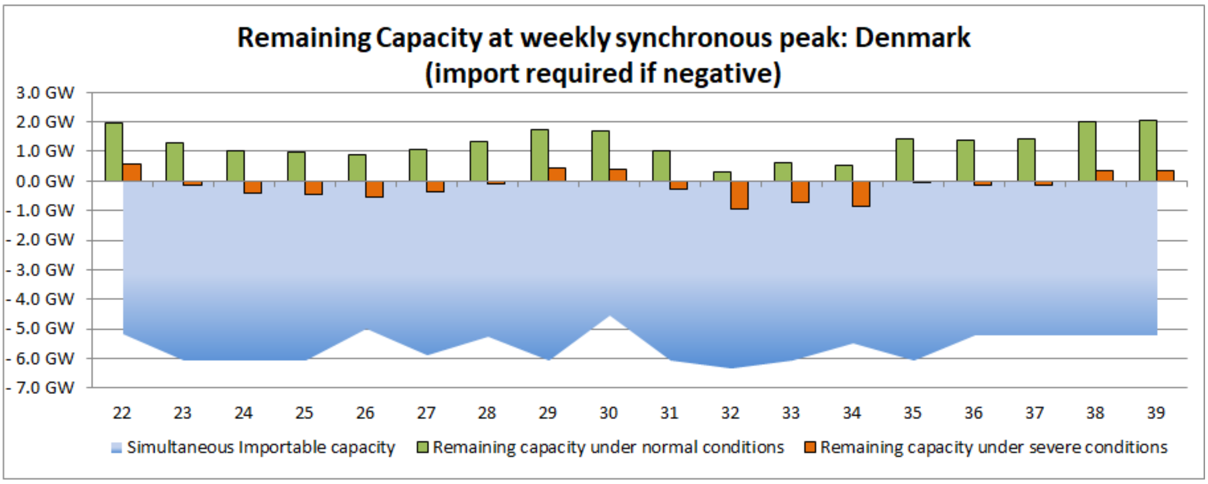
The adequacy in both Danish bidding zones–Western Denmark (DK1) and Eastern Denmark (DK2) –is expected to be ensured in summer 2019.

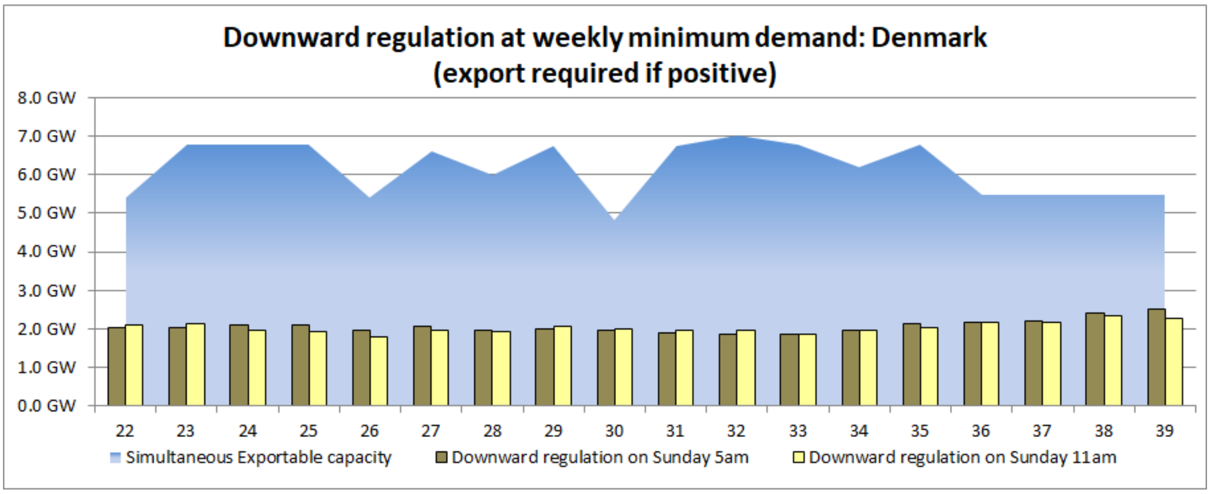
In DK1 there will be work on 400 kV lines which connects this bidding zone with Germany (DK1–DE). This will result in some restriction (need for countertrade) on the border connection. Further on, some maintenance is planned on some of the 400 kV lines in DK2. This maintenance will limit cross–border capacity between Denmark and Sweden (DK2–SE4). No impact on the adequacy is expected.

In autumn 2019, the Cobra and the Kriegers Flak connections will commence operation. The Cobra connection is a new border connection between Denmark and the Netherlands (DK1–NL). Kriegers Flak is a combined border connection and offshore wind farm. Kriegers Flak is a connection between Denmark (DK2) and Germany (German TSO 50Hertz). Therefore, the trading capacity will increase between these two areas going forward.

Energinet expects a large amount of countertrade. The common agreement signed 1 January 2019 between TenneT Germany (TSO in Germany, TTG) and Energinet, which increases guaranteed cross–border capacity in the market from 900 MW to 1000 MW, is expected to cause an increase of countertrades. Energinet expects to down-regulate the countertraded amount in DK1 and/or DK2. Furthermore, guaranteed cross-border capacity will increase to 1300 MW if the transmission system in Denmark is capable of accommodating such exchanges.







Denmark: Winter review 2018/2019

Winter 2018/2019 provided rather favourable conditions for wind production in Denmark, which amounted to a total of 5289 GWh in November, December, January and February (c.f. 5266 GWh in winter 2017/2018). Wind production is typically much higher during the winter than during the summer due to the general weather conditions.

In general, the high level of wind production during the winter months increases the number of hours with negative prices on the day–ahead electricity market. Thus, negative prices were recorded in 66 hours in DK1 and in 63 hours in Eastern Denmark DK2 during the winter 2018-2019. This is a small increase compared to winter 2017/2018 when electricity prices were negative for 52 hours in Western Denmark (DK1) and 48 hours in Eastern Denmark (DK2).

There have only been minor changes to average transmission capacities in winter 2018/2019 compared to winter 2017/2018. Most notably, the average export capacity from Western Denmark to Germany (DK1→DE) has increased from 46.5% to 56.6% of the NTC. A "Joint declaration" between Denmark and Germany ensured this increase in day-ahead capacity. However, much of the available capacity provided by the joint declaration is subsequently countertraded by use of special regulations.

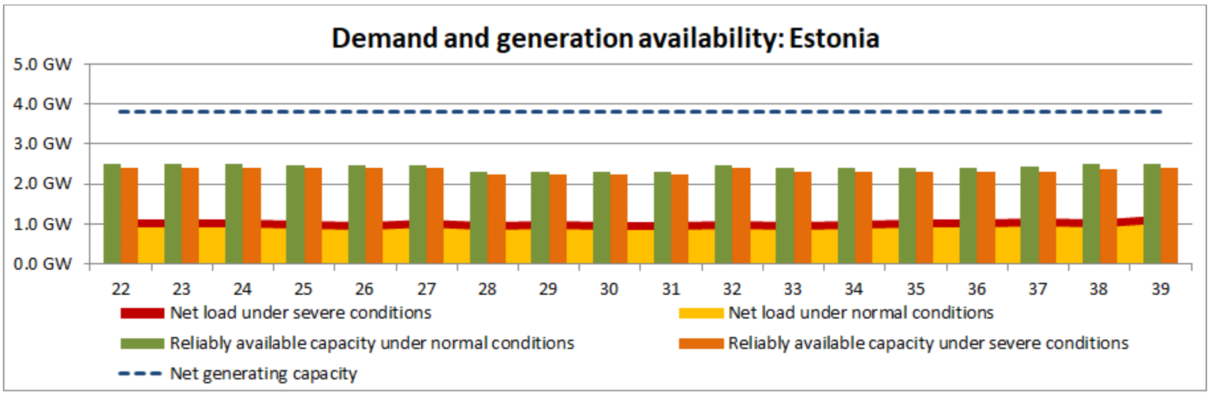
Moreover, the average export and import transmission capacity from Eastern Denmark to Sweden (DK2→SE4) was slightly higher than winter 2017/2018, whereas the export and import transmission capacity from Western Denmark to Norway (DK1→NO2) was slightly lower. The difference in average transmission capacity compared to winter 2017/2018 was mainly due to higher maintenance works on the DK1–NO2 connection and lower maintenance works on the DK2–SE4 connection.

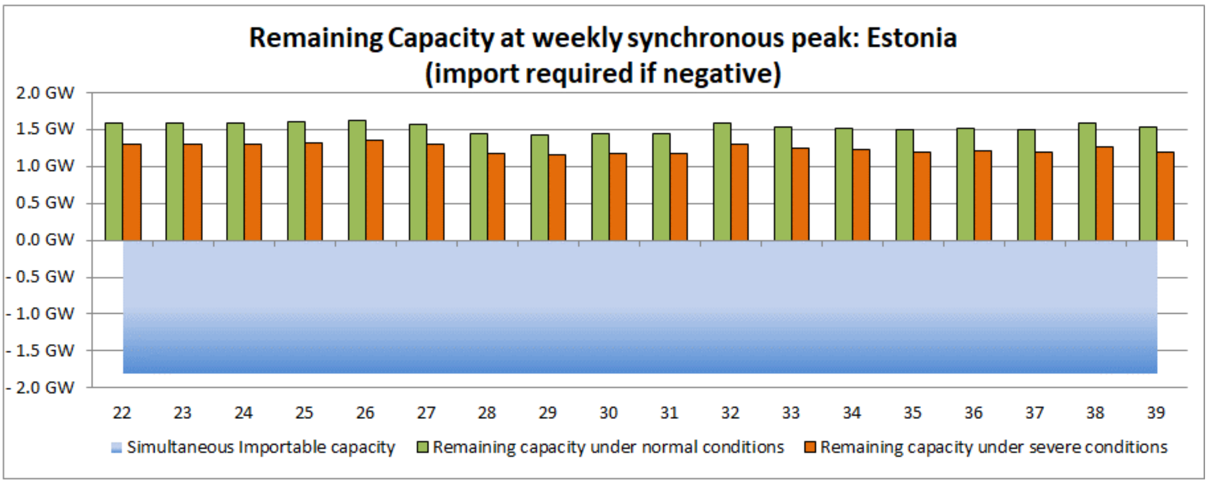
Despite the favourable conditions for wind production, winter 2018/2019 was characterised by high average prices on the day-ahead electricity market compared to the two previous winter seasons. Usually, long–term price movements may be attributed to underlying factors such as the demand for coal and the supply of carbon emission allowances or changes in market characteristics. Recently, the price on carbon emission allowances has increased, which may be a significant driver for the increase in the average electricity price.

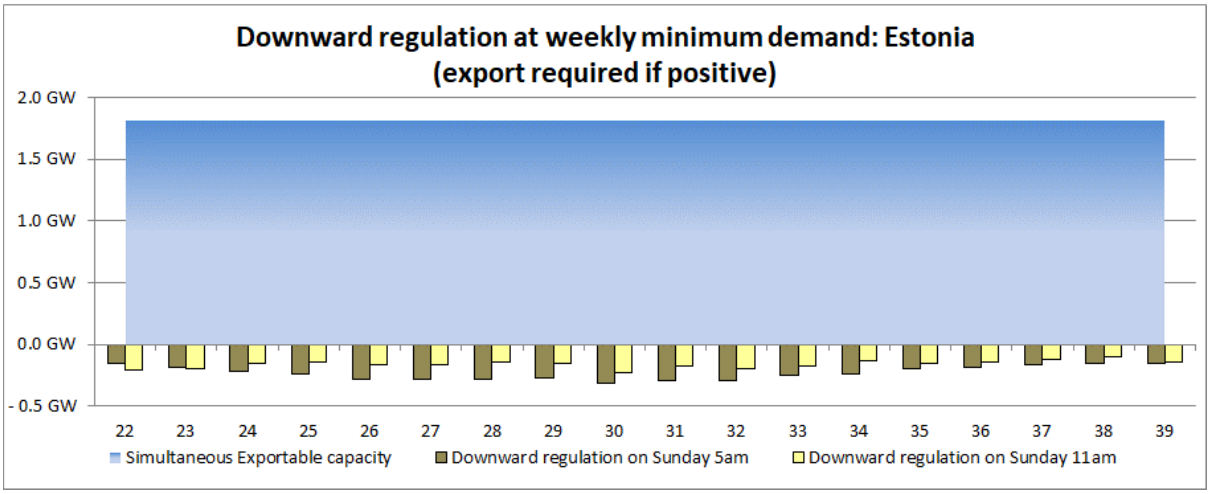
Estonia: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Estonia: Winter review 2018/2019

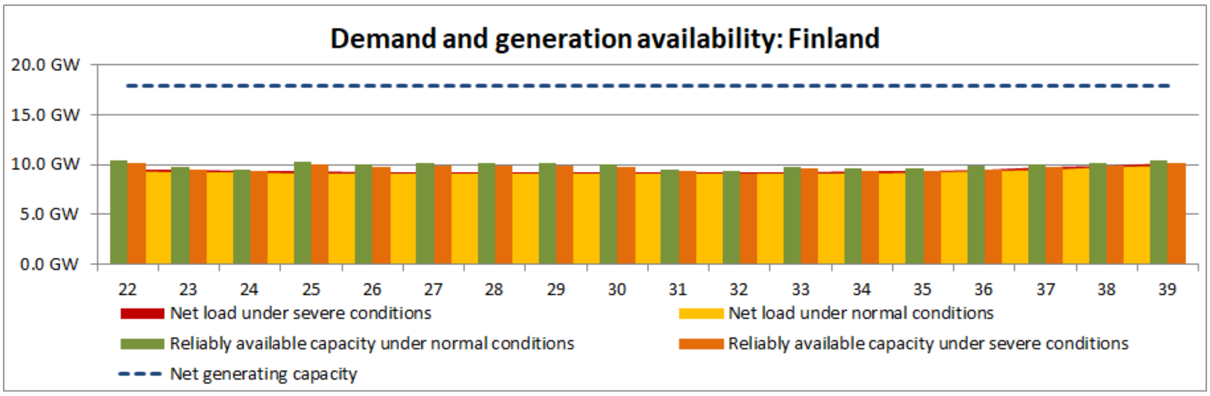
No adequacy or downward regulation issues were identified during the past season.

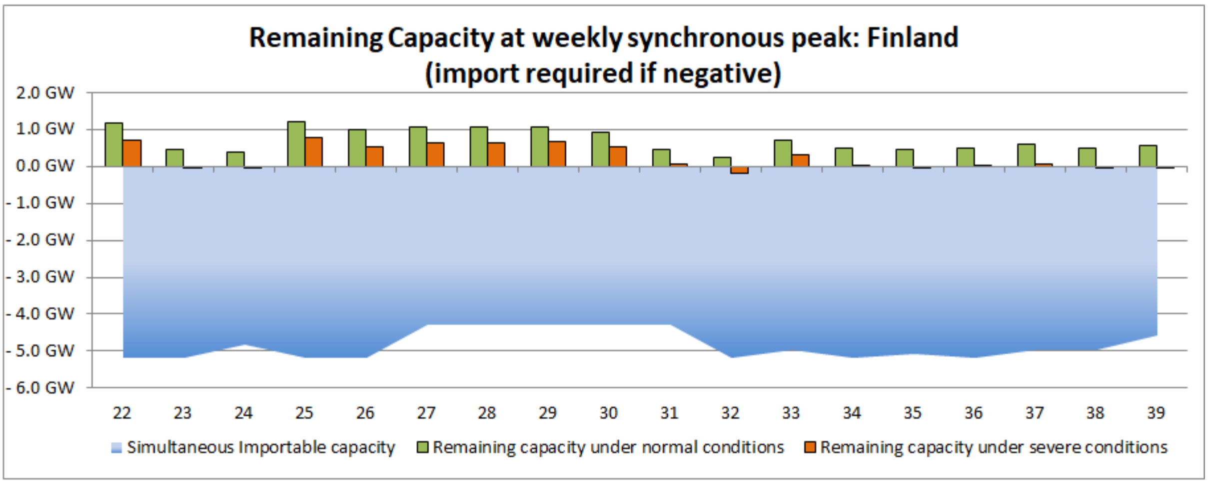
Finland: Summer outlook 2019

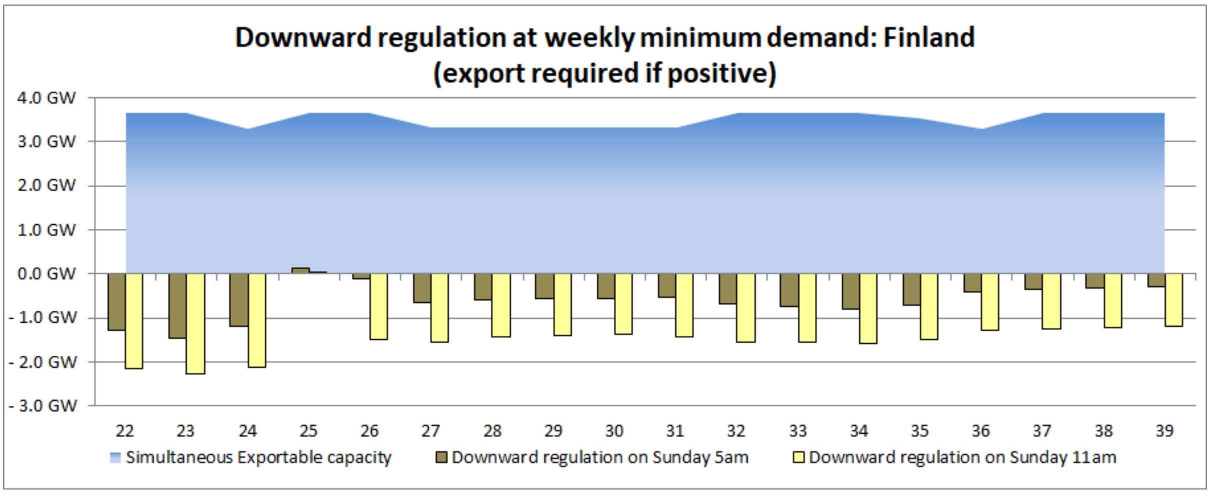
Typically, summer peak demand in Finland is 60% to 70% of the winter peak demand and therefore summer is not as critical from the adequacy perspective as winter. However, summer is a high season for power plant maintenance and overhauls and that is why there is less generation capacity available in the summer than in winter. In addition, there is some maintenance on interconnections during the summer season.

Nevertheless, demand can be met with available generation capacity and there is also a high level of import capacity available.

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







Finland: Winter review 2018/2019

No adequacy or downward regulation issues were identified during the winter 2018/2019 in Finland.

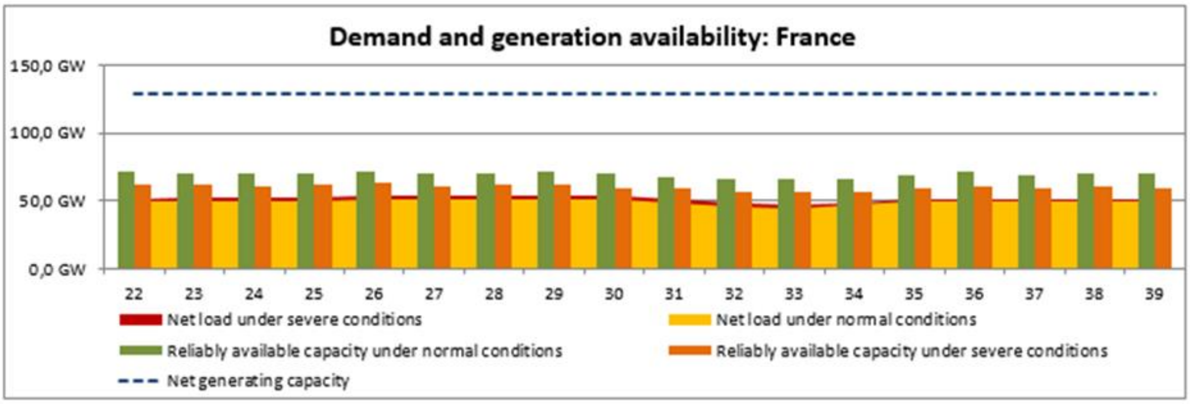
Peak demand reached 14.5 GWh in late January 2019. It was slightly higher than winter 2017/2018, when temperatures dropped below the historical average.

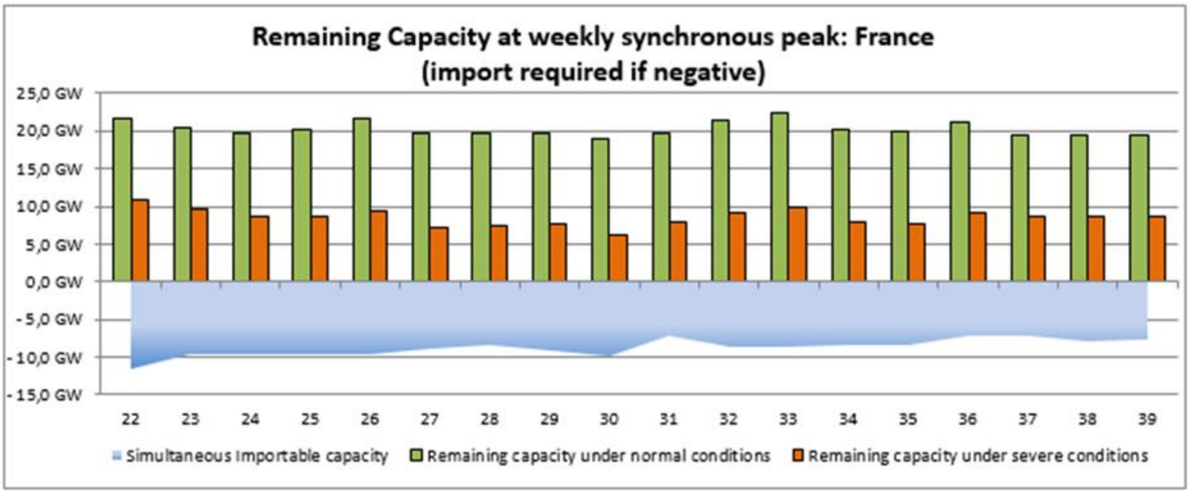
France: Summer outlook 2019

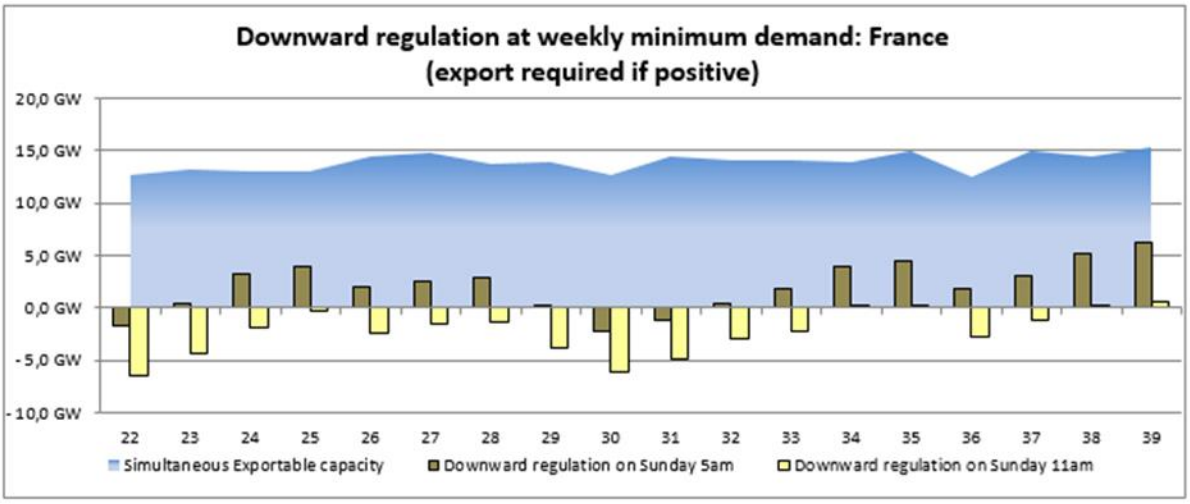
Potential critical periods and foreseen countermeasures

The most constraining period for severe conditions is week 30, when there is a high level of nuclear maintenance. A heatwave this week might result in a combination of increased demand and further constrained nuclear generation availability (due to environmental constraints for use of cooling water). Nevertheless, national generation margins should remain positive during the summer, with no need to import power for adequacy reasons.

The most critical period for downward regulation is from the end of August until end of September, due to numerous nuclear power plants that must run close to their maximum power. Up to 6 GW of exports might be needed, which is compliant with typical exportable capacity of 14 GW. In case of an excess of power in France, some nuclear power plants might be requested to completely stop generation. These situations are especially likely during low consumption periods, like weekends. Nevertheless, this situation is typical for every summer.







France: Winter review 2018/2019

General comments on past winter conditions

Despite a season–consistent January, the winter 2018/2019 ranks among the 10 warmest winters since the beginning of the 20th century. The average temperature was 2°C above normal in December and February. Despite some very cool periods–especially in January–France has not experienced a real cold spell this winter.

The French balance of exchanges stayed globally oriented to export during most of the winter and there were no adequacy issues to be reported.

Specific events and unexpected situations that occurred during the past winter

No specific events or unexpected situations of note for the past winter

Germany: Summer outlook 2019

The German TSOs do not expect significant problems with the generation-demand balance for the coming summer considering the technical availability of power plants. The German demand can be covered with the available capacity even under severe conditions. Therefore, Germany is not expected to be dependent on imports to maintain adequacy.

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 considered by the German TSOs and 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.

Potential critical periods and foreseen countermeasures

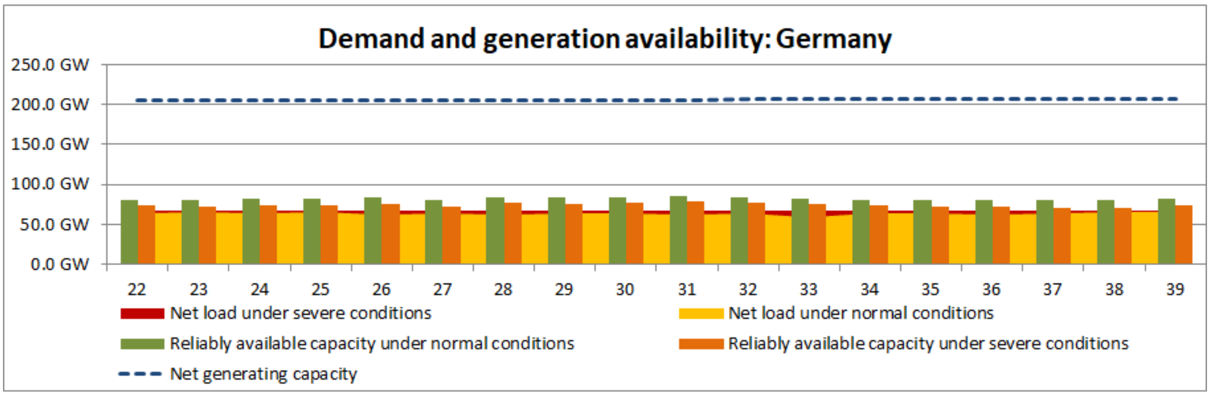
A heat wave (longer hot and dry period) could constrain power plant availability because of problems with the cooling water supply and high water temperature or fuel transporting problems due to low river levels.

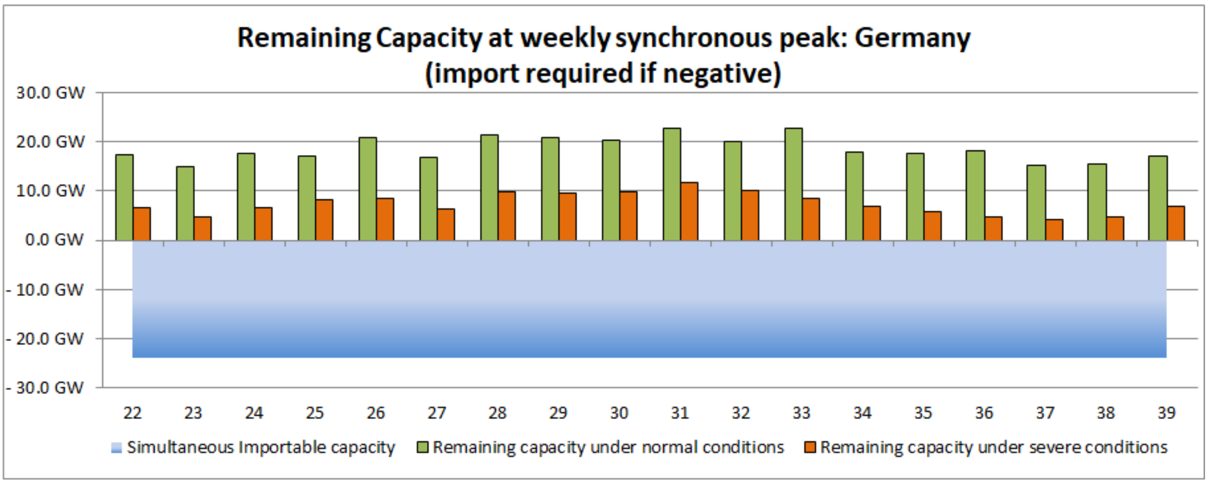
Extensive conventional power plant unavailability abroad can also have effects on the situation in Germany.

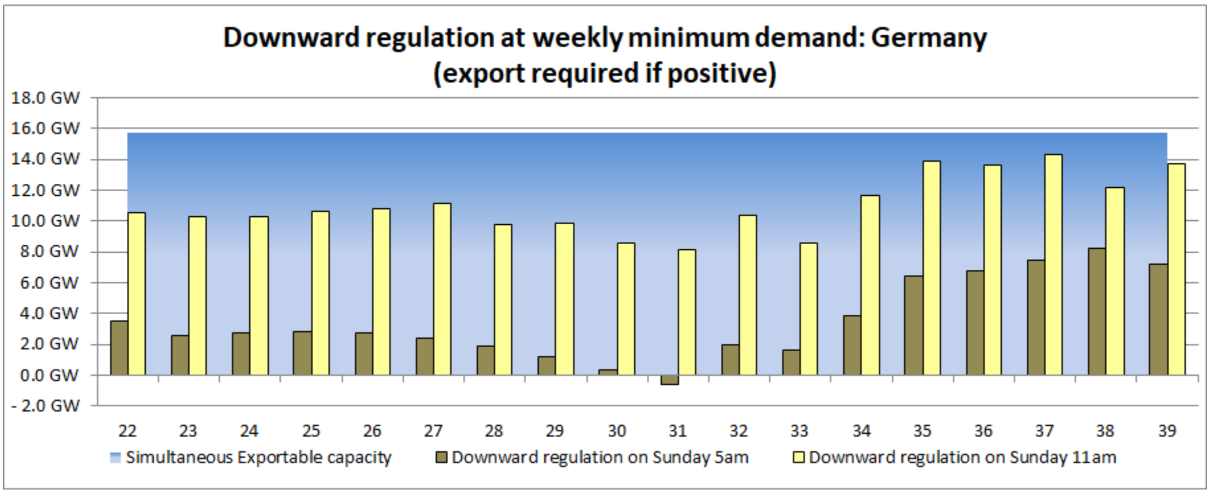
No critical periods for maintaining adequacy are expected.

Potentially, the increasing PV generation could lead to high power flows in the German transmission system. In addition, a situation with high wind generation in the north of Germany and a low PV generation in the south could cause high power flows.

In addition, the time around Whitsunday could be critical concerning voltage problems in case of low demand, no PV generation in the south of Germany but a moderate generation of wind energy. In addition to market-based redispatch, grid reserve power plants could also be used to mitigate voltage problems, which can occur during revisions of other power plants. In periods with high renewable generation and low (regional) demand, high power flows on interconnections are expected. Situations might occur in which regional infeed management is necessary to solve overload problems. Nevertheless, no critical situations are expected.







Germany: Winter review 2018/2019

According to the German Weather Forecast Service (Deutscher Wetterdienst, DWD), December 2018 in Germany was generally comparatively mild, with significantly high precipitation and very little sun compared to average values. Temperatures were colder in January, however milder compared to average values, with precipitation above average. In Alpine regions, extraordinary heavy snowfall occurred, lasting over several days.

In winter 2018/2019 there were events concerning system adequacy. Due to the very dry summer in Germany, the water levels in the river Rhine were very low, limiting hard coal transportation. In the last quarter of 2018, the ship transportation of hard coal was impossible for several weeks. Alternative transportation by railroad was not sufficient. Freight trains could deliver only 50% of the requested freights for several weeks. Due to this lack of transportation capacity of Deutsche Bahn (German railway operator), alternative suppliers had to be engaged. TransnetBW ordered hard coal deliveries via freight train from Poland. A creation of a stockpile of hard coal was reserved for redispatching in the harbour of Karlsruhe. High hard coal supply was needed due to the high non-availability of nuclear power plants in Belgium, which led to attractive market prices for hard coal power plants. The coal stock of the power plants in Baden-Württemberg dwindled rapidly and recovered only at the end of 2018 when Rhine water levels rose and electricity demand was low during the Christmas and New Year holiday period.

This situation had no impact on adequacy. In case of longer draught there would have been a significant risk of:

- Non-availability of the hard coal power plants
- Increased import need of the TransnetBW control area
- Overloading of grid elements due to high imports and the non-availability of redispatching

Great Britain: Summer outlook 2019

Most critical periods for maintaining adequacy margins and countermeasures

Our analysis uses two demand definitions; a normal condition that is based on 30 years' historical weather data, and a severe condition which is normal condition plus an additional 1500 MW of demand.

For normal conditions, peak demand during the summer is anticipated to be 37.6 GW on 25 September 2019 (week 39).

These are the interconnector maintenance works planned for summer 2019:

- Interconnector France–Angleterre (IFA) between 4 June and 6 June (week 23); and between 17 June and 28 June (week 25 and week 26). This will limit cross–border capacity between Great Britain (GB) and France (FR) to 1 GW (from typical 2 GW) during maintenance period;
- BritNed Interconnector will be under maintenance for 5 days, from 16 September (week 38);
- East West Interconnector (EWIC) will be under maintenance for 3 days, from 19 August (week 34);
- Moyle Interconnector will be under maintenance for 9 days, from 12 June (week 24 to 25);
- NEMO link to Belgium will be under maintenance for 12 days, from 23 September (week 39 to 40).

Under normal conditions, expected lowest national generation margin is 8.2 GW on 11 September (week 37) out of which 5.0 GW could be exported with available cross–border capacities.

Under severe condition factors, the expected lowest national generation margin is 4.1 GW on 11 September (week 37). This margin would be the minimum power available for exports.

Generation and cross–border capacity is expected to be sufficient to meet peak demand and requirements to ensure operational security margins this summer.

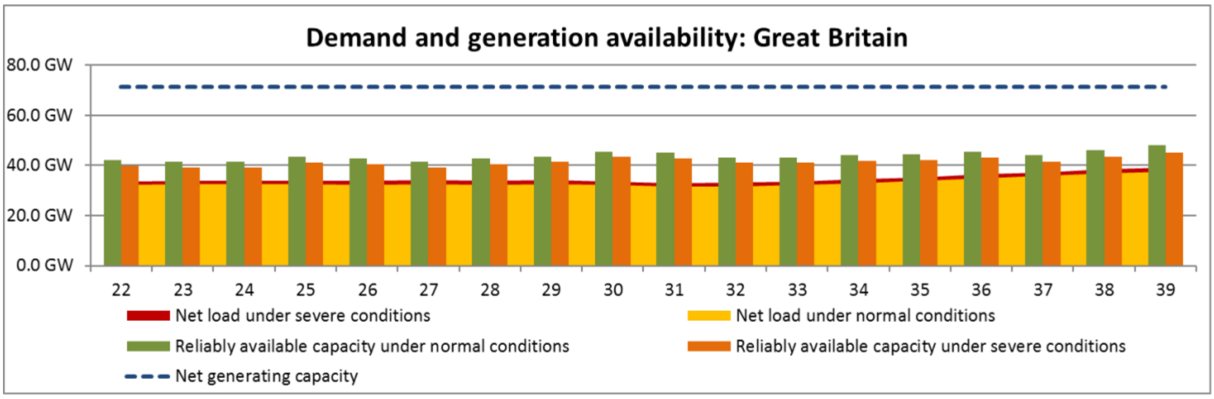
PV continues to impact the residual demand profile. Solar PV and wind generation connected to the distribution networks has increased to 13.1 GW and 6.2 GW respectively. This makes residual demand forecasting challenging.

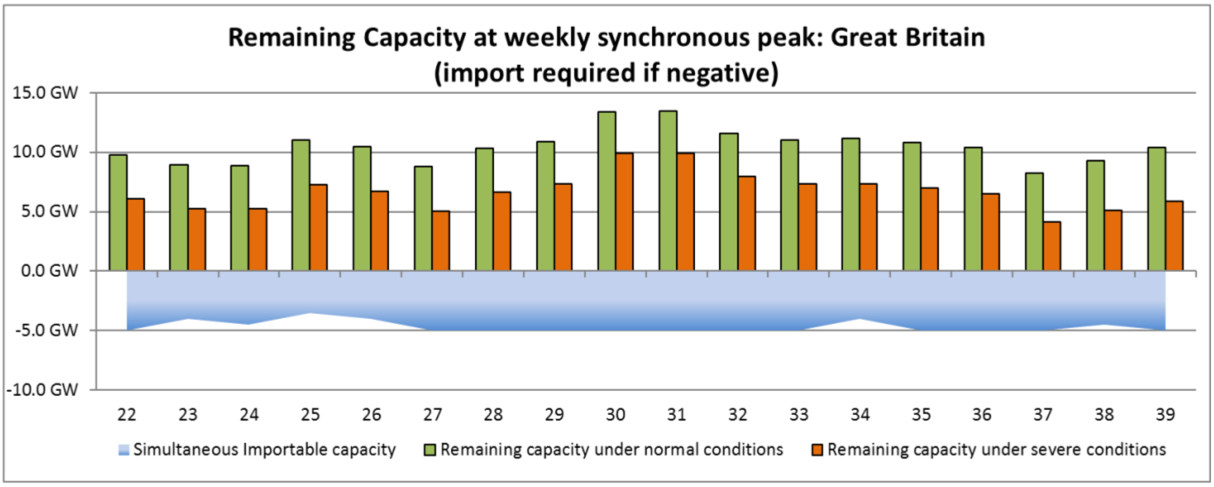
Most critical periods for downward regulation and countermeasures

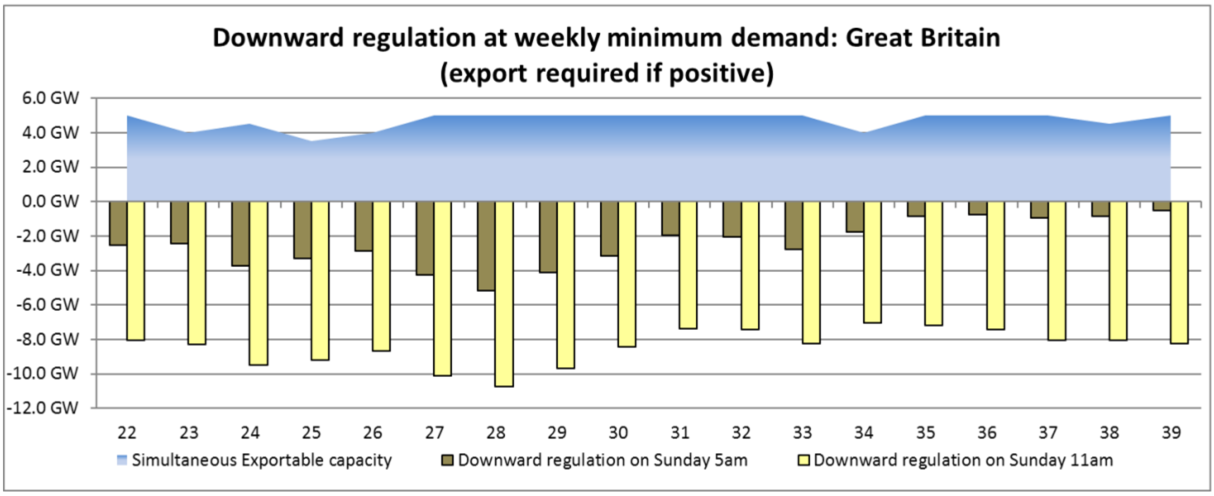
Minimum demand is expected to be 17.9 GW on 31 July (week 31).

The lowest downward regulation margin is expected to be 0.5 GW on 25 September (week 39). This margin suggests that no curtailments would be necessary, but the margin is tight. The downward regulation margin is expected to be below 5.2 GW throughout the summer.

Increased supply and demand variability–especially pronounced in periods of low demand and high renewable generation–can create operational challenges leading to issues such as Negative Reserve Active Power Margin (NRAPM) and high Rate of Change of Frequency (ROCOF). As a result, we may need to take additional actions, such as curtailing renewable, in order to balance the system.







Great Britain: Winter review 2018/2019

General comments on past winter conditions

Great Britain has had reliable generation supply this winter and transmission system demand broadly similar to forecast. Most of January was colder than normal which resulted in demand reaching 46.9 GW on 29 January 2019.

Specific events and unexpected situations that occurred during the past winter

Temperatures were 0.8°C higher than average. Most of January was colder than normal. The highest demand was recorded on 29 January 2019. It reached 46.9 GW after the 2.3 GW of market–based Customer Demand Reduction.

Cross-border flows from France to Great Britain on some days were lower or even in the opposite direction than typical. For some days, exports from Great Britain to France were recorded (between 12 December and 17 December and between 21 January and 28 January). The same trend was recorded on cross–border flows from Netherlands and Great Britain.

The NEMO Interconnection, connecting Belgium and Great Britain, began operations on 31 January 2019.

The highest wind production recorded was 12.5 GW on 2 January 2019 at 21:00.

No major maintenance or forced outages were recorded on any of the interconnectors (French interconnector, EWIC to Ireland, Moyle interconnector to Northern Ireland, BritNed interconnect to Netherland and NEMO interconnect to Belgium (from 31 January 2019).

Greece: Summer outlook 2019

The Greek system is expected to be in balance in the coming summer period (2019). The maintenance of indigenous national generation is not high and the estimated good hydraulic storage of hydropower stations suggests no risk for adequacy in the Greek power system, even under severe weather conditions.

In very warm periods during the summer, fire incidents are probable, which may affect the transmission network. These extreme contingencies may result in some local loss of access to the power system.

Additionally, a new limit of lignite production during the summer period is possible.

Potential critical periods and foreseen countermeasures

The most critical period during summer is the beginning of July, when highest demand might be observed due to a possible heat wave.

The role of interconnectors for the upcoming summer period is important for system stability. This is especially relevant in periods with large demand variations and in the event that significant differences of energy prices in markets appear compared with neighbouring countries. Due to the fact that no market coupling exists, the exports or imports can enhance or not the system stability problem.

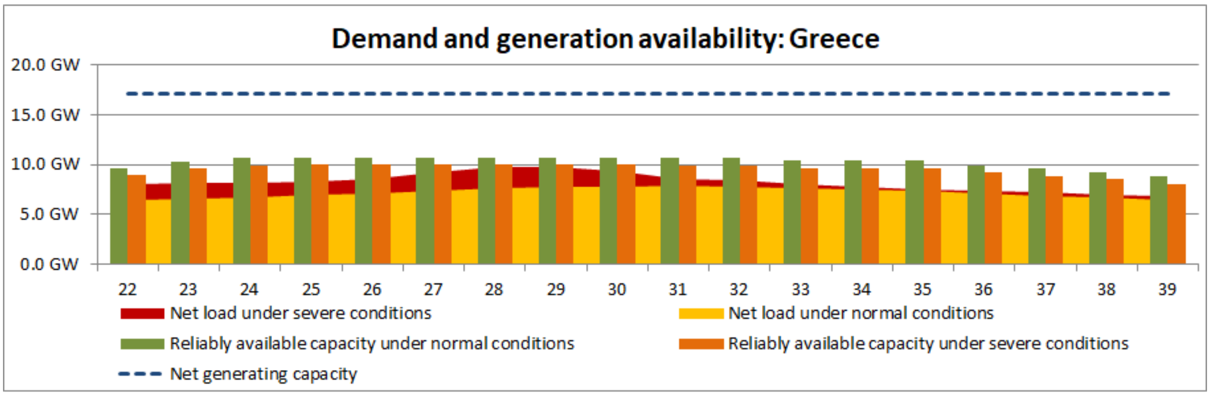
Most critical periods for downward regulation and countermeasures

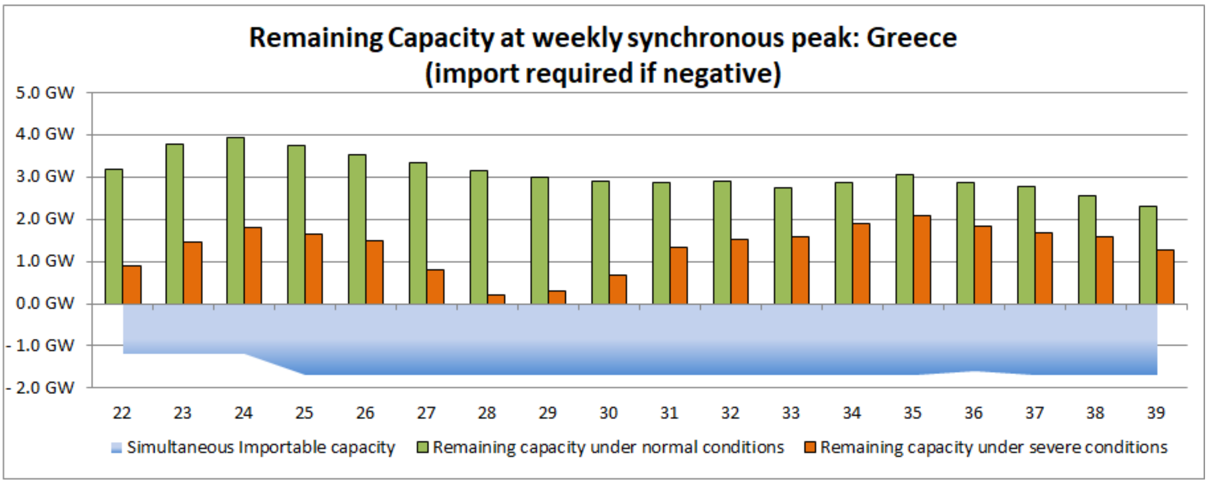
The most critical periods for downward regulating capacity are usually between 00:00 and 06:00 (due to low demand); and between 11:00 and 17:00 (due to high PV production).

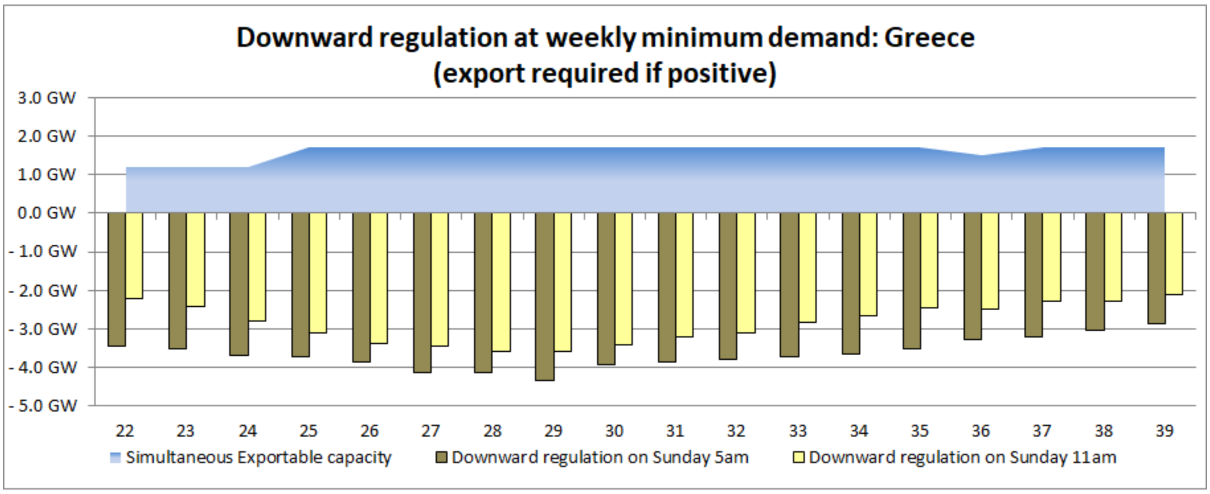
The available countermeasures are:

- Ensuring sufficient secondary downward reserve (frequency restoration reserves– FRR);
- Use of Pump Units.

The interconnectors are not used for reserve exchange.







Greece: Winter review 2018/2019

During winter 2018/2019 in Greece, temperatures ranged from low to normal for most of the season with some severe weather occurrences, but no adequacy issues were recorded.

Specific events and unexpected situations that occurred during the past winter

The HVDC Link GR-IT interconnection was out of operation for weeks, but adequate power supply was ensured by hydro powerstations using the energy stored in their reservoirs.

Finally, there was a lack of lignite fuel which led to a limitation in the power production from lignite thermal power plants, but no supply disturbances were registered (for residential, nor for industrial consumers).

Hungary: Summer outlook 2019

As a result of the constantly growing demand, there is no period of time when the imports could be ignored. The unavailable capacity remains high, which enhances the dependence on the imports and decreases the flexibility of the system.

High transit flows can be expected through the interconnections in summer as well.

The most critical periods can be caused by the severe weather conditions in June and July, since the units are temperature-dependent.

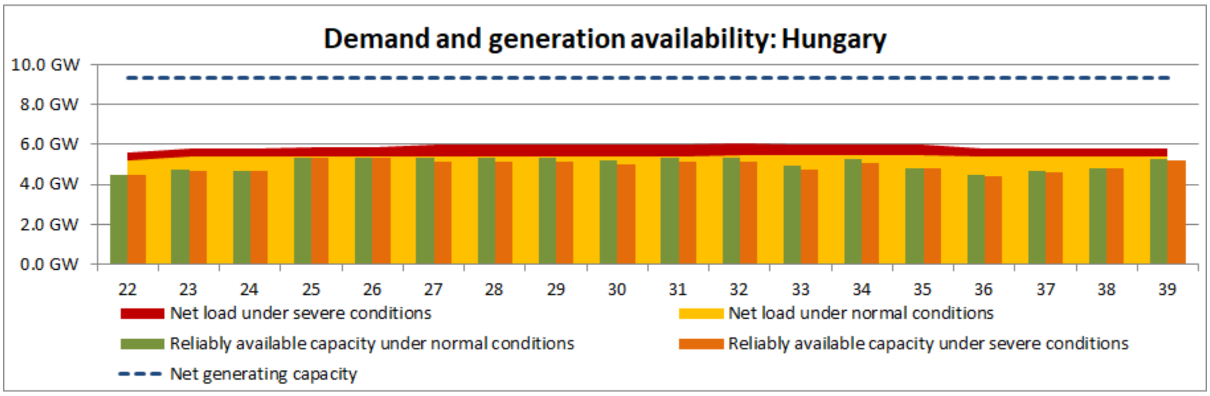
A further high increase of PV installed capacity is expected in the near future, but the procured amount of system reserve can mitigate the risk of balancing problems.

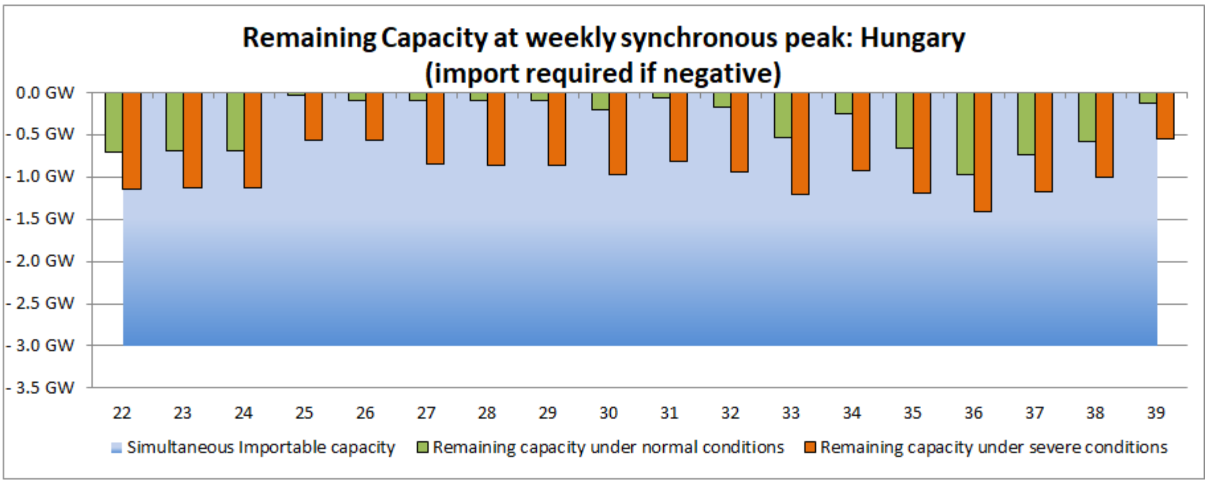
Most critical periods for maintaining adequacy margins and countermeasures

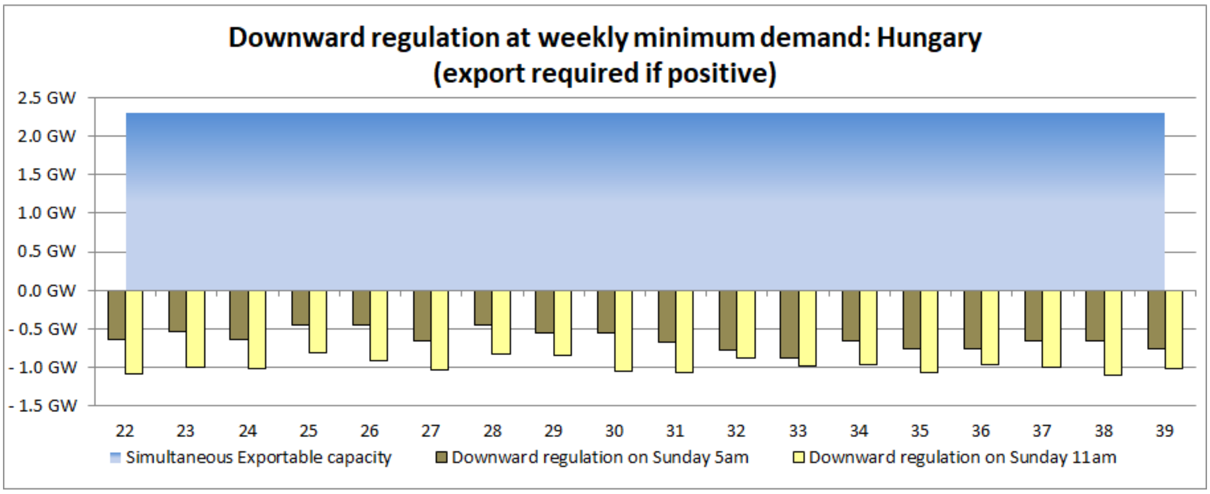
The level of maintenance is normal during the summer. It is mainly between 0.2 GW and 1.1 GW. The most critical periods are between week 22 and week 24; and between week 35 and week 37. During this period, around 1 GW of generation capacity will be in maintenance.

Most critical periods for downward regulation and countermeasures

Critical periods for downward regulation are not expected. The available downward regulation reserve can ensure the system balance besides the high level of PV generation.







Hungary: Winter review 2018/2019

General comments on past winter conditions

During the winter 2018/2019, demand levels of the Hungarian system increased compared to winter 2017/2018 despite the mild winter. Demand exceeded the expected level more times in December and January, with a peak demand record of 6491 MW being registered on 19 January 2019. Outages of generators were kept at a low level, without any unexpected event.

Hungary usually imports electricity between 2 GW and 3 GW at daily peak demand. The major part of this import is necessary to guarantee system adequacy, and no major issues concerning cross-border exchange were experienced during the winter time.

Specific events and unexpected situations that occurred during the past winter

There was no critical event last winter.

Iceland: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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

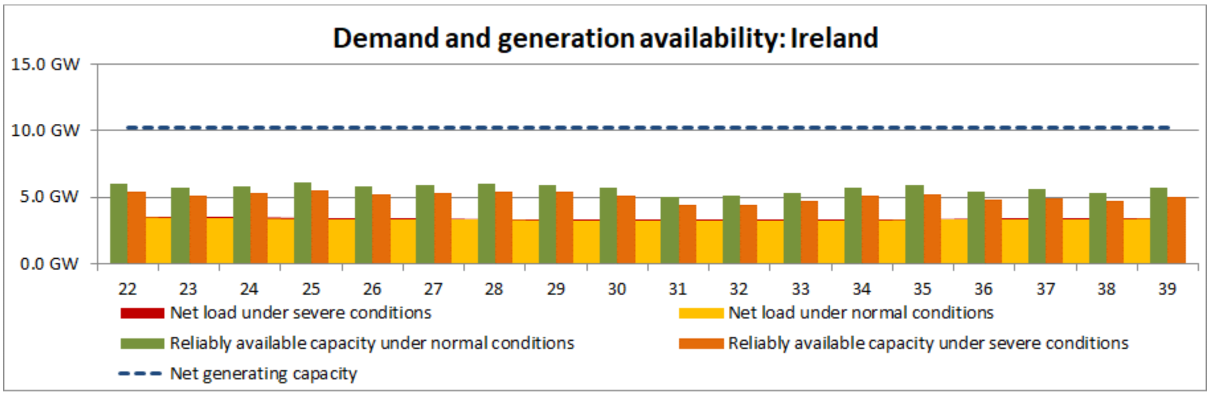
Iceland: Winter review 2018/2019

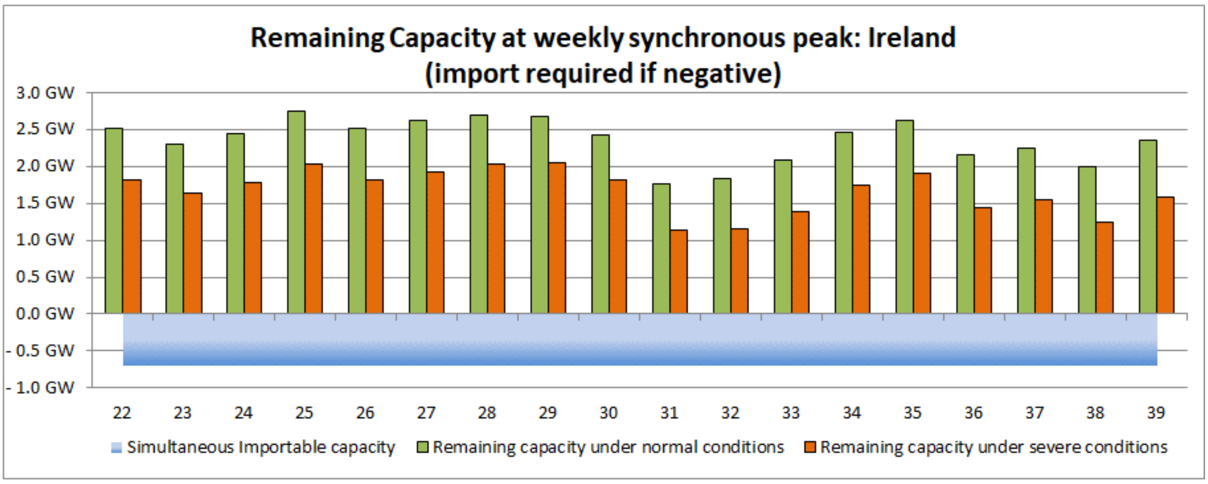
No adequacy or downward regulation issues were identified during the past season.

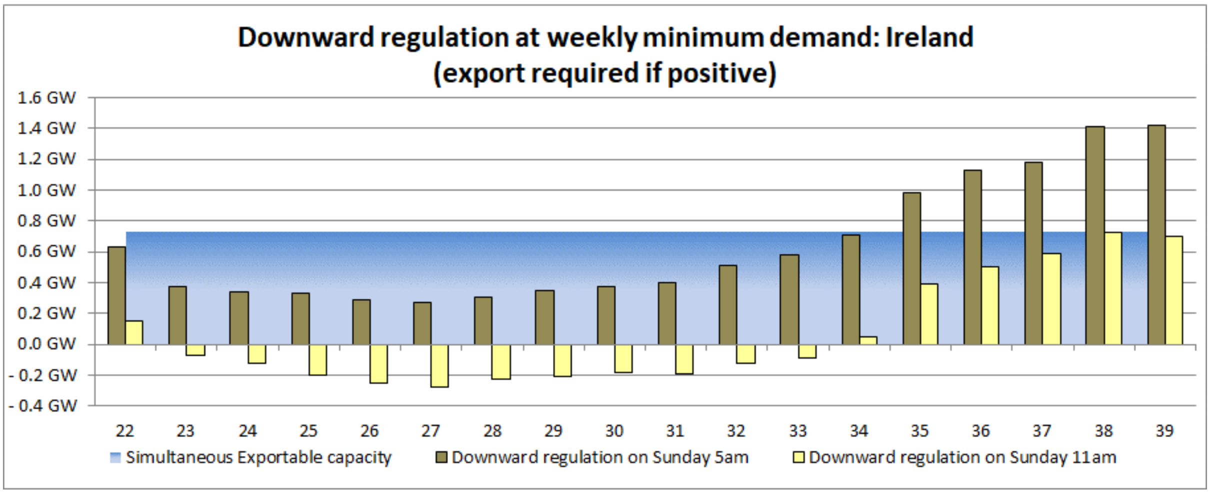
Ireland: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Ireland: Winter review 2018/2019

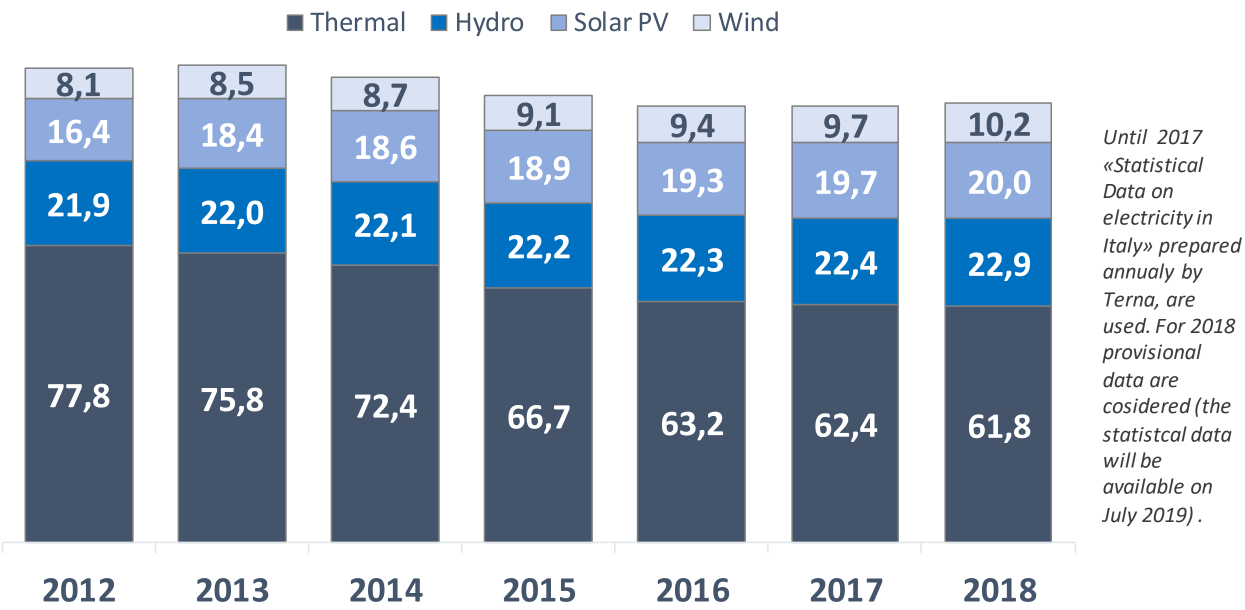
No adequacy or downward regulation issues were identified during the past season.

Italy: Summer outlook 2019

Potential critical periods and foreseen countermeasures

<u>*Generation capacity in Italy*</u>

In recent years, the Italian Power System has faced a significant reduction of the conventional (thermoelectric) power fleet. The growth of variable (e.g. wind and PV) generation, together with stagnant demand, is putting commercial pressure on traditional generators, leading to the decommissioning of the oldest power plants. Between 2012 and 2018, the following phenomena affected the power system operation and adequacy in Italy: about 16 GW installed generation was phased out (data for 2018 are provisional). The total amount of installed conventional power plants fell from 77.8 GW down to 61.8 GW and an additional 3.1 GW of installed conventional power capacity is not available due to environmental, legal and technical constraints. This trend can be observed on the figure below. This phenomenon has been seriously affecting the power system adequacy in Italy and some important warning signals were already registered in the last few years during the summer 2015 period as well as during the winter of 2016/2017.



Net Installed Capacity in Italy

Since 2017 (SOR 2017), the decommissioning of conventional capacity has slowed down and the available thermal capacity is similar to the values of the previous year.

Grid reinforcements, developed by the Italian TSO in these last few years, also helped to mitigate some effects caused by the power plants decommission (especially in the main islands).

Main outcomes of the adequacy assessment

Under normal conditions:

Under normal conditions, even if import from neighbouring areas is generally needed to cope with adequacy standards in the central part of Italy (Bidding Zones Central-Northern IT02 and Central-Southern IT03), no problem regarding system adequacy is expected for the Italian Power System.

Under severe conditions:

Under severe conditions, imports from neighbouring countries will be required in the northern Italian Bidding Zones (being the available generation capacity expected to be below the demand level and considering that the excess of capacity in the southern Italian bidding zones cannot be fully transferred to the north) due to internal grid constraints. Nevertheless, available imports from neighbouring countries are expected to be able to cover the needs of this area (generally composed by Bidding Zones Northern IT01 and Central-Northern IT02), despite the decrease in the transfer capacity with Switzerland due to the forced outage on the line 400 kV Filisur-Robbia occurred in the winter (the line is expected to be put back into operation on 31st July).

Hence, for the next summer, adequacy problems can be expected only in the event of an extraordinary decrease of available transmission capacity (e.g. forced outages of grid elements or further reduction of Net Transmission Capacity due to unscheduled flows on the northern border of the country) or generation capacity (e.g. forced outages of generation units inside or outside this area).

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

Most critical periods for maintaining adequacy margins and countermeasures

Under normal conditions, no problem regarding system adequacy is expected, and the least comfortable period is expected during the month of July.

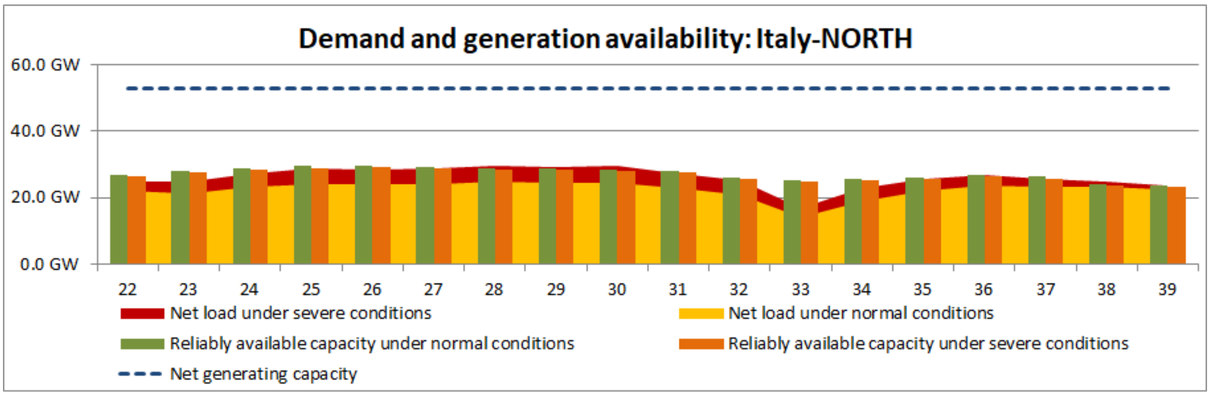
Under severe conditions, the situation for the summer could lead to need for imports for several weeks from June until end of September (excluding the central part of August).

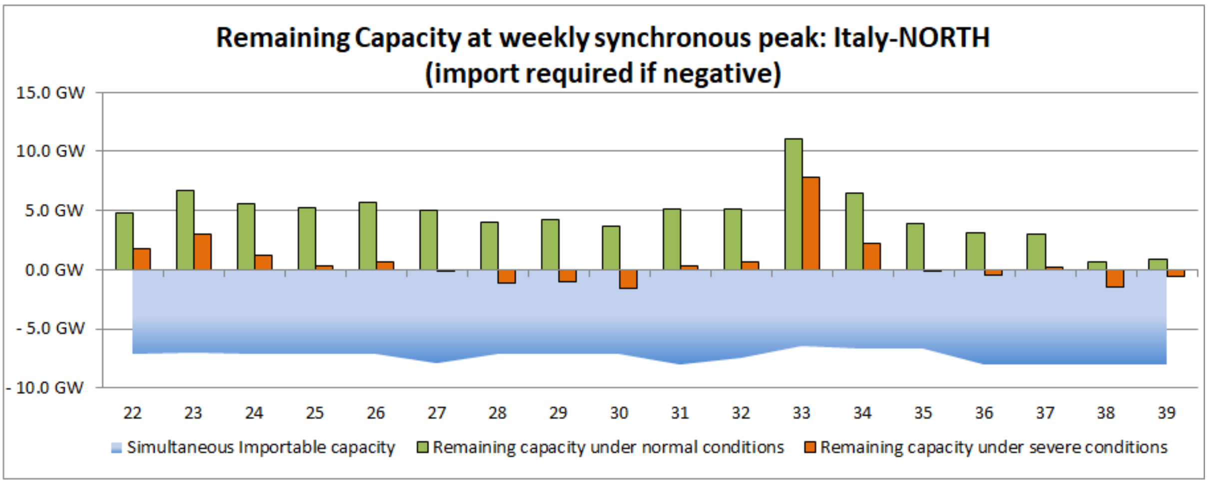
An appropriated planning (and coordination) of planned grid and generation outages has been performed, but in case of need, postponement and/or cancellation of maintenance could be required.

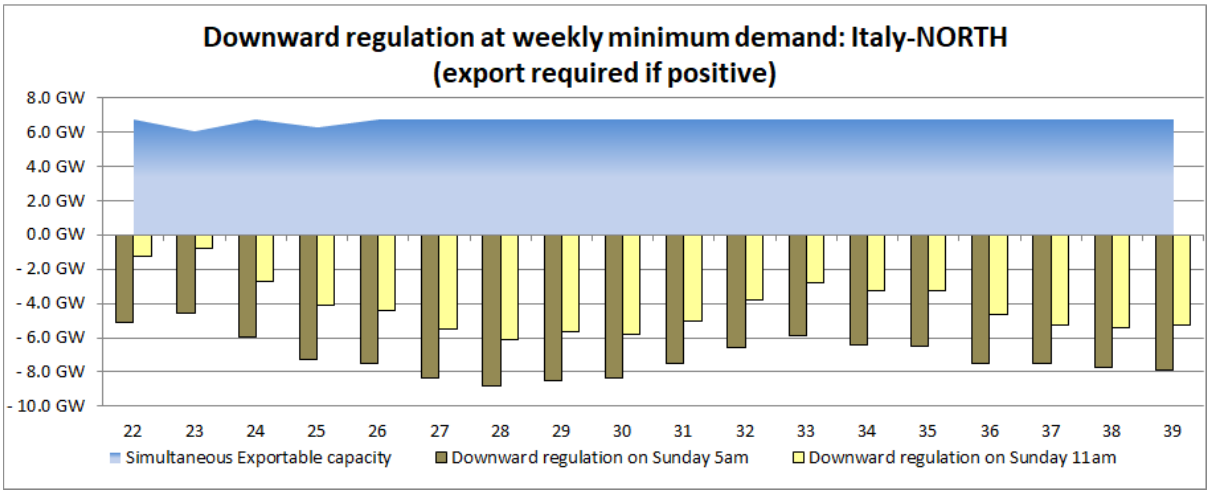
Improved regional coordination processes (including regional weekly adequacy assessment - Short Term Adequacy Analysis project, STA) will support the definition of proper and efficient countermeasures, in case the risk of incurring in critical situations is detected in short term horizon.

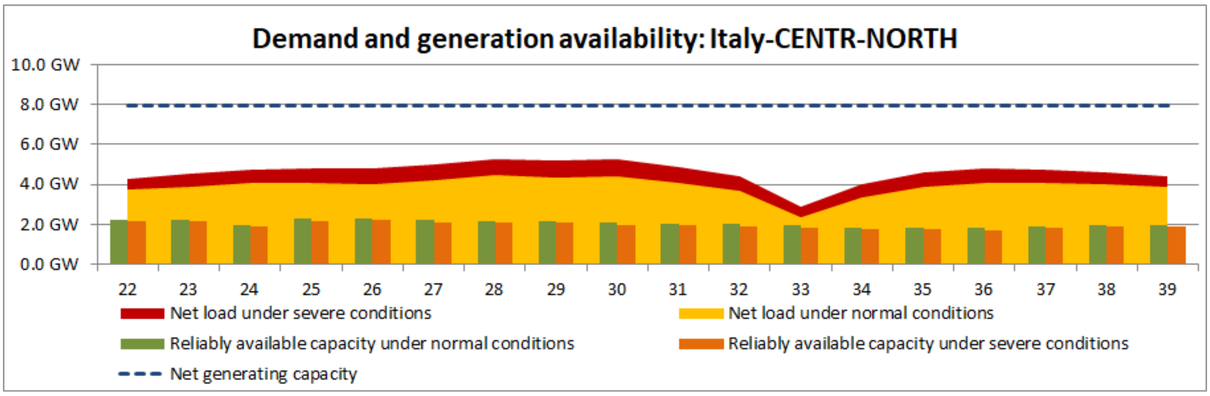
Most critical periods for downward regulation and countermeasures

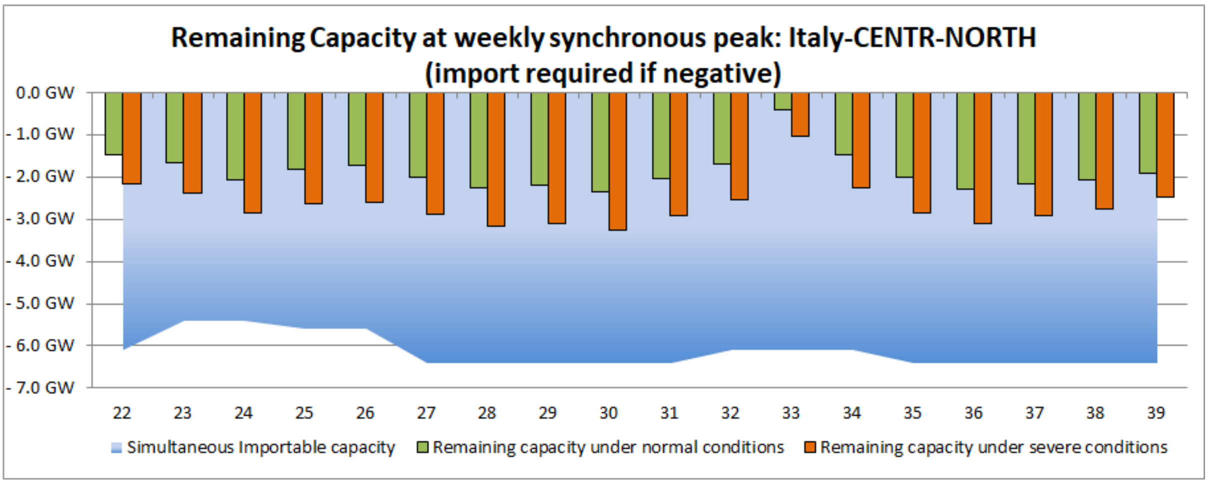
The worst weeks for downward regulation are expected to be the middle weeks of August, and the start and end of the summer period (June and September). In order to cope with this risk, the Italian TSO (Terna) has prepared preliminary actions and emergency plans and, in case of need, will adopt the appropriate countermeasures. In order to guarantee system security, Terna could adopt enhanced coordination with neighbouring TSOs and special remedial actions, such as the curtailment of inflexible generation. Further special actions, such as NTC reductions, could be planned in cooperation with neighbouring TSOs.

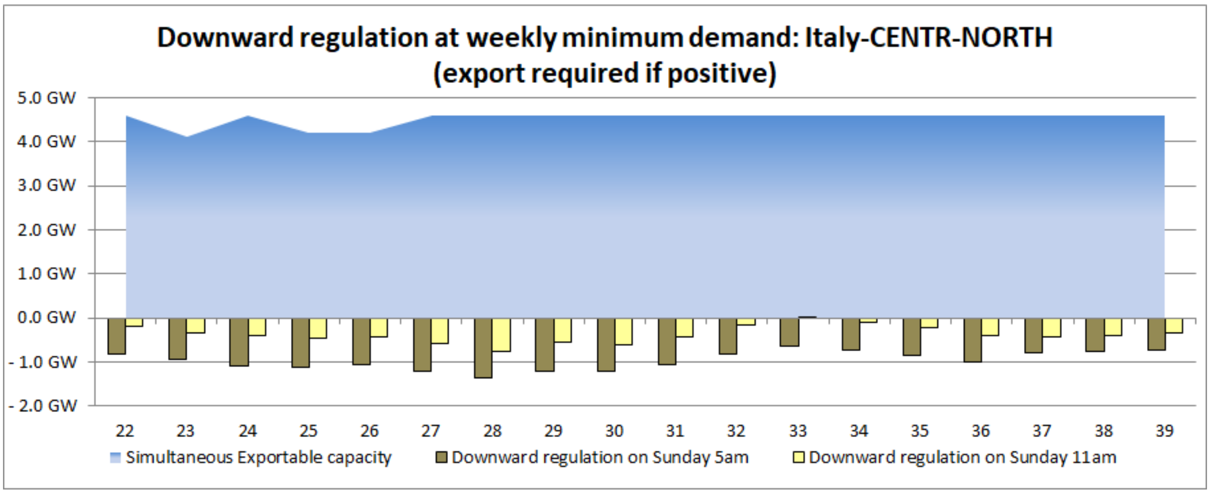

Demand and generation availability: Italy-NORTH
60.0 GW
40.0 GW
20.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

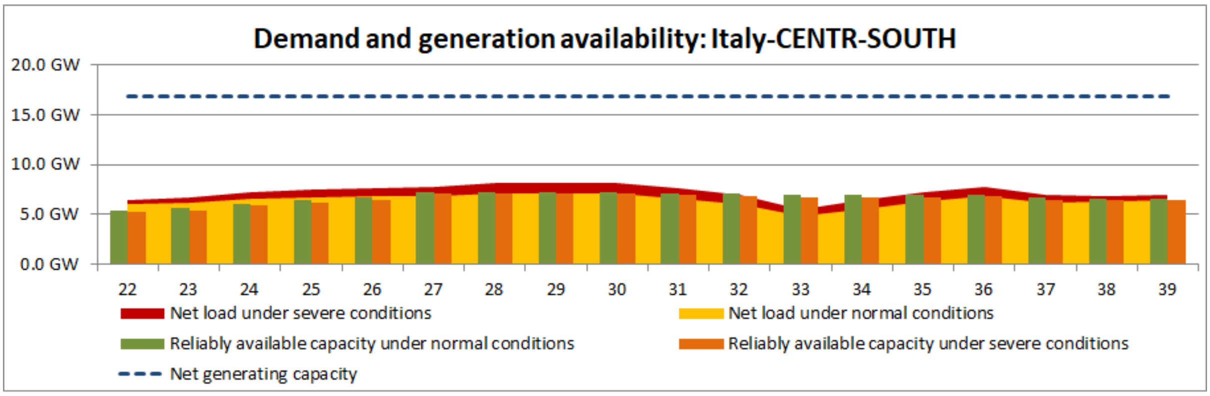

Remaining Capacity at weekly synchronous peak: Italy-NORTH
(import required if negative)
15.0 GW
10.0 GW
5.0 GW
0.0 GW
- 5.0 GW
- 10.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

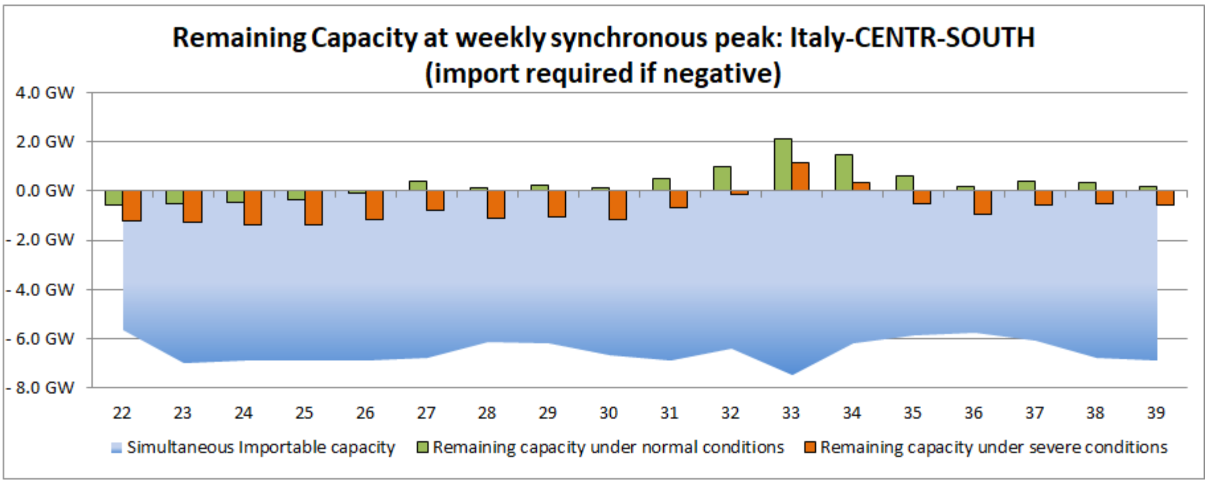

Downward regulation at weekly minimum demand: Italy-NORTH
(export required if positive)
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
- 2.0 GW
- 4.0 GW
- 6.0 GW
- 8.0 GW
- 10.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

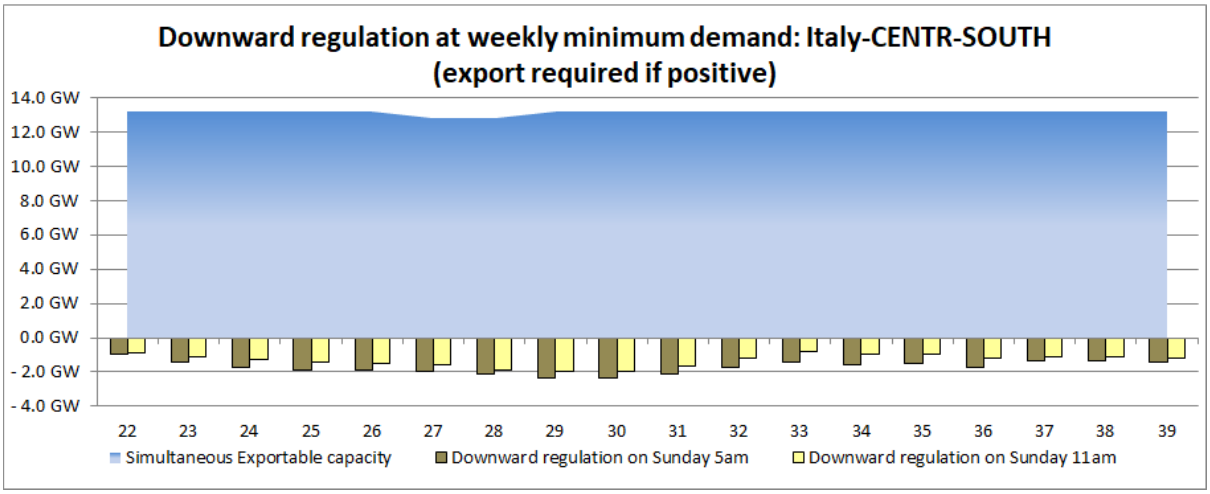

Demand and generation availability: Italy-CENTR-NORTH
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

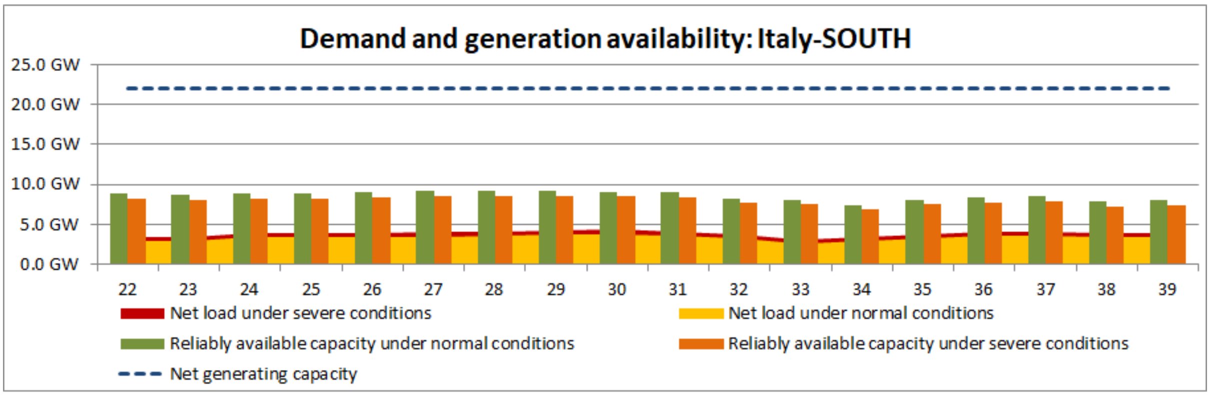

Remaining Capacity at weekly synchronous peak: Italy-CENTR-NORTH (import required if negative)
0.0 GW
- 1.0 GW
- 2.0 GW
- 3.0 GW
- 4.0 GW
- 5.0 GW
- 6.0 GW
- 7.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining 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
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

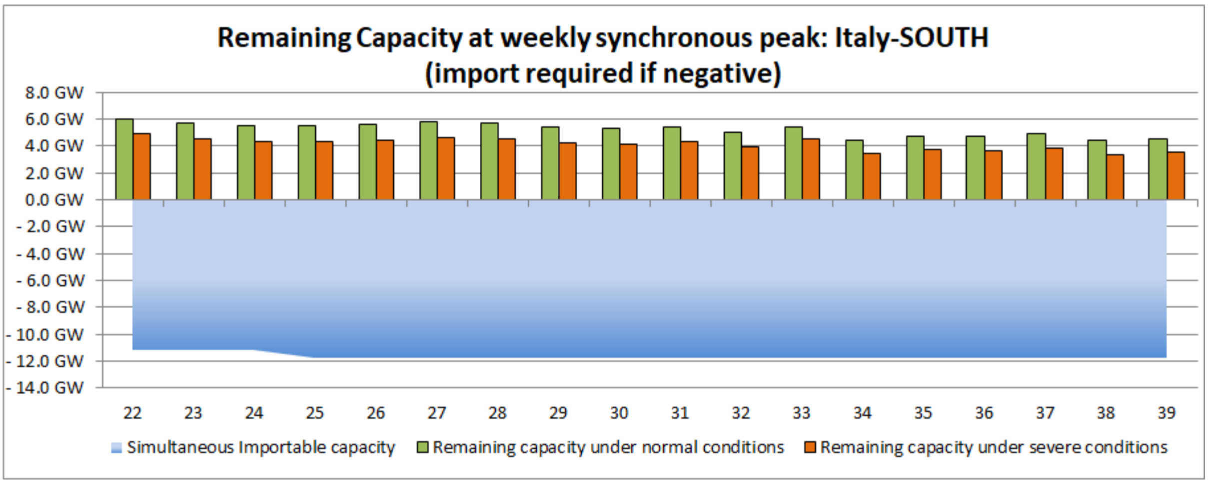

Demand and generation availability: Italy-CENTR-SOUTH
20.0 GW
15.0 GW
10.0 GW
5.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe 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
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

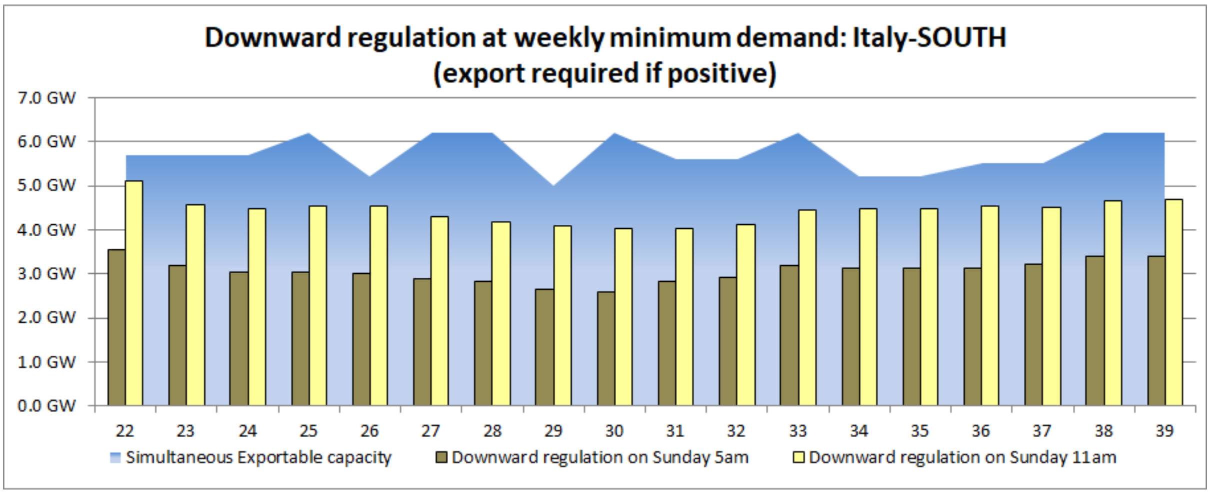

Downward regulation at weekly minimum demand: Italy-CENTR-SOUTH (export required if positive)
14.0 GW
12.0 GW
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
- 2.0 GW
- 4.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am



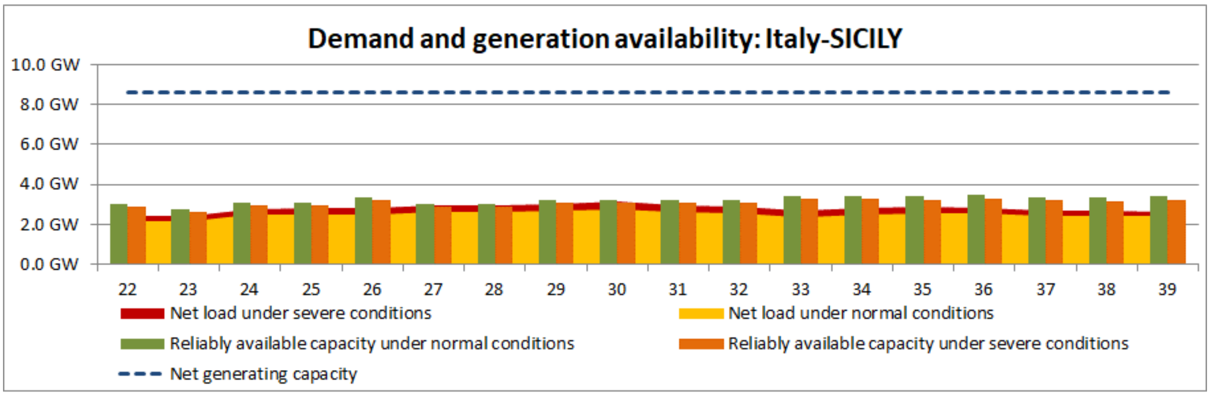
Demand and generation availability: Italy-SOUTH
25.0 GW
20.0 GW
15.0 GW
10.0 GW
5.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity

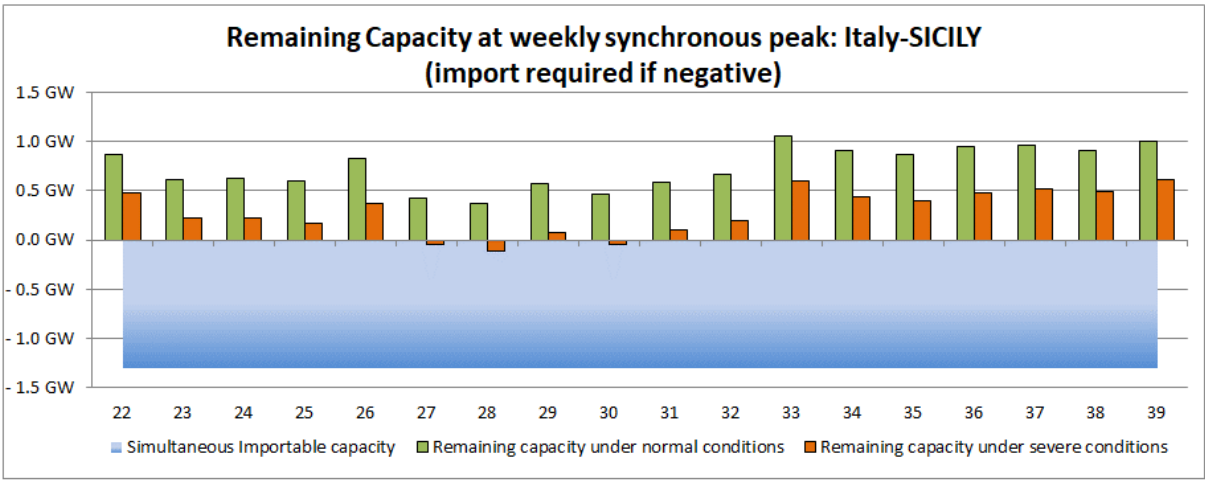


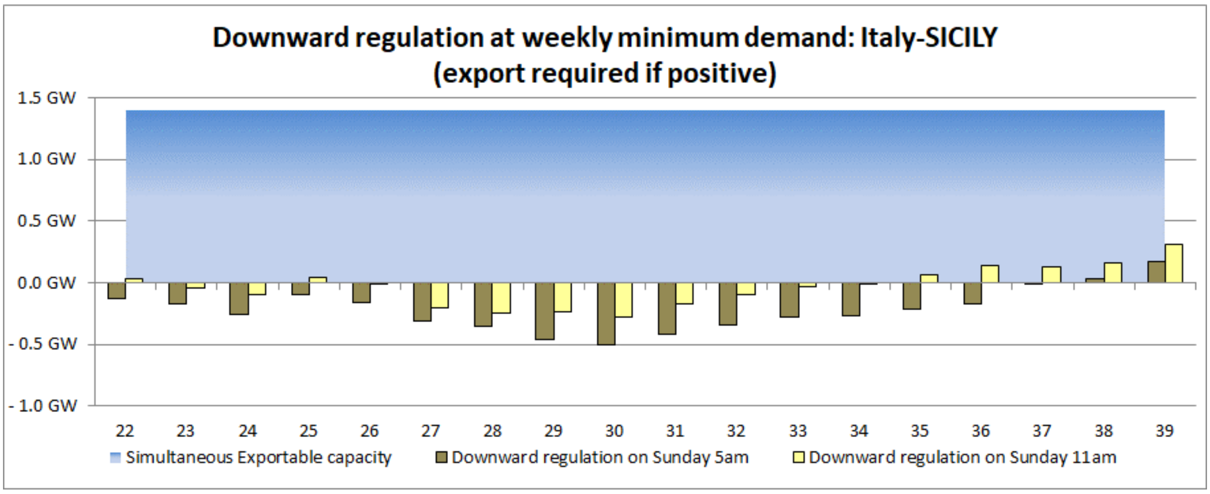
Remaining Capacity at weekly synchronous peak: Italy-SOUTH (import required if negative)
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
- 2.0 GW
- 4.0 GW
- 6.0 GW
- 8.0 GW
- 10.0 GW
- 12.0 GW
- 14.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

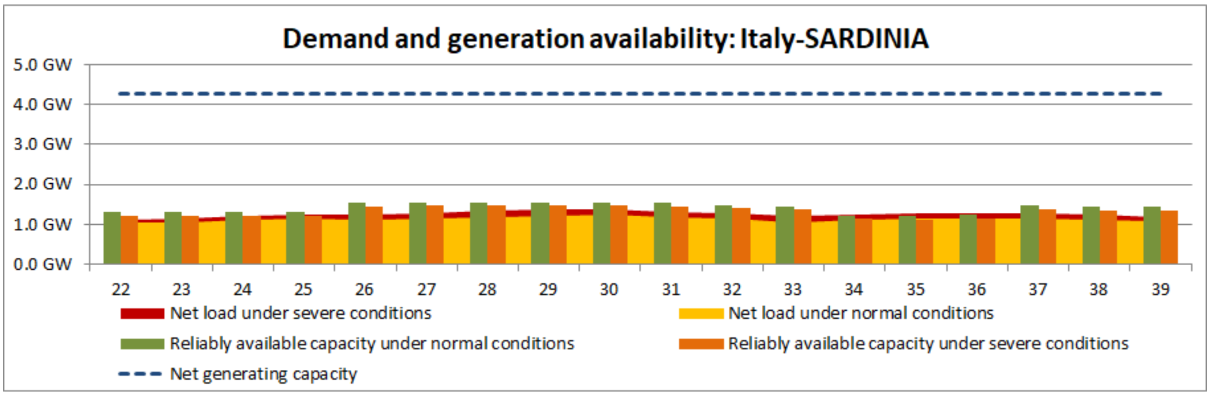


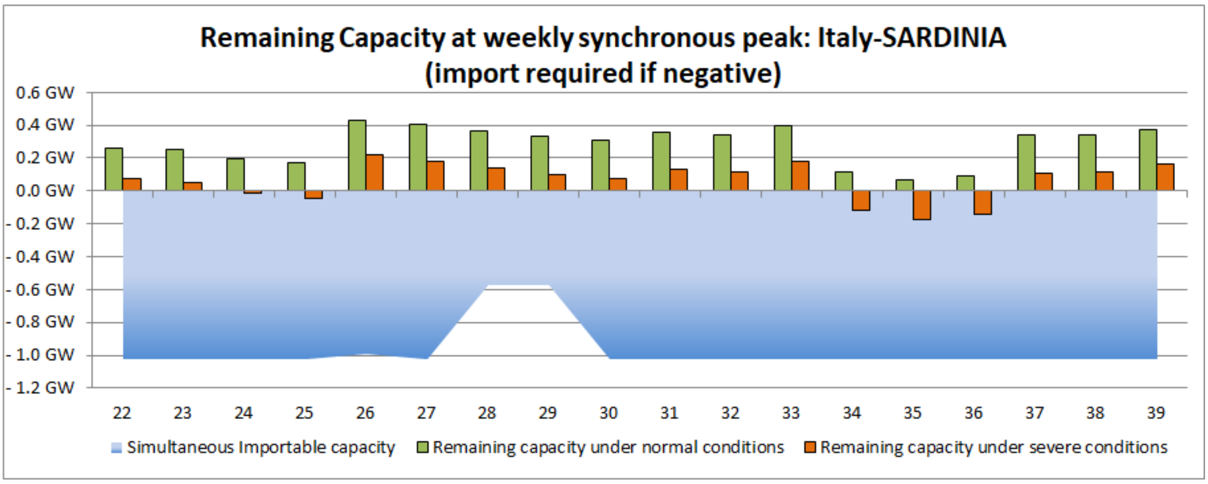
Downward regulation at weekly minimum demand: Italy-SOUTH (export required if positive)
7.0 GW
6.0 GW
5.0 GW
4.0 GW
3.0 GW
2.0 GW
1.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am

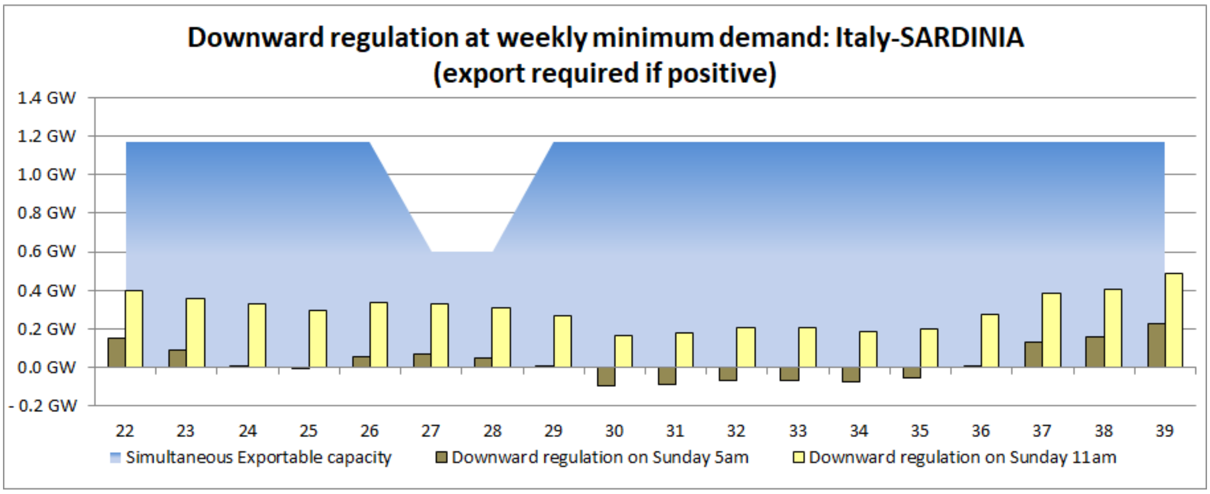

Demand and generation availability: Italy-SICILY
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe conditions
Net generating capacity


Remaining Capacity at weekly synchronous peak: Italy-SICILY (import required if negative)
1.5 GW
1.0 GW
0.5 GW
0.0 GW
- 0.5 GW
- 1.0 GW
- 1.5 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
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)
1.5 GW
1.0 GW
0.5 GW
0.0 GW
- 0.5 GW
- 1.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am







Italy: Winter review 2018/2019

General comments on past winter conditions

The past winter has been characterised by a variable climatic trend.

In the first ten days of January, a harsh climate was recorded with temperatures lower than the seasonal averages, strong winds and snowfall even at low altitudes. Significant low temperatures were also recorded in the last third of the month, due to cold air masses coming from Eastern Europe.

All this determined, for the month of January, an average temperature value of 3.3°C lower than that of the previous year.

February presented a different climate situation: after a short transition period, temperature increased significantly, reaching typical spring temperatures which exceeded historical records for February.

Despite the aforementioned weather conditions, there were no significant problems regarding the adequacy of the system. Electricity demand (from December 2018 to February 2019) was 0.28% higher compared to the same period of the previous year.

Finally, there were no significant outages of generation plants.

Specific events and unexpected situations that occurred during the past winter

The most significant event in winter 2018/2019 was a storm that occurred between the end of October and the beginning of November in the north of Italy and neighbouring countries, damaging the 220 kV tie-line Avise-Riddes between Italy and Switzerland. This line was put back into operation on 1st December. The same storm damaged two 400 kV lines in Switzerland in the Albula pass, and also affected the internal transmission grid in northern Italy (mainly in the northeast).

Latvia: Summer outlook 2019

The total net generating capacity in power plants in Latvia during summer 2019 is expected to be around 2.89 GW. In the first part of summer, one unit of Riga CHP2 has planned maintenance. In August, the second unit of Riga CHP2 has planned maintenance. This will result in a decrease of 419 MW generation capacity in Latvia for both periods. In July the Riga CHP1 has planned maintenance. This will result in a decrease of generation capacity between 59 MW and 79 MW for this period.

Hydro generation is limited by water inflow and maintenance schedule on Daugavas HPPs. The generation capacity due to maintenance schedule will decrease between 120 MW and 510 MW. However, it does not influence the generation adequacy because water inflow is the main limiting factor for hydro generation during summer period.

Under normal conditions it is assumed that there is no generation reduction on gas power plants. The gas supply is unlimited and gas generation is available at full net capacity. Some reduction of generation capacity of Biomass and Biogas power plants are expected (around 30 MW in total) and HPPs on Daugava river which are dependent on the water inflow in the river. It is assumed that under normal conditions, the available capacity of HPPs on Daugava river is around 300 MW. Under severe conditions the generation from gas power plants could decrease by 100 MW. It is assumed that all small gas power plants which are distributed in the area of Latvia have restrictions (economical or gas supply) in electricity production. The generation of Biomass and Biogas power plants is much more limited and the capacity reduction could reach 50 MW. The production of HPPs on Daugava river could be limited to 200 MW to ensure generation during peak demand moments.

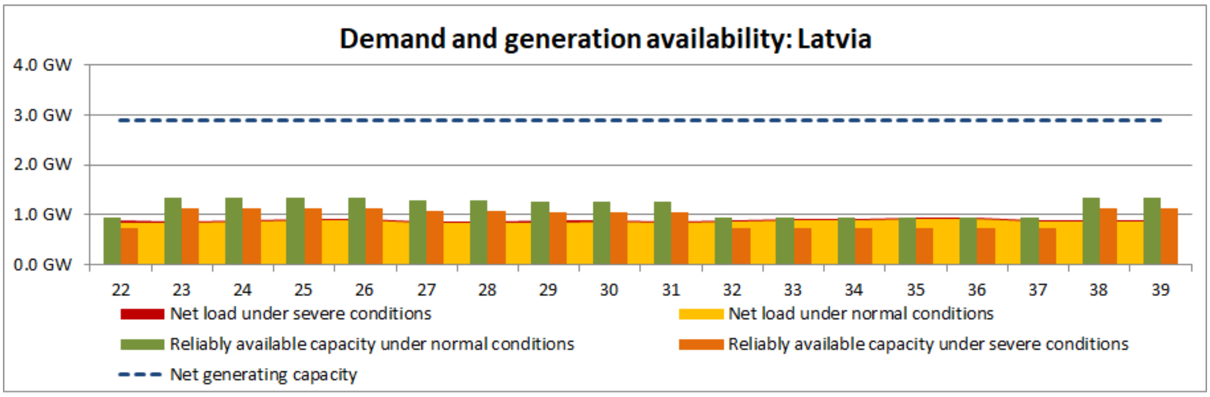
The system service reserve is 100 MW during the whole year according to the BRELL agreement.

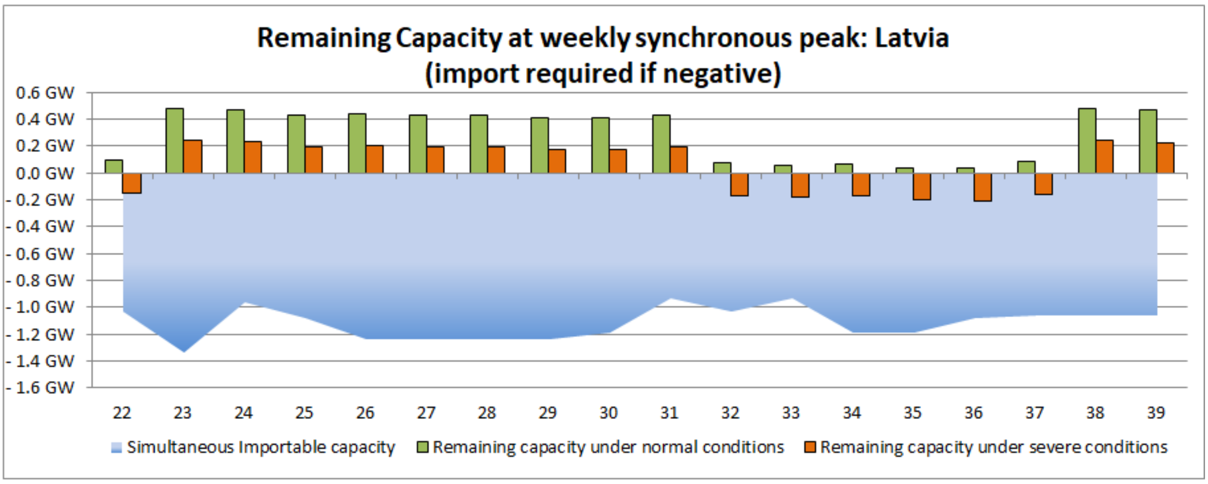
The peak demand under normal conditions is expected to increase by 1.5% compared with peak demand in summer 2018. Under severe conditions, peak demand is assumed to be 5% higher compared to peak demand values in summer 2018. The expected average peak demand increase in 2019 is expected to be around 2%. The minimum demand during the night minimum is assumed using statistical values from summer 2018.

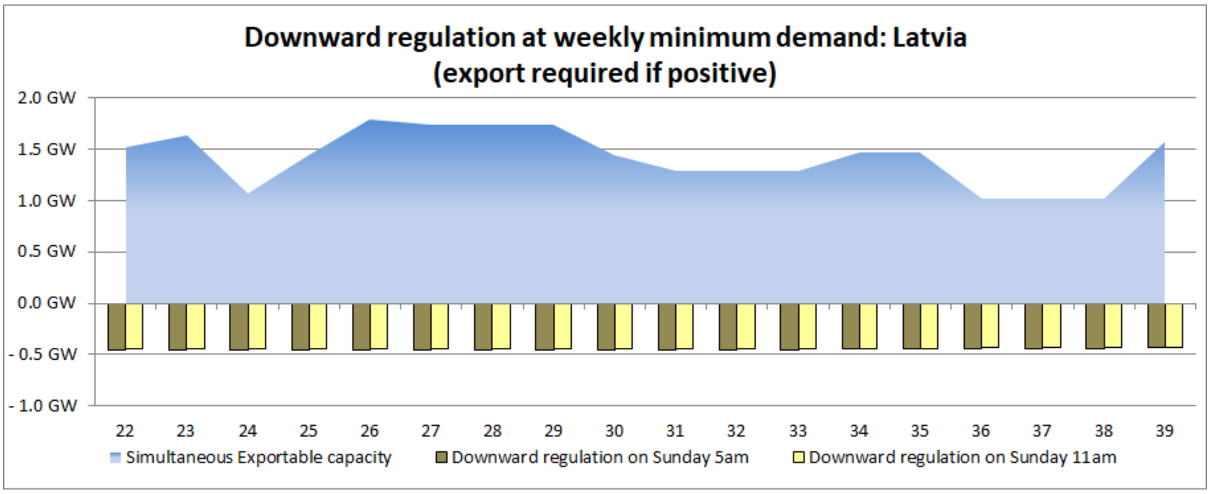
Potential critical periods and foreseen countermeasures

The most critical weeks for the Latvian power system under normal conditions are week 35 and week 36 when the available generation capacity is equal to forecasted peak demand. Under severe conditions, the Latvian power system would require imports to cover peak demand in the first week of summer 2019 and between week 32 and week 37 when one unit of Riga CHP2 is on maintenance (capacity reduced by 419 MW). During the rest of summer, the reliable available capacity can cover the demand under normal and severe conditions. Latvian TSO will rely on imports from neighbouring power systems or run system service reserve in case of adequacy issues.

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







Latvia: Winter review 2018/2019

The temperature in Latvia in November and December was close to the historical average.
The forecasted peak demand compared with actual peak demand was higher between 4% and 15%.
The year 2018 was normal from a hydrological perspective and hydro generation dominated electricity production in Latvia during the winter period. Water inflows in Daugava River were higher than expected and hydro power plants generation exceeded 500 MW for most of the winter 2018/2019.
During winter 2018/2019 the Latvian TSO could rely on electricity import from neighbouring countries.
The other RES has on average generated the same amount of energy as winter 2018/2019.
The small deviations of schedule registered did not cause any trouble for the security of supply in Latvia and the updated capacities were used for power exchange within Baltic States.
No adequacy or downward regulation issues were identified during the past winter period.

Lithuania: Summer outlook 2019

The demand estimation under normal conditions was based on the statistical data of the previous three years. However, consumption is highly dependent on actual weather conditions. Compared with a previous summer, total demand is expected to be around 3% higher, with a maximum (under normal conditions) of 1741 MWh in the end of September.

Since the last summer season, net generating capacity has increased by 41 MW and is currently equal to 3421 MW.

Total volume of frequency restoration reserves for the summer season will not change significantly and replacement reserves will increase by 37 MW. Reserves will be equal to 920 MW during the whole season, which represents 27% of NGC. The maintenance schedule will not be intensive, the largest (7% of NGC) generation unavailability due to maintenance will be on week 26 of 2019 when one generating unit of Kruonis Pumped Storage Plant will not be available. Each of the four Kaunas Hidroelectric Power Plant generating units will be unavailable for two weeks, one after another, from week 27.

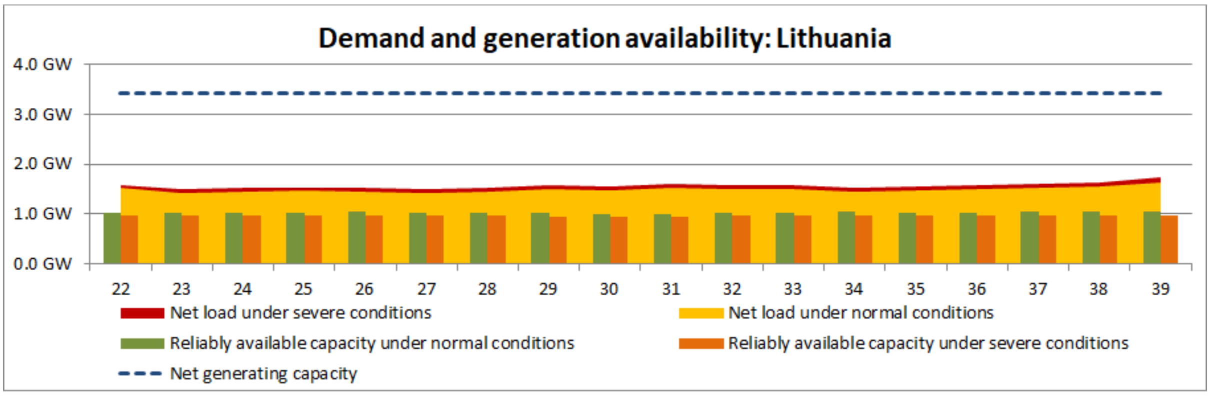
The lowest simultaneous importable and exportable capacity is forecasted in week 37 due to the planned maintenance of the HVDC interconnection with Sweden.

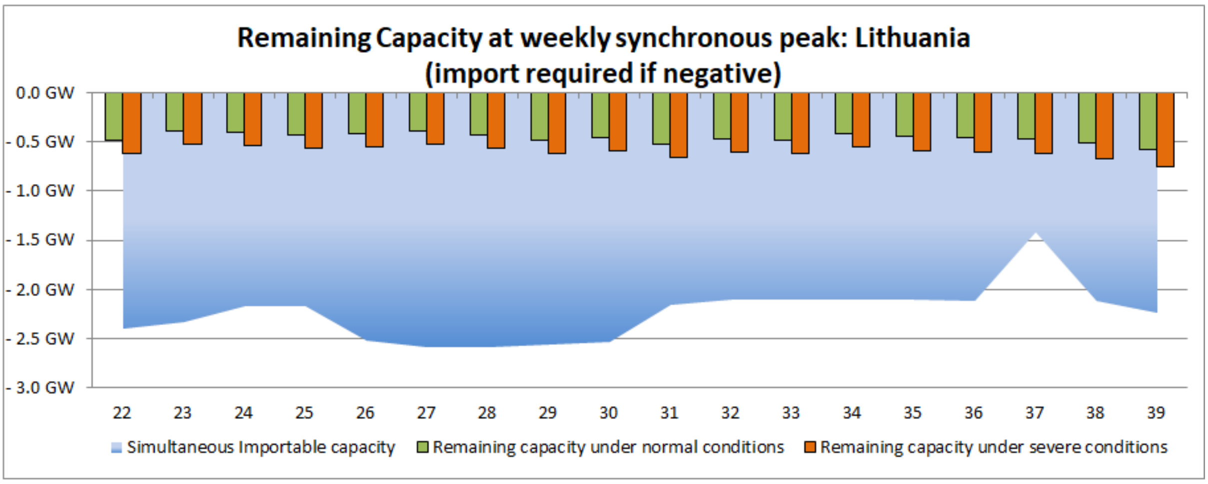
All import volume from third countries (Russia, Belarus) based on power flow calculations and allocated at the Belarus-Lithuania interconnection highly depends on Estonia-Latvia interconnection capacity, which is reduced during the summer period because of higher ambient temperature and planned maintenance activities on the interconnection lines. That causes significant import restrictions from third countries to the Lithuanian power system for the whole summer. Moreover, according to the new methodology "Terms, Conditions and Methodology on Cross-Zonal Capacity Calculation, Provision and Allocation with the 3rd Countries" that became effective from 1 February 2019, the amount of assured secondary emergency power reserves maintained in the Lithuanian power system is no longer considered as a minimal capacity value of the Belarus-Lithuania interconnection. Therefore, the forecasted importable capacity from third countries is lower compared with a previous summer period.

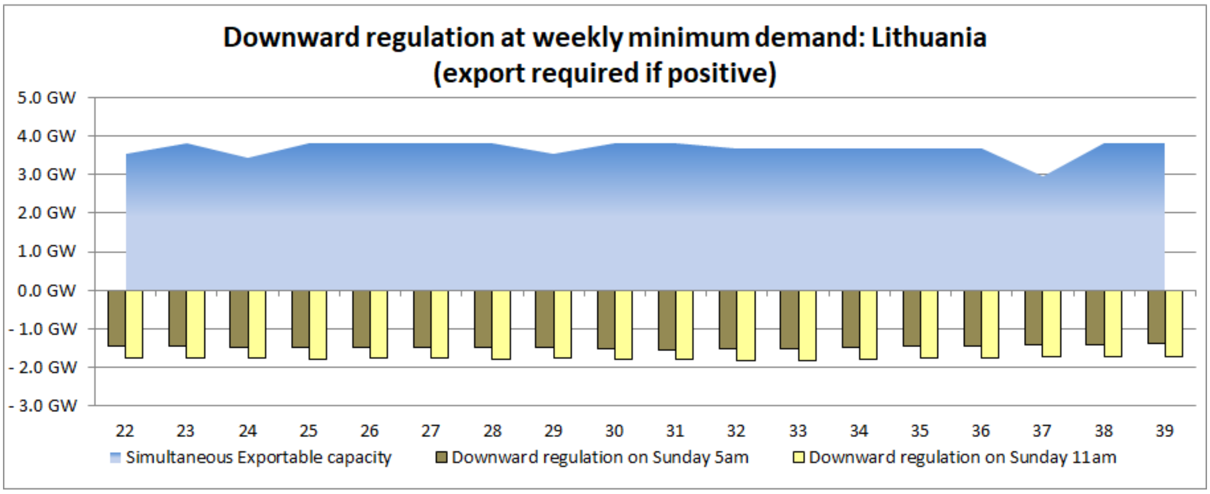
The import ability of the Lithuanian power system also depends on available generation in the Kaliningrad region. Import restrictions are foreseen in week 22 due to the planned maintenance activities of Kaliningrad Thermal Power Plant.

Typical generation–load balance level of the Lithuanian power system during the upcoming summer season is forecasted to be negative. Nevertheless, the cross–border interconnection capacity is expected to be sufficient for maintaining system adequacy.

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







Lithuania: Winter review 2018/2019

In winter 2018/2019, national consumption was 2% higher than in winter 2017/2018. The highest increase was recorded in December (5%) when the average monthly temperature was −2°C. Maximum demand (2029 MW) was reached on 24 January 2019, when the average temperature of this day was −11°C.

In general, the winter balance portfolio consisted of 28% local generation and 72% imports from neighbouring countries. During the winter 2018/2019, total generation was 15% lower compared with the winter 2017/2018. Wind generation grew only by 5% (12 GWh) compared with last year's winter. Total hydro generation dropped by 36% (113 GWh) and total fossil fuel power plant generation dropped by 24% (47 GWh). This was the main reason why imports to Lithuania increased by 3%.

The largest part of imported electricity was from Russia (64%). DC interconnections with Poland (LitPol Link) and Sweden (NordBalt) covered 17% of imports.

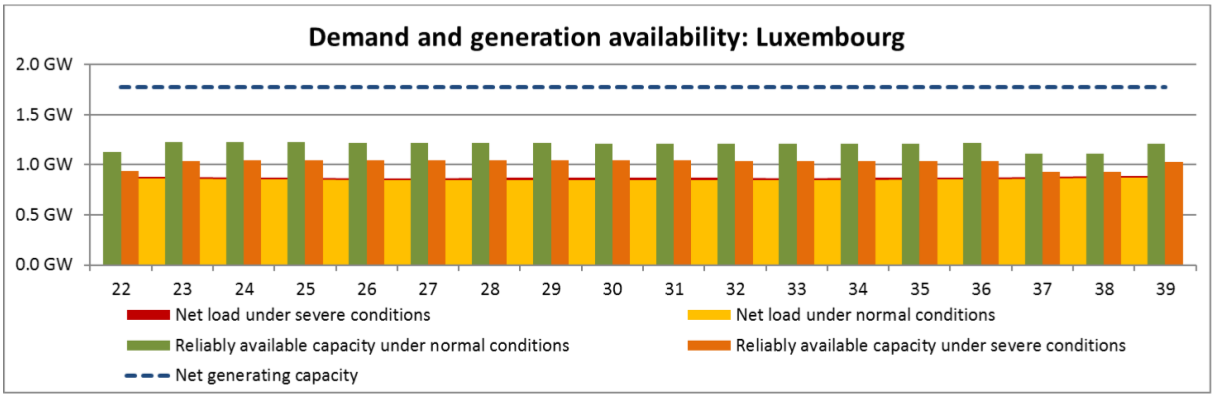
During the winter 2018/2019, import and export capacities of the Lithuania power system had no significant deviations from what was expected. Any forced outages of HVDC interconnectors were recorded. Cross–border capacities with third countries were limited due to constraints on the cross–border interconnection between Estonia and Latvia. At the beginning of winter 2018/2019 (between week 48 and week 52), available import capacity from Kaliningrad region to Lithuania was higher than initially planned, because of changed maintenances of thermal power plant in Kaliningrad.

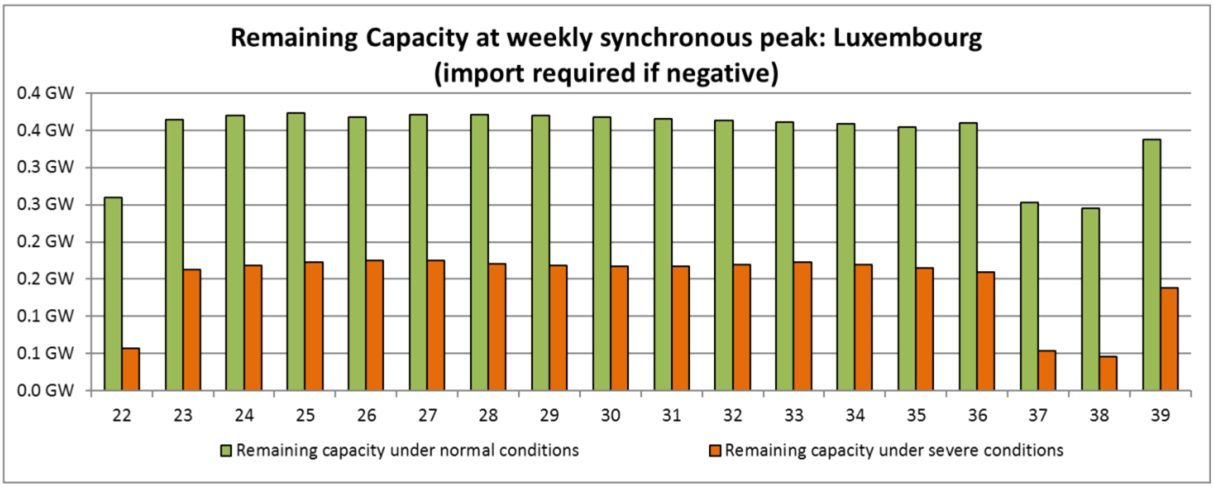
Import contributed significantly to adequacy in Lithuania.

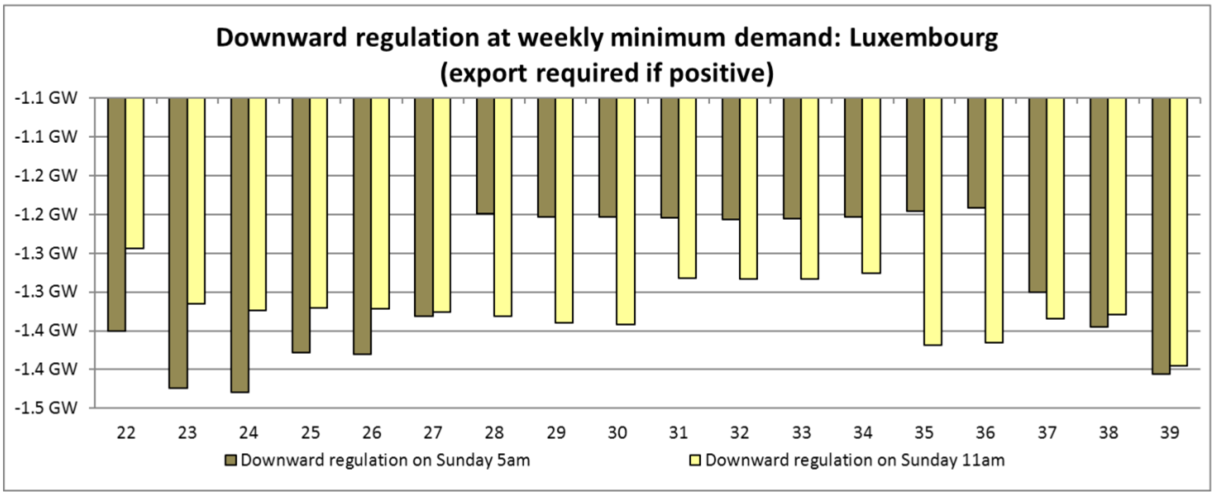
Luxembourg: Summer outlook 2019[14]

Potential critical periods and foreseen countermeasures

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







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

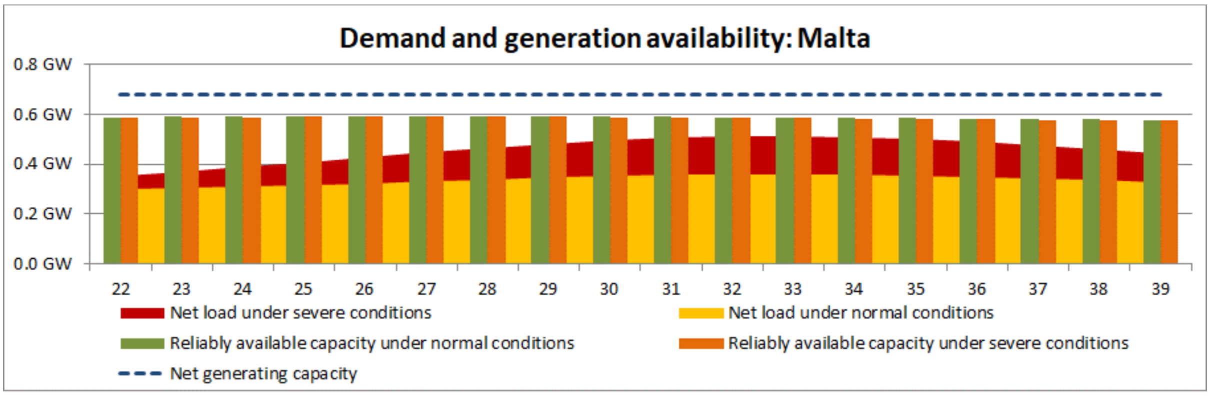
Luxembourg: Winter review 2018/2019

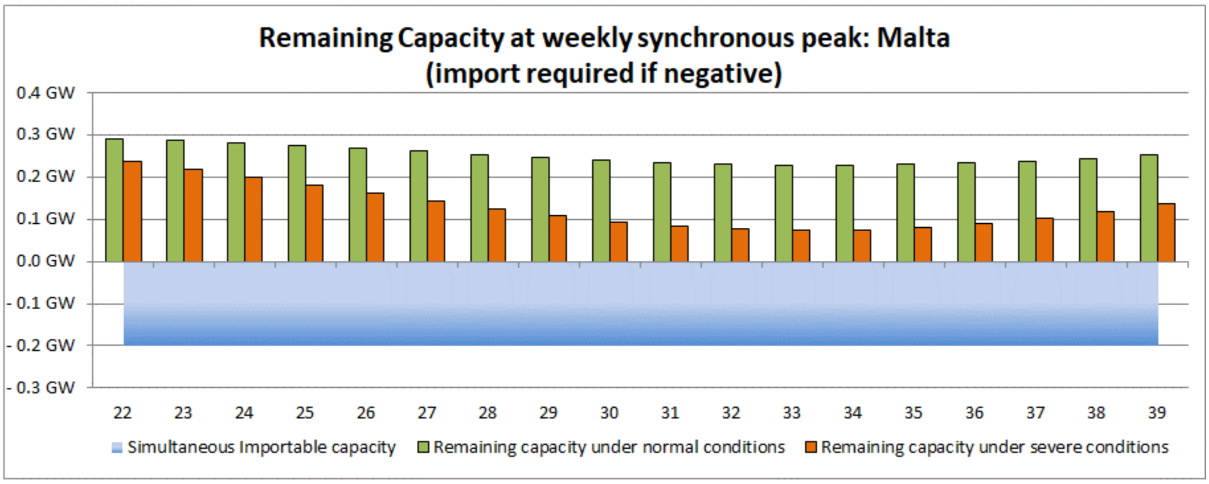
No adequacy or downward regulation issues were identified during the past season.

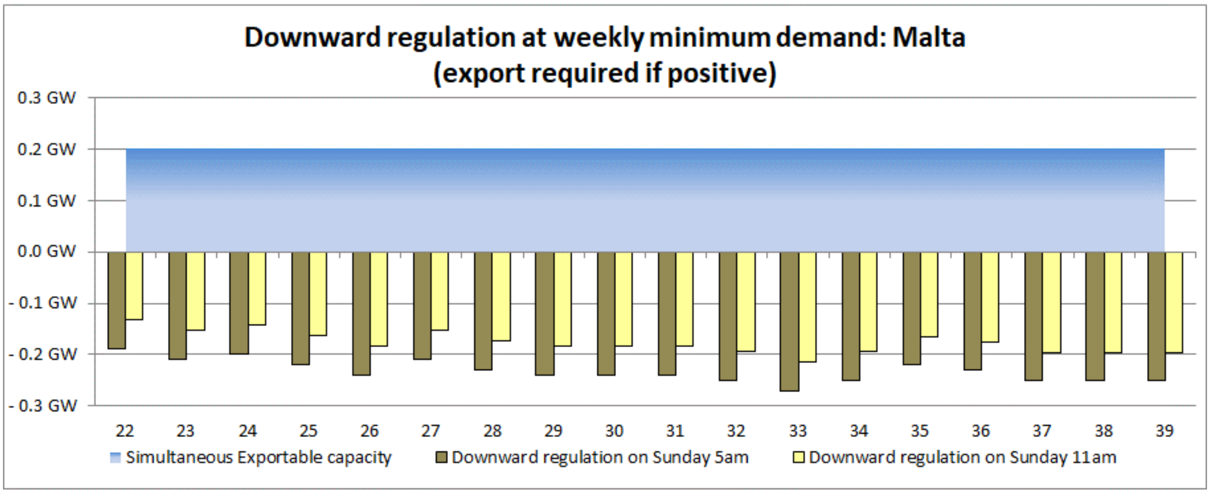
Malta: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







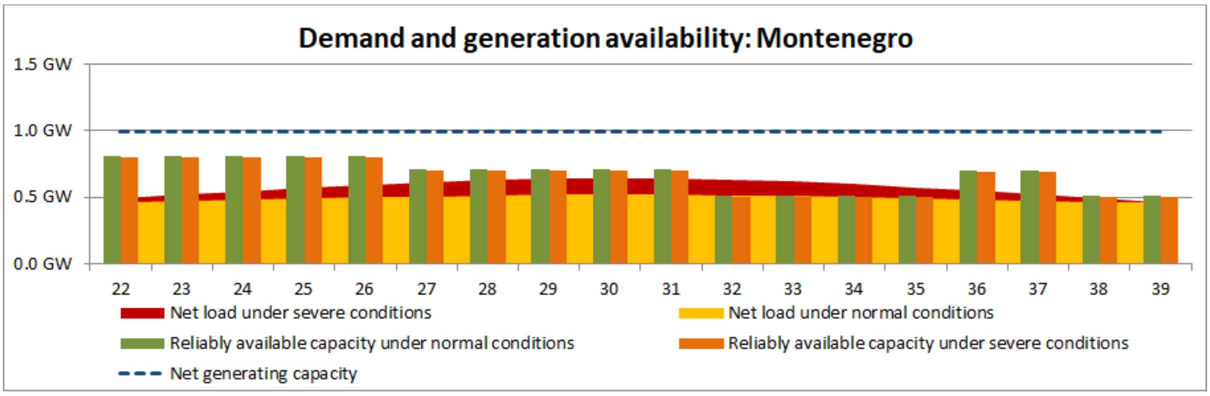
Malta: Winter review 2018/2019

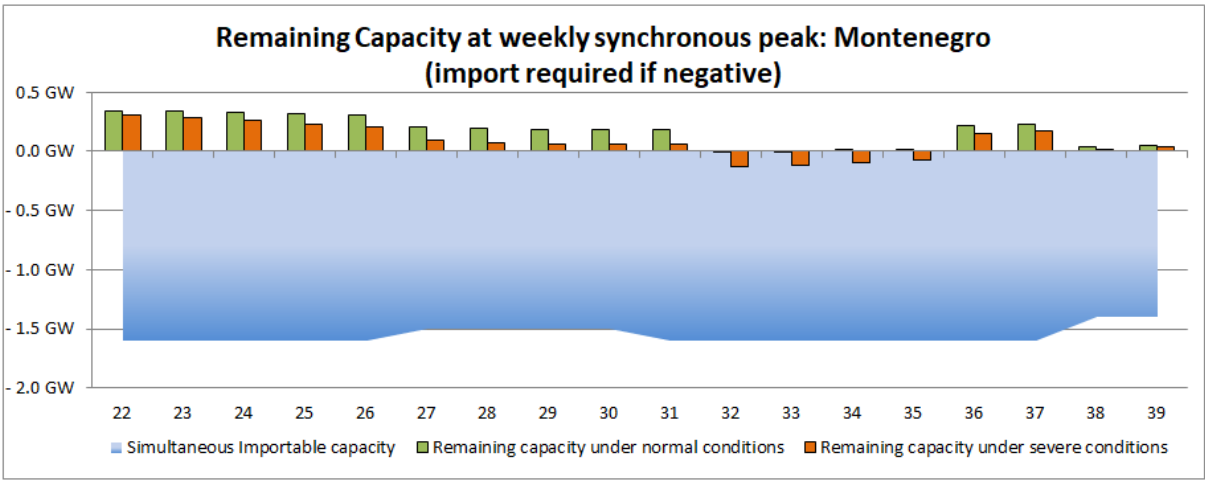
No adequacy or downward regulation issues were identified during the past season.

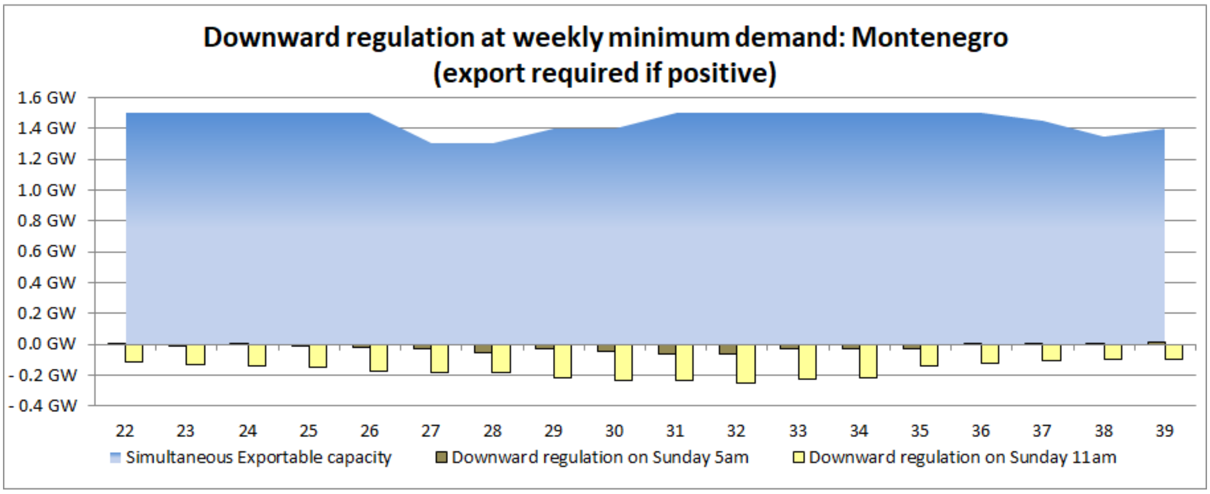
Montenegro: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







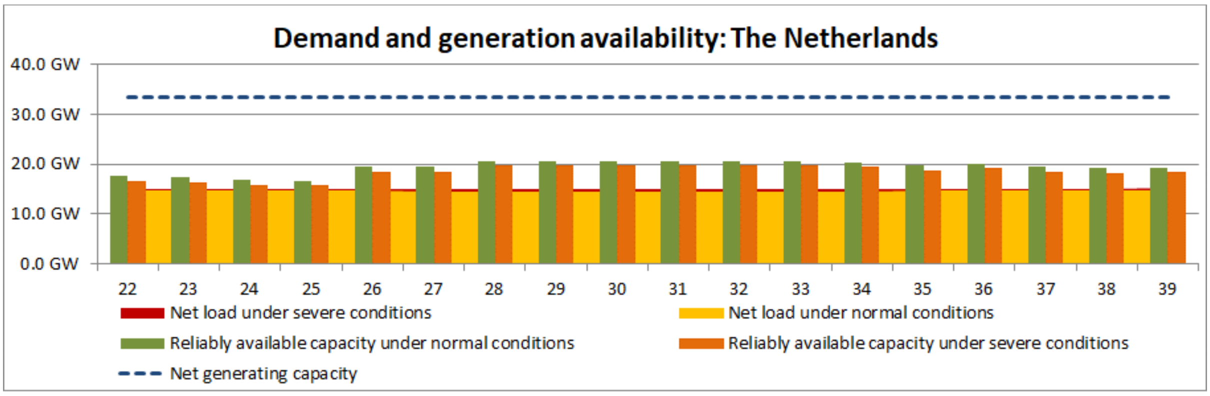
Montenegro: Winter review 2018/2019

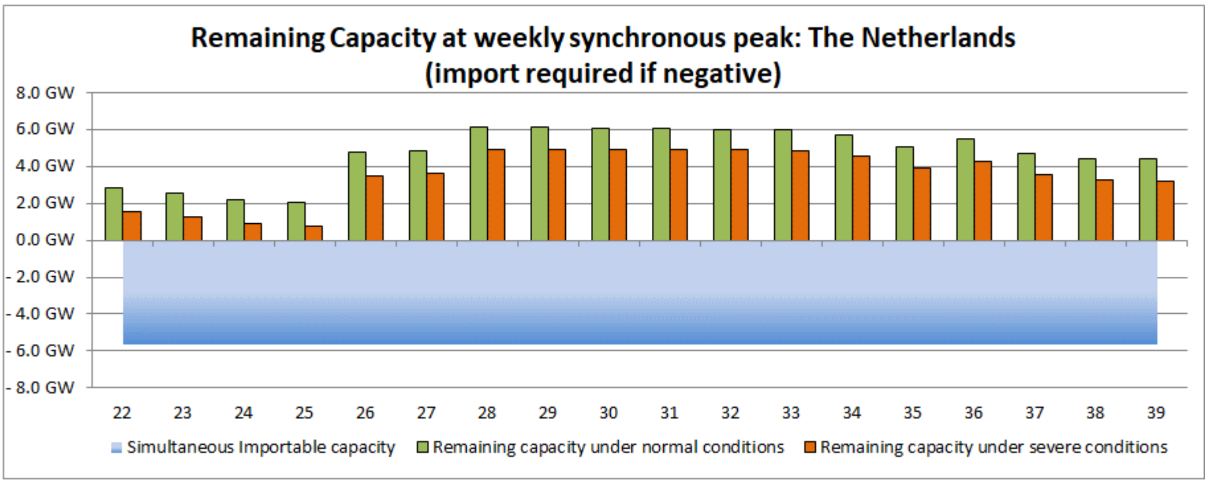
No adequacy or downward regulation issues were identified during the past season.

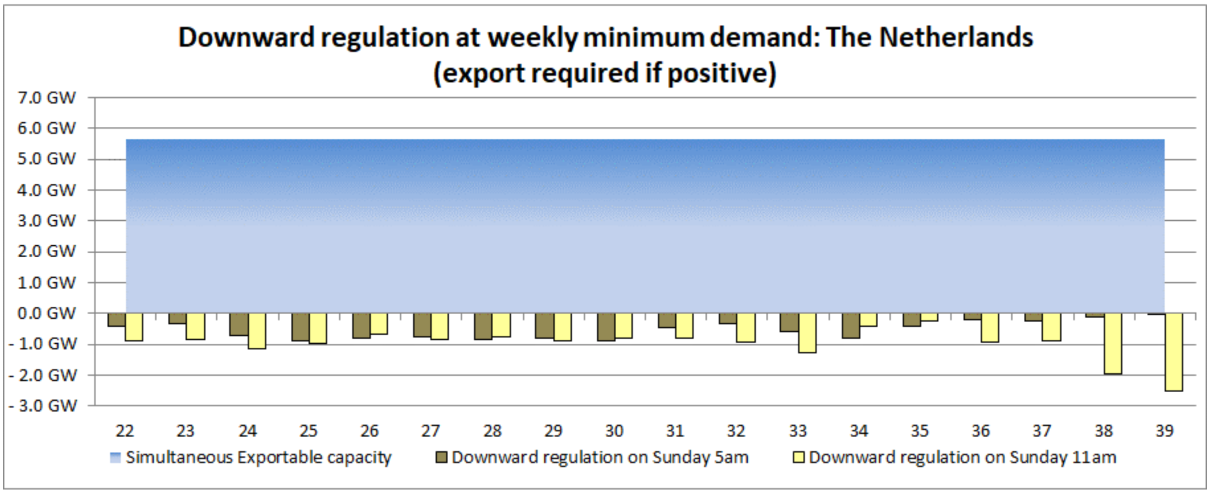
Netherlands: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







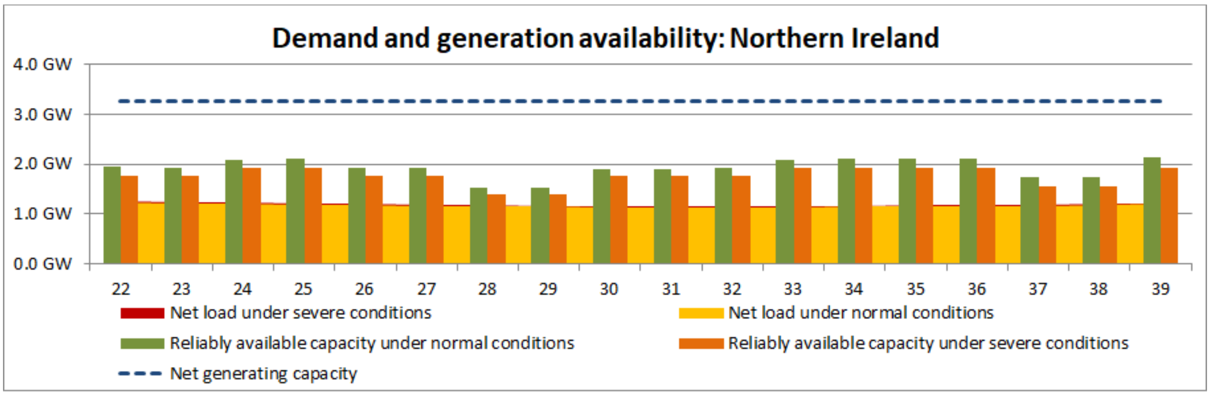
Netherlands: Winter review 2018/2019

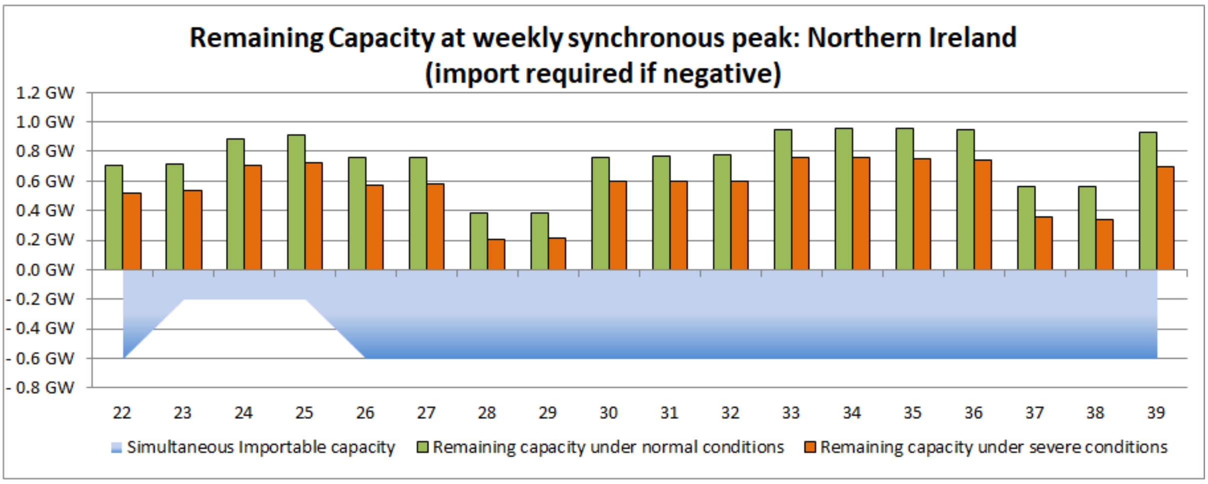
No adequacy or downward regulation issues were identified during the past season.

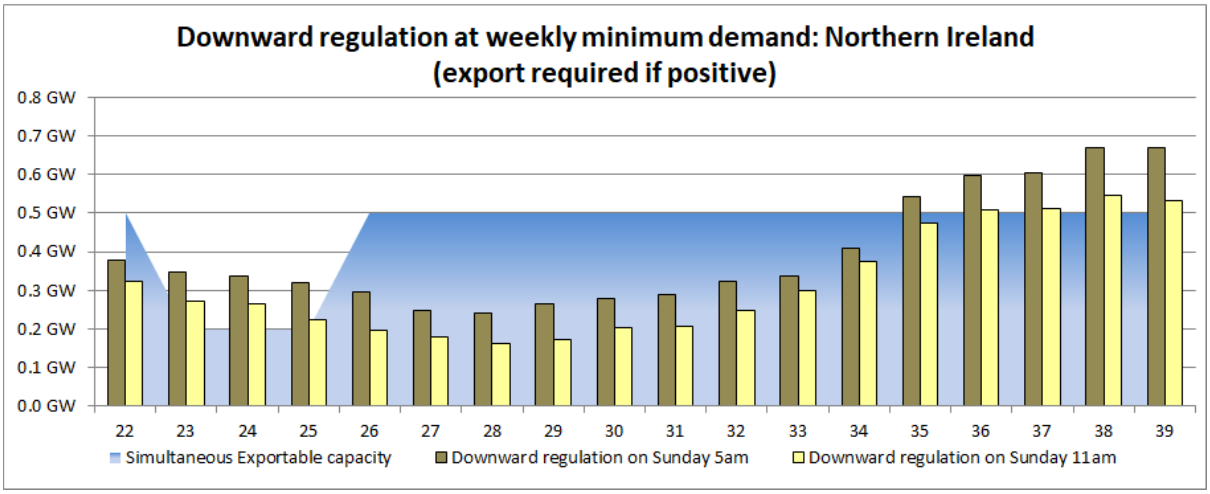
Northern Ireland: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







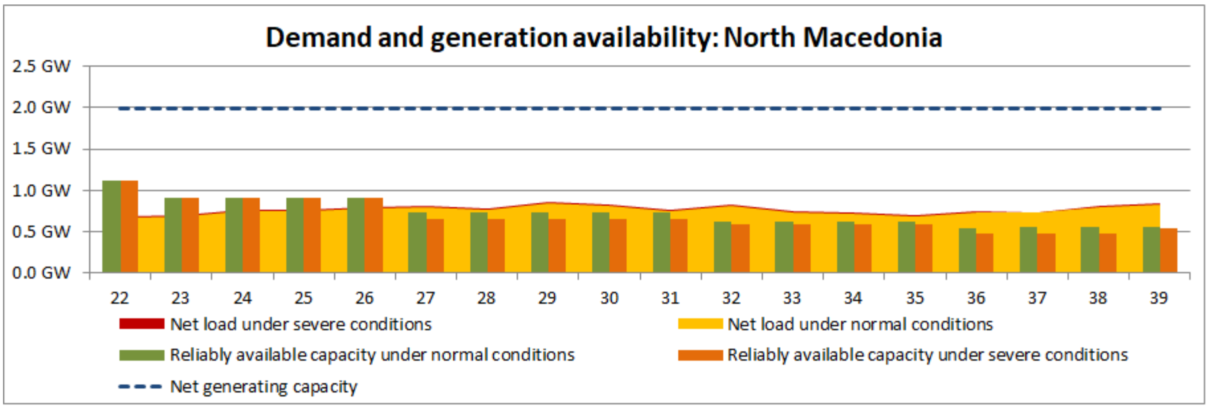
Northern Ireland: Winter review 2018/2019

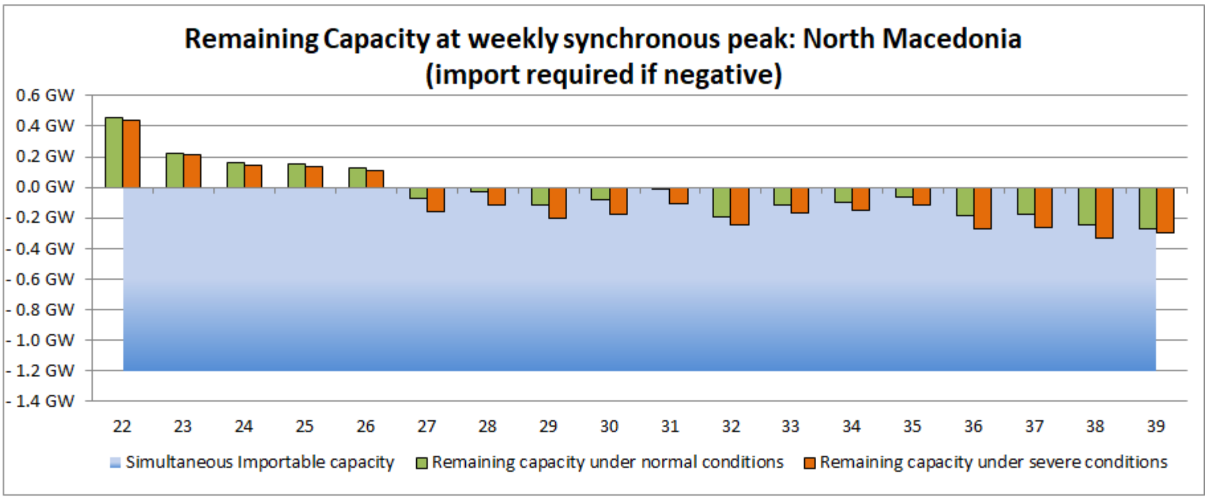
No downward regulation issues were identified during the past season. The TSO issued an Amber Alert 1 to all participants on 9 October and 24 January due to the combined effect of system constraints and forced generation outages.

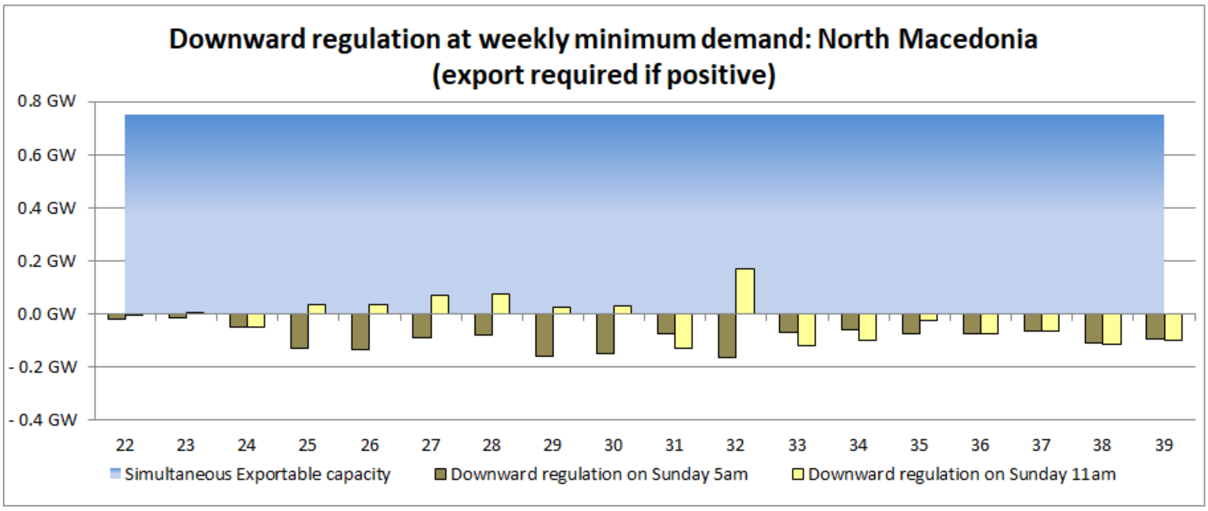
North Macedonia: Summer outlook 2019

To achieve adequate reliability in the summer 2019, the planned maintenance of the power plants should begin as scheduled. During this period, some of the 110 kV and 400 kV substations will undergo carefully planned revitalisations. No impact on system operation is expected. Given the dry winter 2018/2019, the hydro reservoir levels in North Macedonia are expected to be low, especially in the second half of the summer period. Electricity imports are expected to increase due to lower than expected hydro generation. No adequacy issues are expected in the coming summer.

The interconnections will have a key role in securing the adequacy of the system. North Macedonia relies on imported energy in summer 2019. However, North Macedonia transmission system capabilities are sufficient to ensure all necessary energy imports and all necessary transit flows in the region.







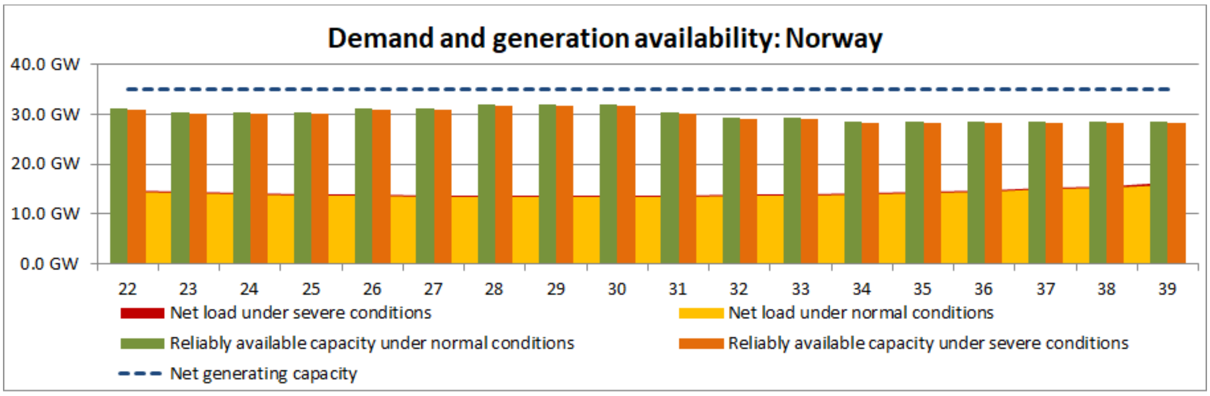
North Macedonia: Winter review 2018/2019

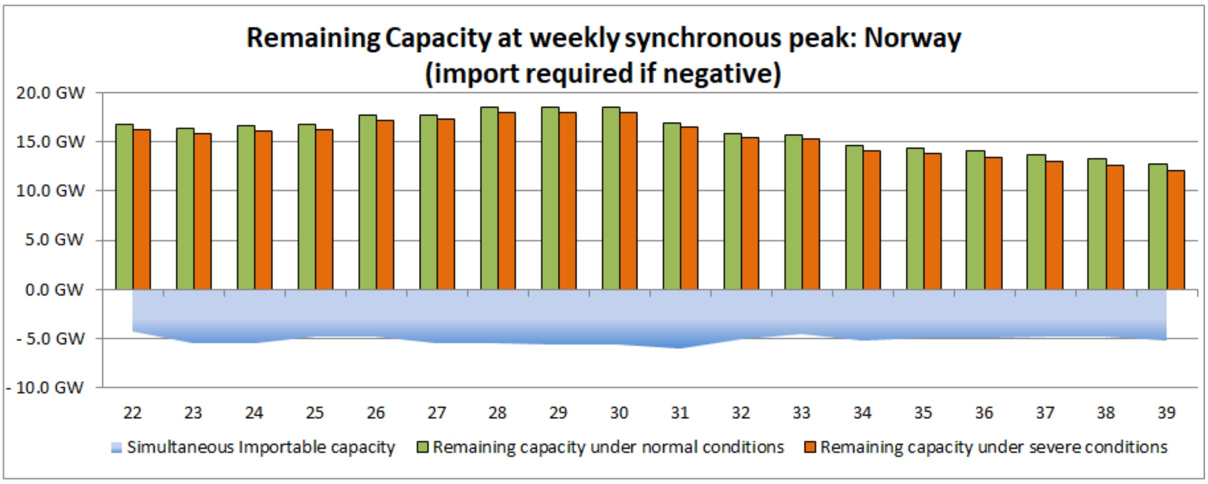
North Macedonia experienced a mild to chilly winter with no unexpected events in the system. There were no critical outages and there were no icings on the transmission lines. The system operation was secure and reliable throughout the winter period.

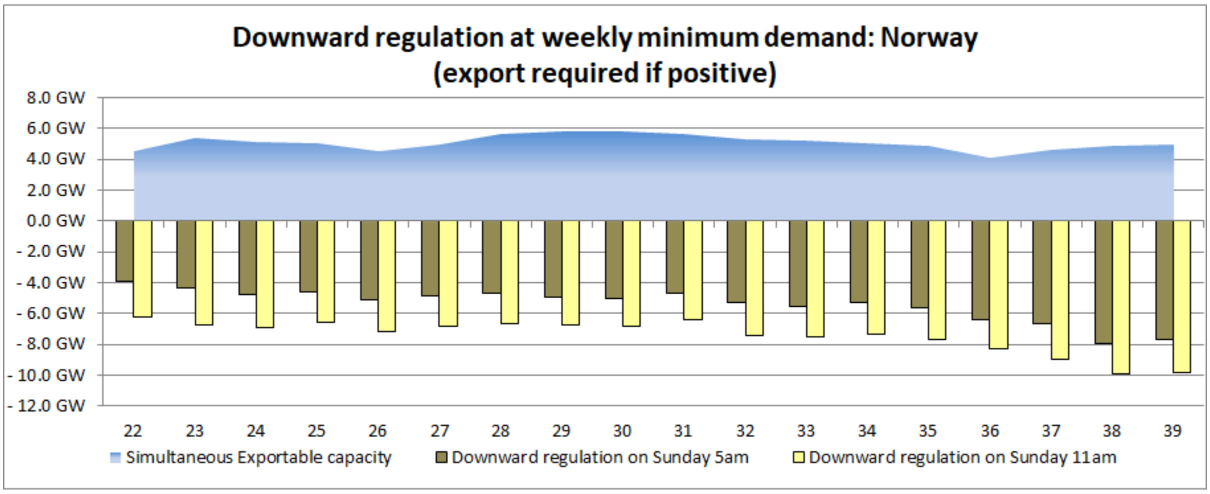
Norway: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







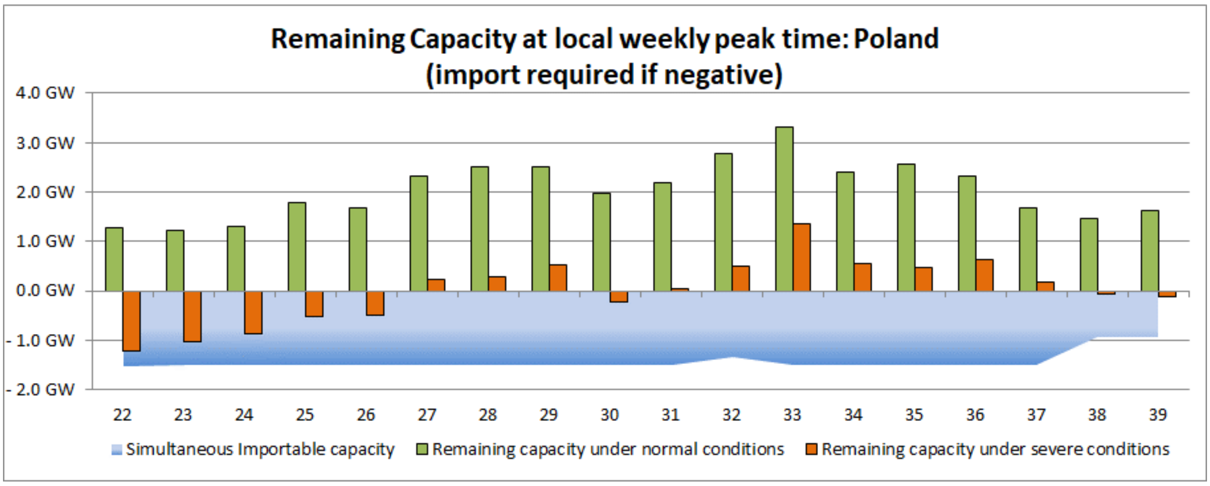
Norway: Winter review 2018/2019

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

Poland: Summer outlook 2019

Potential critical periods and foreseen countermeasures

The Summer Outlook presents the pan-European adequacy situation for 19:00 CEST, as Midday European demand is fed by high amounts of photovoltaic generation. As solar power in Poland is still negligible and Polish peak demand during the main summer period takes place between 13:00 CEST and 14:00 CEST, the adequacy results for the Polish power system are definitely much worse during the day than during the evening. Indeed, no problems are observed in evening peak in summer, even under severe conditions. Therefore, all the descriptions below regarding the situation in Poland refer to sensitivity on country peak time.



Summer Outlook 2019 adequacy results are better compared with previous Summer Outlook ones, as in mid-June, a new hard coal power plant with the capacity of c.a. 800 MW is expected to be fully available after the test period. Under normal and severe conditions, PSE expects no adequacy issues, however under severe conditions import via interconnections may be necessary, especially at the beginning of the summer period. In particular, the level of available import capacity on synchronous profile with Germany, Czech Republic and Slovakia is hard to predict due to high uncertainty caused by the level of unscheduled flows through the Polish power system (the issue is described at length in the previous Outlook's report). Therefore, a situation may occur where there would be enough available solar generation in Germany at midday to support adequacy in the Polish power system, while interconnections (in the direction to Poland) might be congested. On the other hand, it is expected that the full capacity of interconnections from Sweden and Lithuania will be available, but generation resources, mainly in Lithuania, might not be sufficient to cover the import needs of the Polish power system.

Installation of Phase Shifters in the Mikułowa substation in June 2016[15] improved operational conditions, and allows PSE to increase import capacity on synchronous profile. Nevertheless, such capacity might be offered only in day ahead and intraday horizon and depends[16] on operational conditions.

On 25 March 2019, recommissioning of the upgraded 380/400kV double circuit line Krajnik-Vierraden took place with temporary configuration in Vierraden substation (two from four planned PSTs installed). PSE is monitoring the impact of the connection on operations for the coming summer.

In the event of adequacy issues during the extremely severe conditions and the need to increase import capacity on synchronous profile, PSE has a dedicated agreement with 50Hertz. This remedial action is described in detail in the Summer Outlook 2018 report[17].

In addition, PSE has contracted 0.66 GW of DSR till 30 June, which may be activated in case of inadequacy. From 1 July 2019 PSE expects to have similar level of DSR, however a detailed level is not confirmed at the moment (end of April). Nevertheless, the mentioned DSR potential was not considered in the Summer Outlook 2019 study as this DSR is procured to be used as a remedial measure and is out-of-market.

PSE does not expect problems with the renewable infeed at 5:00 and 11:00 CEST on Sundays. Solar generation is still negligible in the Polish power system.

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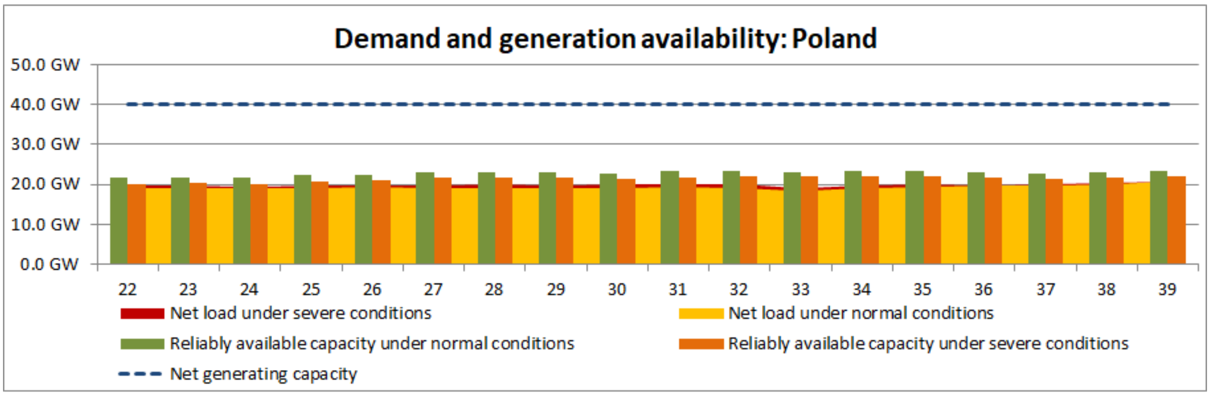
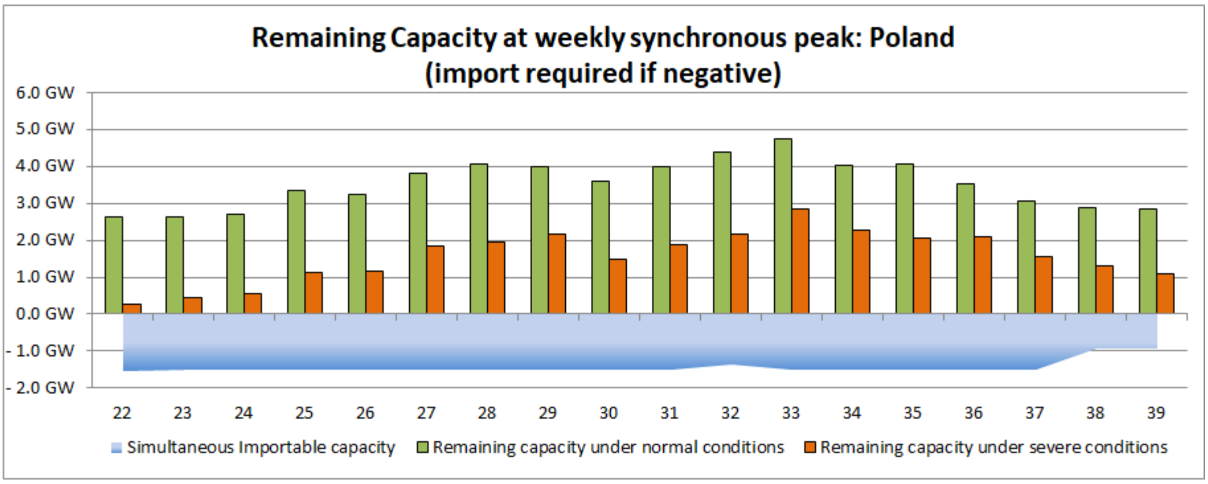
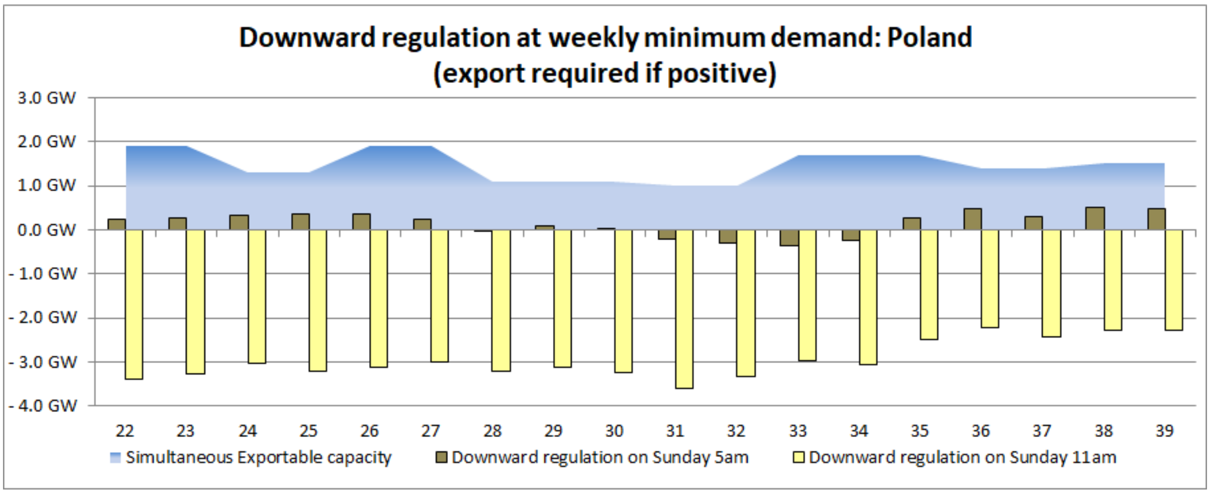
[15] More details can be found on page 100 of the Summer Outlook 2016.

[16] The remark about the dependency of capacity possible offered to the market and operational conditions also refers to the best estimate of NTC provided in the report in the direction PL->LT and PL->SE.

[17] Summer Outlook 2018, page 102







Poland: Winter review 2018/2019

A new hard coal Power Plant with the capacity of c.a. 800 MW was synchronised in January 2019. It is expected it will be fully available after the test period, in June 2019.

No adequacy issues occurred last winter, however new peak demand was registered on 25 January, at 13:15. For the first time in history, the winter peak took place during the day, not in the afternoon–evening. It amounted to 24.7 GW (previous peak was registered on 28 February 2018 and amounted to 24.6 GW).

On 25 March 2019, the recommissioning of upgraded 380/400kV double circuit line Krajnik-Vierraden took place with a temporary configuration in Vierraden substation – two from four planned PSTs were installed and currently operate in series with a single circuit of the Krajnik-Vierraden line. This northern connection on the PL-DE border operates in parallel with a southern one – Mikułowa-Hagenwerder double circuit 380/400kV, where PSTs have been already installed. However, the upgrade of the internal connection of Vierraden on the German side from 220 to 380/400 kV is still pending, therefore the installation of the remaining two from four PSTs in Vierraden, which will complete the project referring to PSTs on the PL-DE border, is due approximately in 2021/2022.

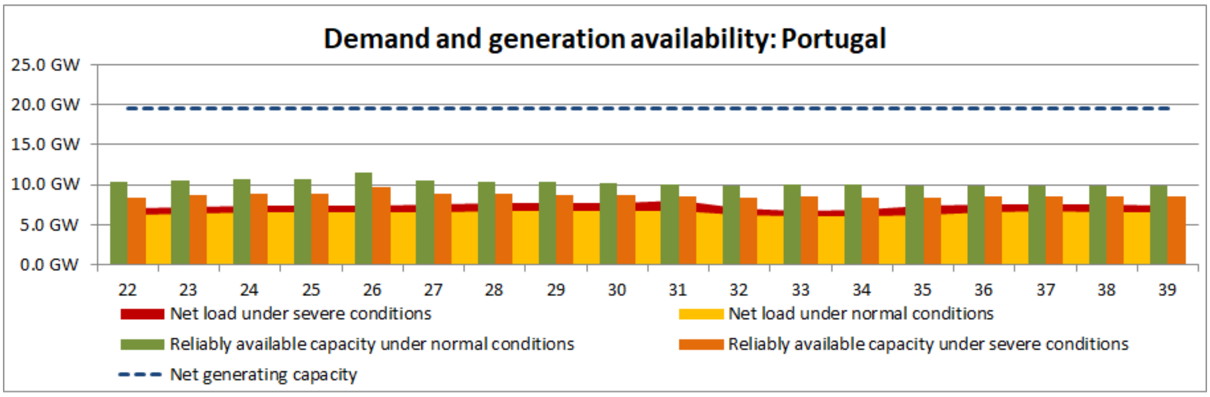
Reconnection of the Krajnik-Vierraden line with PSTs in Vierraden substation plus the nearest PSTs in the region. Transitional state until the completion of the project, referring to PSTs on the PL-DE border.

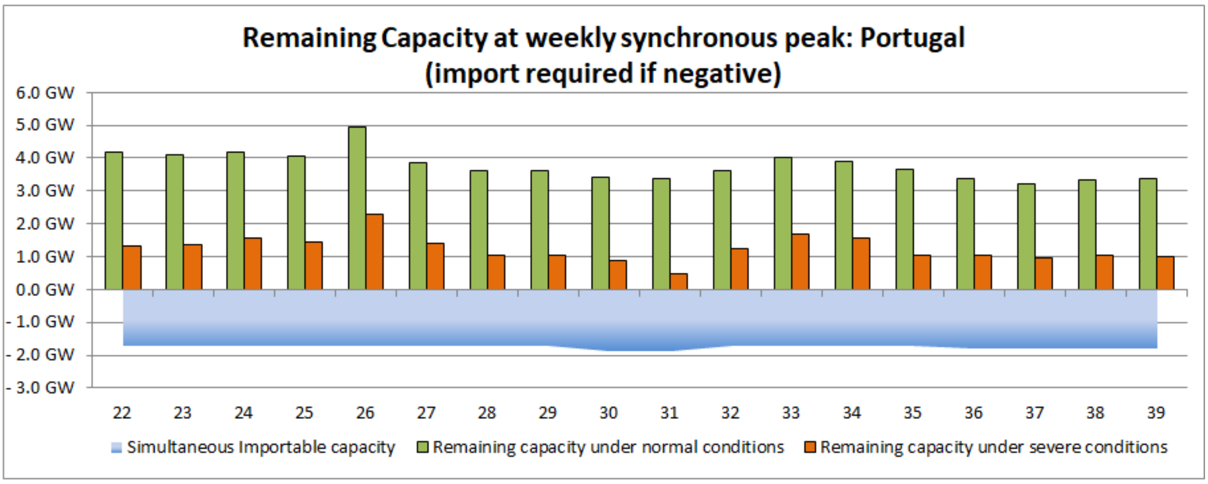
Portugal: Summer outlook 2019

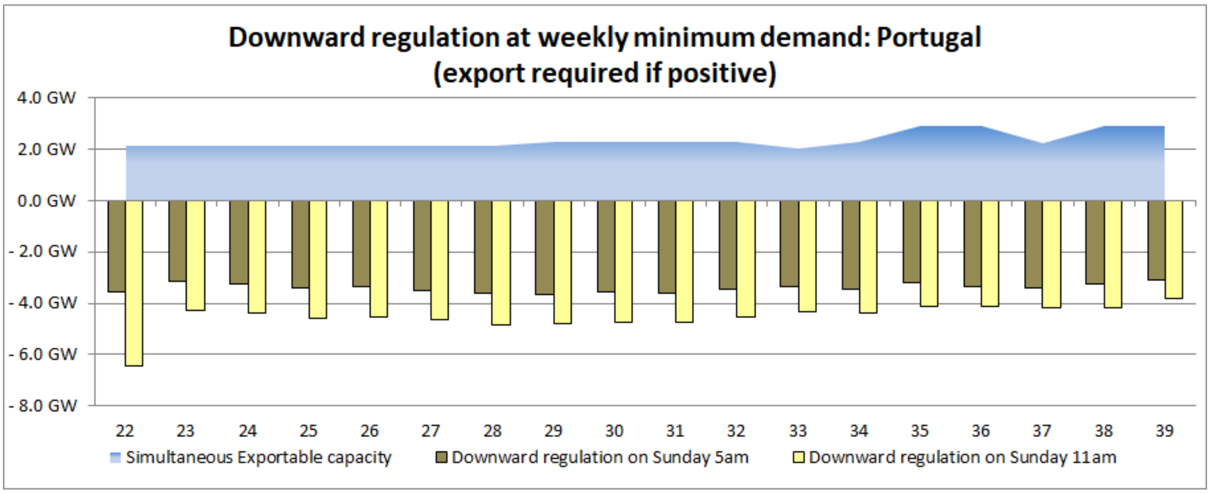
Potential critical periods and foreseen countermeasures

REN's outlook for summer 2019 season is positive, despite a difficult scenario expected for hydro generation: in mid–April, hydro storage is about 55% of its maximum capacity, which is considerably lower than in the previous year and below the average for this time of the year. As in recent years, Portugal may experience an extreme drought during the summer.

Our assessment of the downward regulation capability of the system reveals a sufficient margin to deal with periods of high wind and low demand.







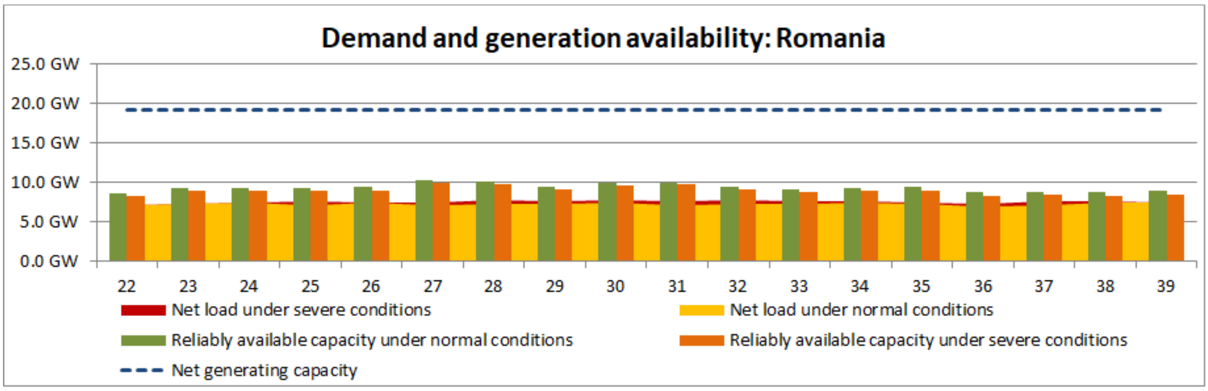
Portugal: Winter review 2018/2019

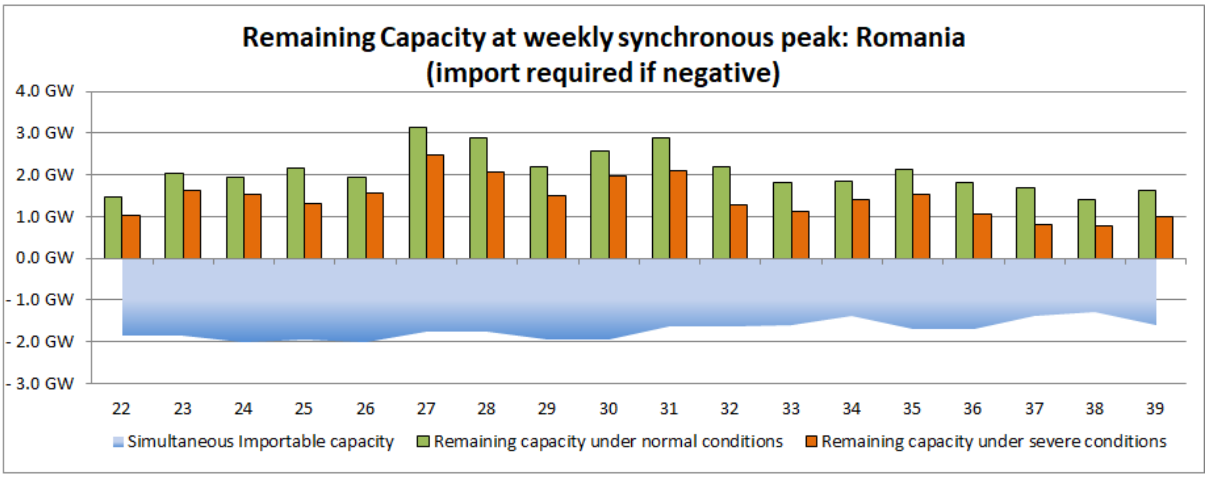
The winter 2018/2019 was generally mild, with temperatures in some periods significantly above the average, which contained demand (more than 2% below winter 2017/2018 values). In the first months of 2019, hydro generation was about 49% of average values and wind generation only 91% of the average. Despite this, renewable generation share (50%) were barely affected because, combined with low demand, market conditions favoured imports. In fact, thermal generation even registered a decrease of about 20%.

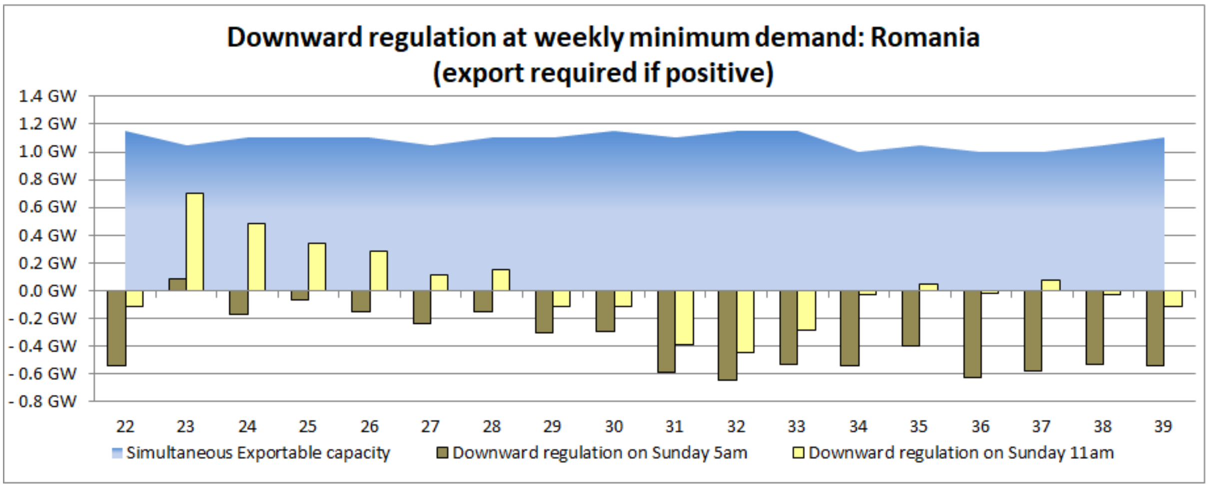
Romania: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Romania: Winter review 2018/2019

Winter 2018–2019 was characterised by normal temperature values. However, in areas of the southern part of Romania, at high mountains and at the seashores, lower than average temperatures were recorded occasionally in December and January. In February, temperatures increased and were higher than average.

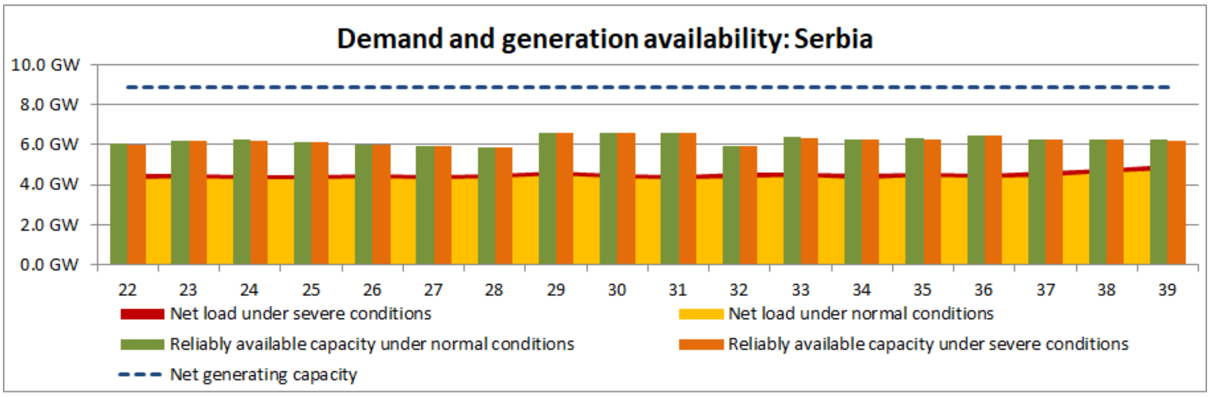
The snowfalls were high in December and January and low in February.

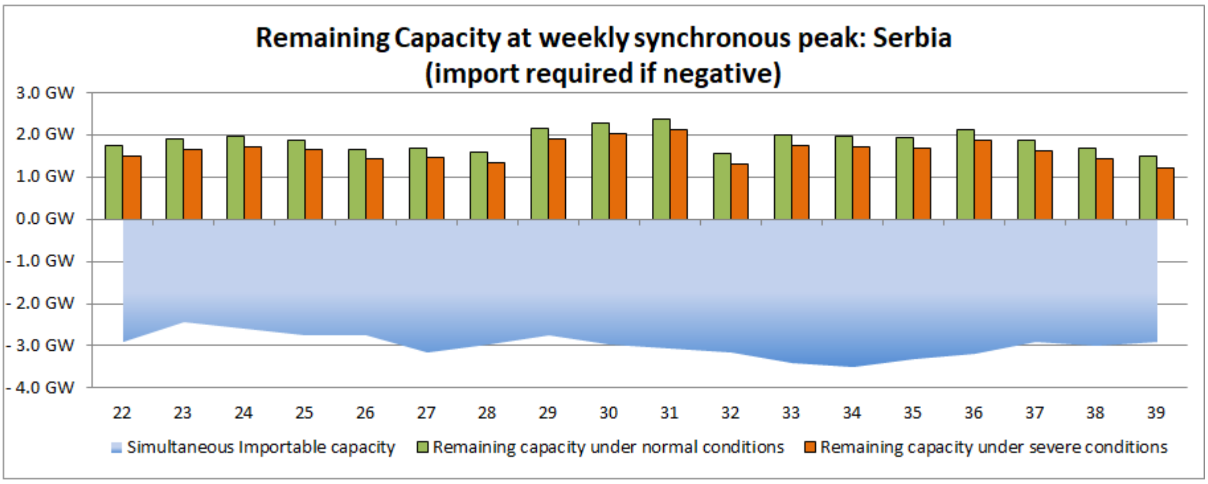
No adequacy issues in Romanian power system were recorded during winter 2018/2019. The reserves in the main hydro reservoirs were between 60% on the last days of November and 47% on the last days of February. All scheduled exchanges were delivered for the past season.

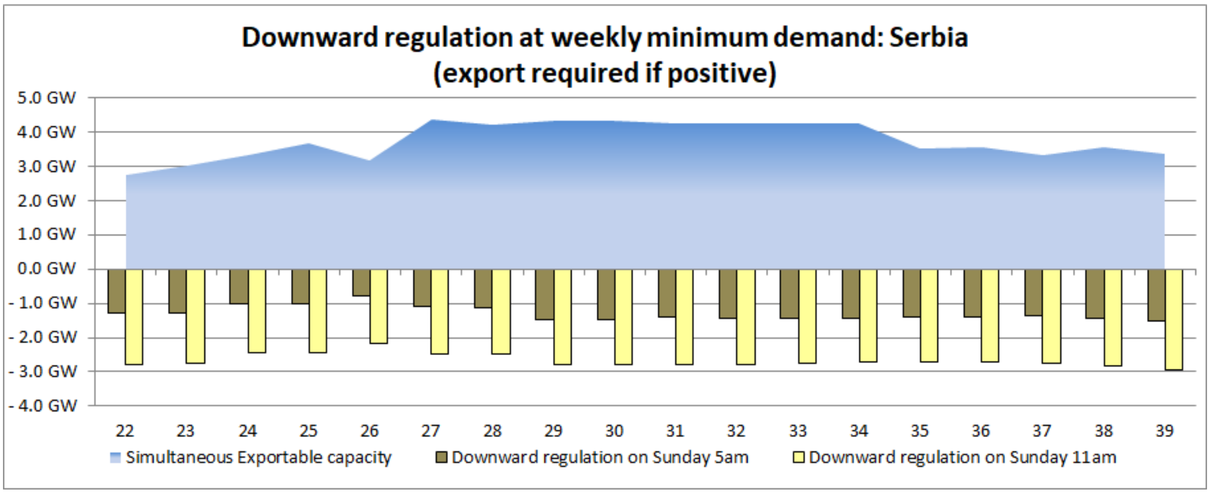
Serbia: Summer outlook 2019

In summer 2019, no problems are expected for supply demand. The hydro reservoir levels are high and the planned maintenance is moderate. Significant energy exports are expected under normal weather conditions through the whole summer.

Under severe weather conditions, i.e. extremely high temperatures and longer dry periods, extremely high peak demand might occur. Exports might decrease, or even, in some instances, energy might be imported.







Serbia: Winter review 2018/2019

The winter 2018/2019 passed without major problems. Weather conditions were generally as expected during the whole winter, without longer periods of very low temperatures.

A small amount of energy imports was realised in January and the first half of February, while the warmer weather in late February and March led to significant energy exports.

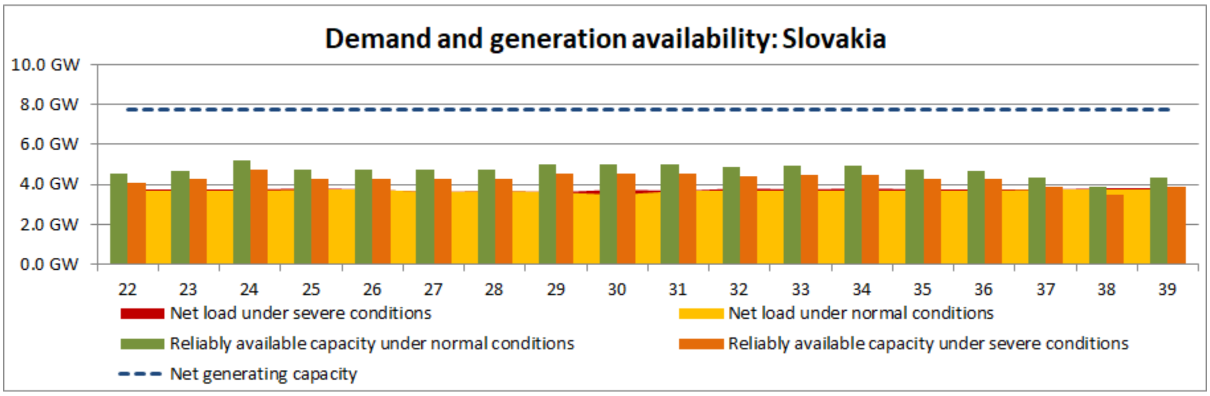
Problems from last summer related to the lack of energy in the sub-area KOSTT, which operates within the EMS control area, continued throughout the last winter. However, Regional Group Continental Europe (RGCE) managed to keep the synchronous time within the permitted limits.

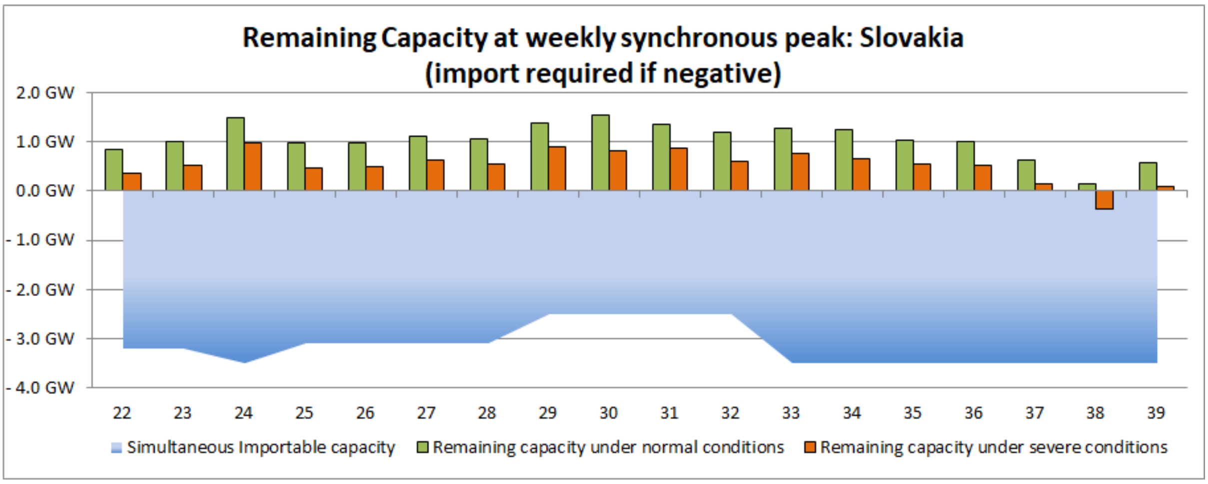
Slovakia: Summer outlook 2019

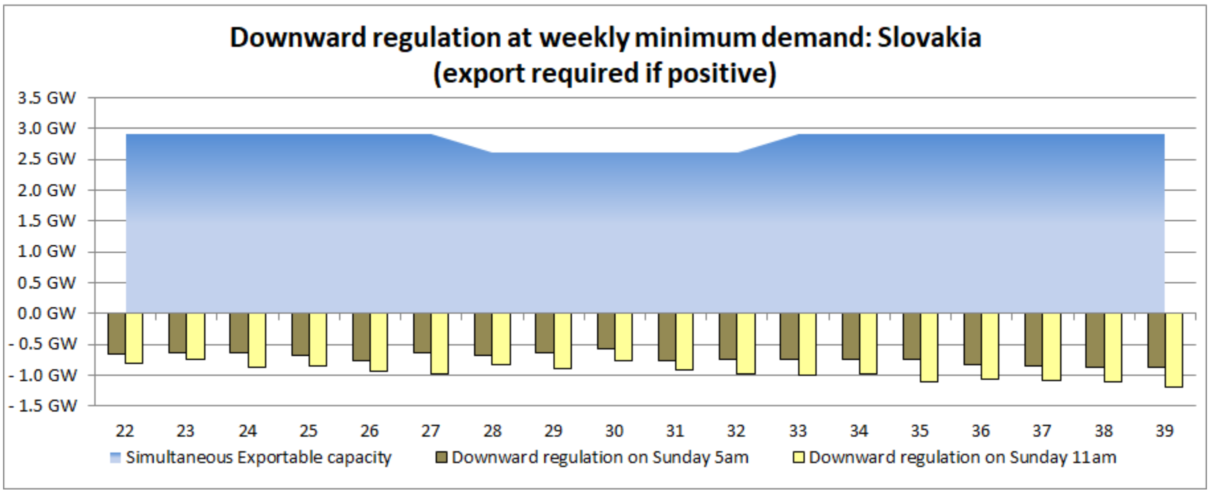
No adequacy risk is foreseen in Slovakia during summer 2019. In summer 2019, the expected generation capacity of Slovakia will be sufficient in all weeks, except for the second half of September under severe conditions scenario. Cross-border capacities for electricity import are still sufficient. Persistent extreme dry and hot weather can cause a decrease generation resulting in a possible lack of power to cover the load without import.

The weekly peak demand under severe conditions is assumed to be about 3880 MW in September (in summer outlook 2018 it was 3850 MW in June). The peak demand recorded in the summer 2018 was in August (3878 MW).

The level of maintenance is normal during the summer. The most important scheduled maintenance relates to nuclear units (500 MW) in the beginning and in the end of summer.







Slovakia: Winter review 2018/2019

Winter 2018/2019 compared to winter season 2017/2018 from a weather point of view can be divided into two parts. December 2018 and especially January 2019 were colder months than in the previous winter. The average temperature in December was 0.8°C (1.3°C in 2017) and in January -1.1°C (2.0°C in 2018). In the second half of winter, the weather was much warmer. The average temperature in February was 3.0°C (-1.1°C in 2018) and in March 2019 it was 7.4°C (2.7°C in 2018).

The total production of electricity of Slovakia during the winter period was slightly higher compared with the previous winter (index 100.6%). This winter was very rich in snow, which impacted hydro production in March (index 158.8%). Increases in the total production of fossil power plants (index 110.7%) was noticed in the winter period, mainly in January (index 125.4%). The increased generation of fossil fuels power plants was from hard coal (118.9 %) and natural gas (127.9%). After three months of break, the combined-cycle natural gas power plant Malženice (capacity 419.6 MW) begun its generation again from the beginning of January 2019.

The electricity consumption was lower compared to the previous winter (index 98.7%). Increase in consumption was in January (103.4%). Significant decrease in consumption was in February (96.7%) and March (94.6%). These variations in consumption were influenced by different weather conditions. The winter peak load of 4571 MW was on 22 January 2019 at 9:00; in the previous winter it was 4506 MW (27 February 2018 at 9:00).

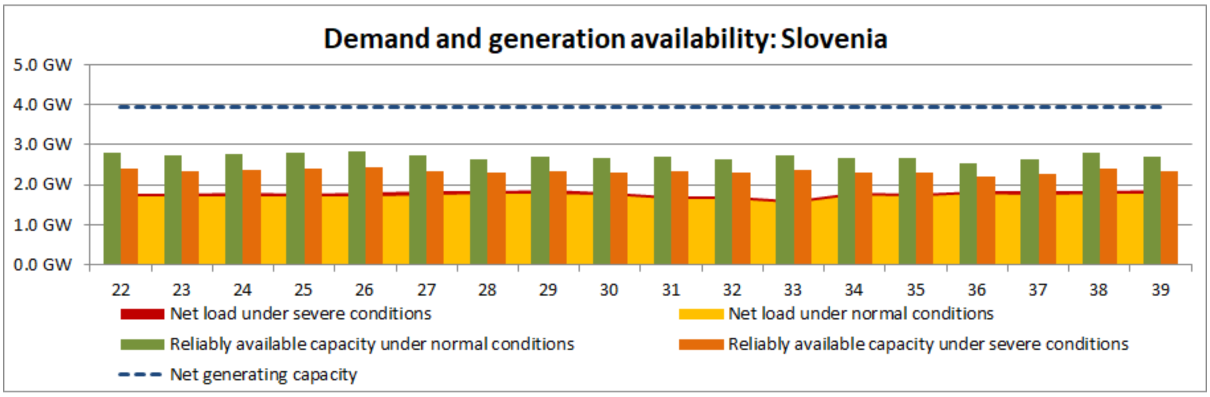
Except for March, the electricity was imported to the power system of Slovakia to cover the load of the system. The total import of electricity decreased significantly compared to the previous winter (index 78.8%). Also, the share of imported electricity in consumption decreased to 6.1% (compared with 7.6% in winter 2017/2018).

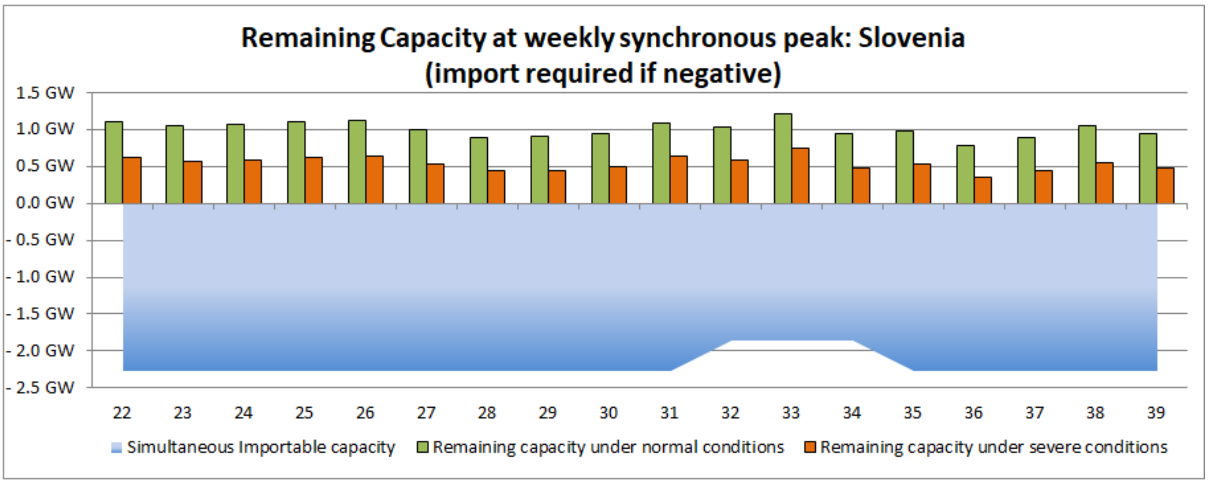
Metered cross-border physical flows of electricity increased substantially in winter 2018/2019 in all months. Total imports increased to 143.6% and total exports increased to 164.1% compared to electricity cross-border physical flows of the previous winter.

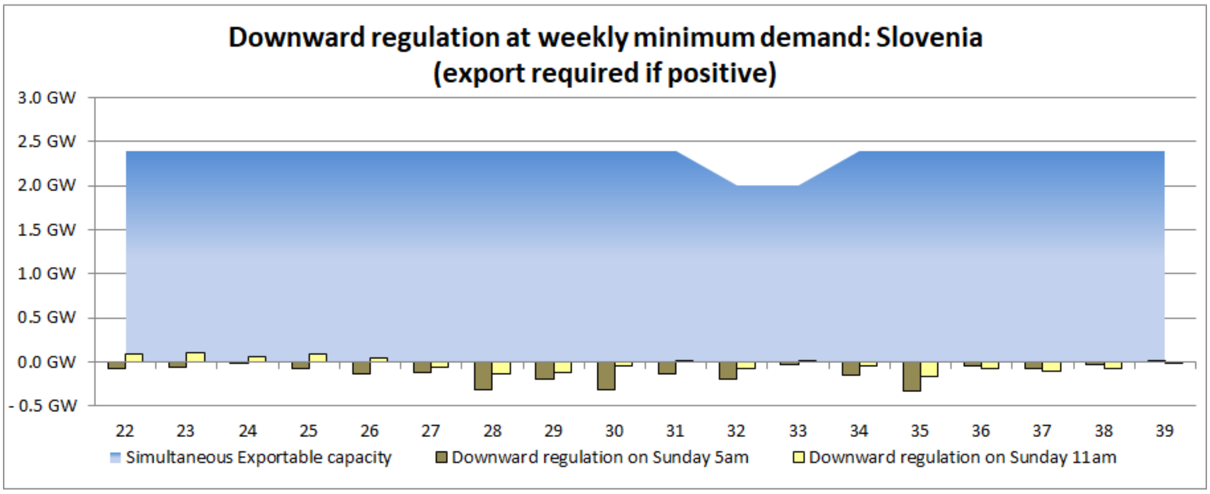
This analysis and data are still preliminary and can be changed.

Slovenia: Summer outlook 2019

No adequacy issues are expected in summer 2019 in Slovenia. All the major power units are expected to be available during the whole period and our estimations indicate that even in the event of severe conditions, the Slovenian power system will be able to cover all of its energy needs.







Slovenia: Winter review 2018/2019

Temperatures this winter were slightly above the last 30 years' average and there were more sunny days. Hydrological conditions were below the five-year average and hydro power plants did not produce as much energy as anticipated. Additionally, a pumping power plant with an installed capacity of 180 MW was under maintenance during the whole of winter 2018/2019 and the second biggest power unit was not available for several weeks. However, Slovenia did not experience any adequacy related issues.

Spain: Summer outlook 2019

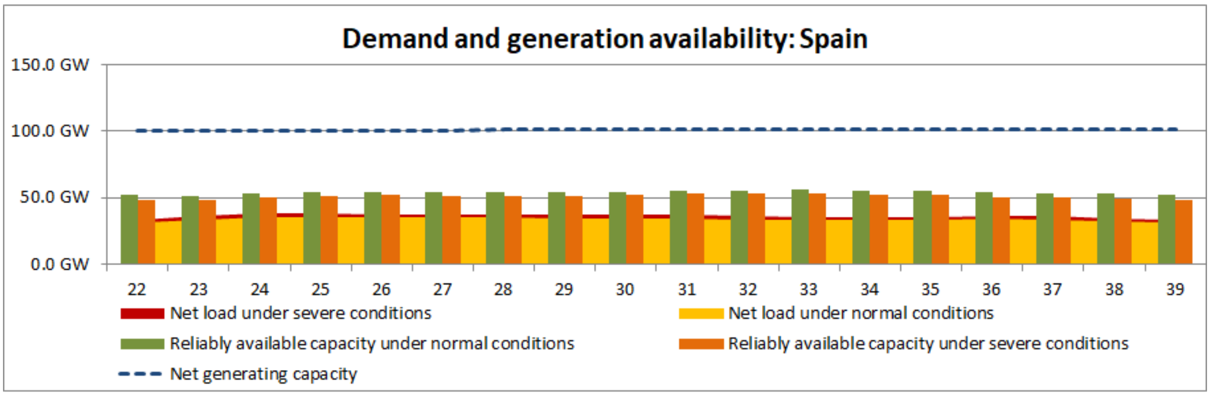
No adequacy risk is expected in the Spanish peninsular system for the upcoming summer. Generation availability should be sufficient regardless of import availability from neighbouring countries. If average conditions are considered, remaining capacity around the hour considered for Summer Outlook (19:00 CEST) will be over 17 GW. In the case of severe conditions, the assessed remaining capacity is still over 12 GW.

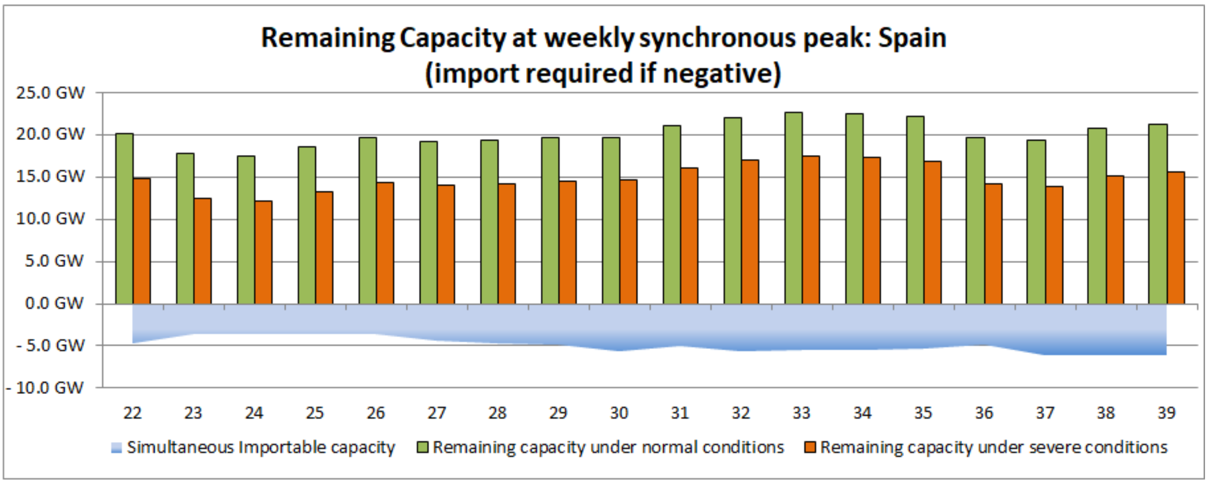
In Spain, peak summer demand takes usually place around 12:00–14:00. Even in the case of simultaneous extreme peak demand, very low wind generation (less than 10% of wind installed capacity), drought conditions and a high thermal forced outage rate, assessed remaining capacity is still over 11 GW.

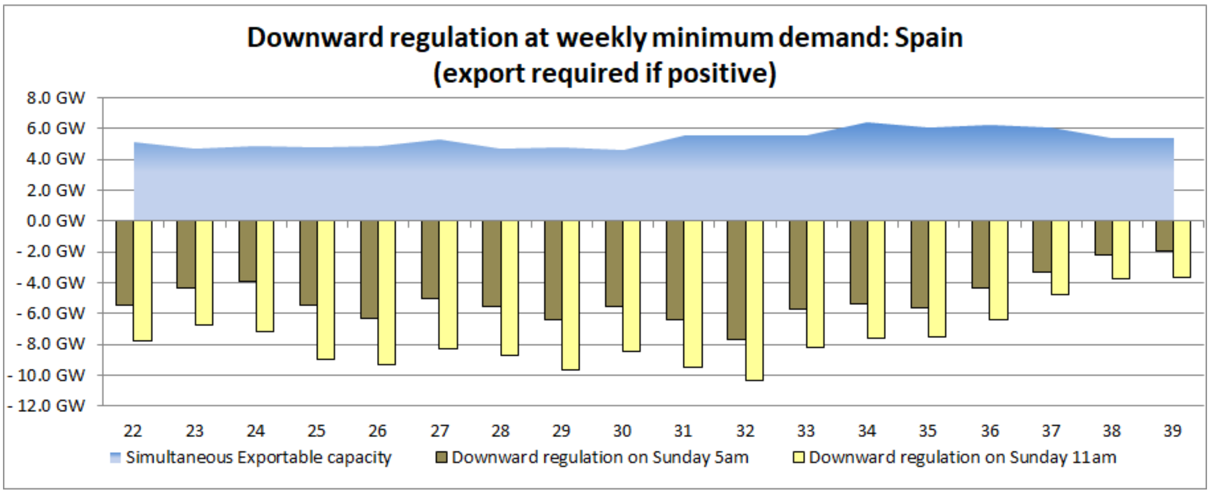
Hydro reservoirs levels are currently slightly below the historical average values.

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

There are no downward regulation issues expected in the quantitative analysis.







Spain: Winter review 2018/2019

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

Sweden: Summer outlook 2019

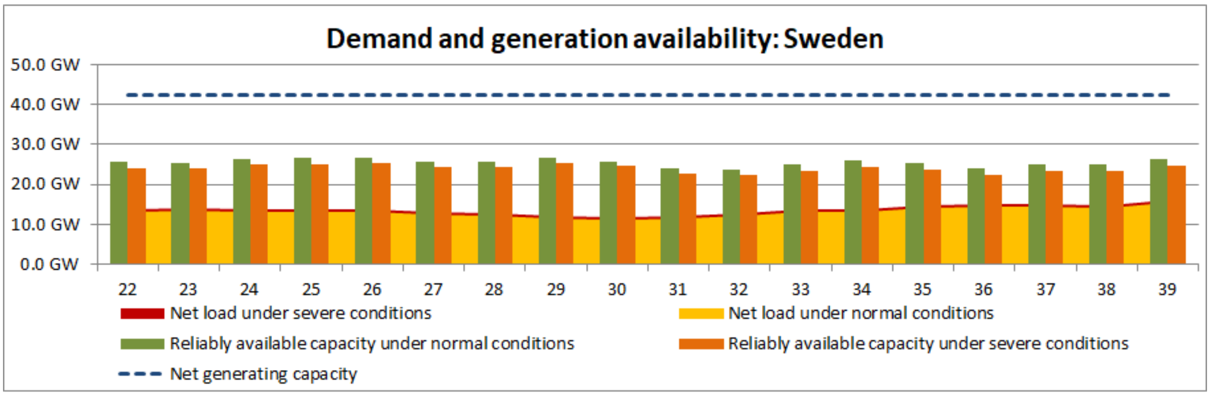
All through the summer there are planned transmission system outages in order to allow for the rebuilding of old substations as well as power lines and the connection of new wind power farms to the grid. The national grid is very old and many reinvestment projects are planned, not only for this summer, but for many years to come. Over 2 GW of wind power is expected to be installed in 2019 and the trend of increased wind power is expected to continue.

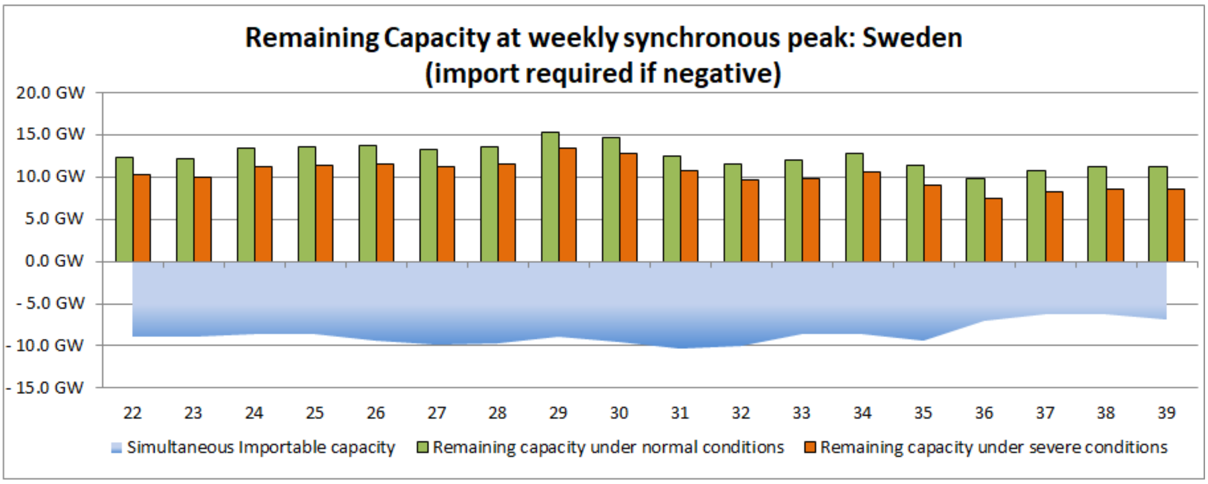
In summer 2019, adequacy problems are not expected in Sweden, since electricity demand is strongly dependent on temperatures and peak demand occurs at times with cold weather. However, there is less generation capacity available during the summer due to the maintenance allocation of nuclear reactors during this period. In addition, all the remaining capacity should not be assumed to be available for export since internal congestions are not accounted for in the analysis.

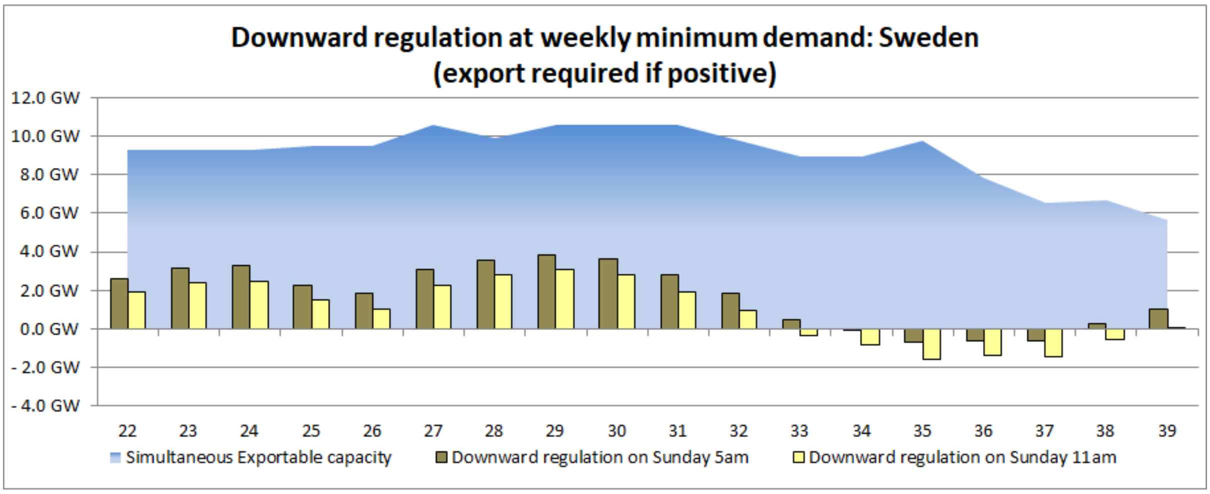
There is a risk of not meeting the requirements for frequency stability as a result of a large power imbalance occurring in a low inertia situation. The risk is higher during the summer when less conventional power plants–the main source of inertia–are operating. Countermeasures, such as reduced power output from the largest production unit in operation, are expected to be activated in some low inertia situations.

An excess of inflexible generation can normally be handled thanks to a high share of flexible hydro power in the system. However, at minimum demand and high wind conditions in combination with high nuclear power generation, dependency on export of around 3 GW is expected for some hours in order to handle the excess of inflexible generation. During the first half of the summer in particular, when a high proportion of installed nuclear power is running, the situation will be challenging and additional downward regulation capacity is expected to be necessary.

Import and export limitations are expected due to the bottleneck in the so called West Coast Corridor (inside SE03, in the vicinity of Gothenburg), especially during summertime at conditions with low demand and high nuclear power generation.







Sweden: Winter review 2018/2019

The winter was generally mild but several storms occurred with local power shortages as a result. Nationally, power adequacy was not of critical concern as southern Sweden (where most consumption is found) saw above-average temperatures.

An oil leakage in the Öresund-cables was discovered during week 2. This led to reduced transmission capacity between DK2 (Western Denmark) to SE4 from 1700 MW to 350 MW and from SE4 to DK2 from 1300 MW to 0 MW for 3.5 days.

Ringhals 2 has been operating at half capacity (452 MW) since 27 December due to a generator fault. As of late March, it is planned to return to full production on 30 April. After a failure on 23 January, production in Oskarshamn 3 dropped from 1400 MW to 450 MW but returned to normal during the following day. As a response to this, the activation time of a portion of the strategic reserve ('peak load reserve') was reduced at that time, but no actual generation was ultimately required.

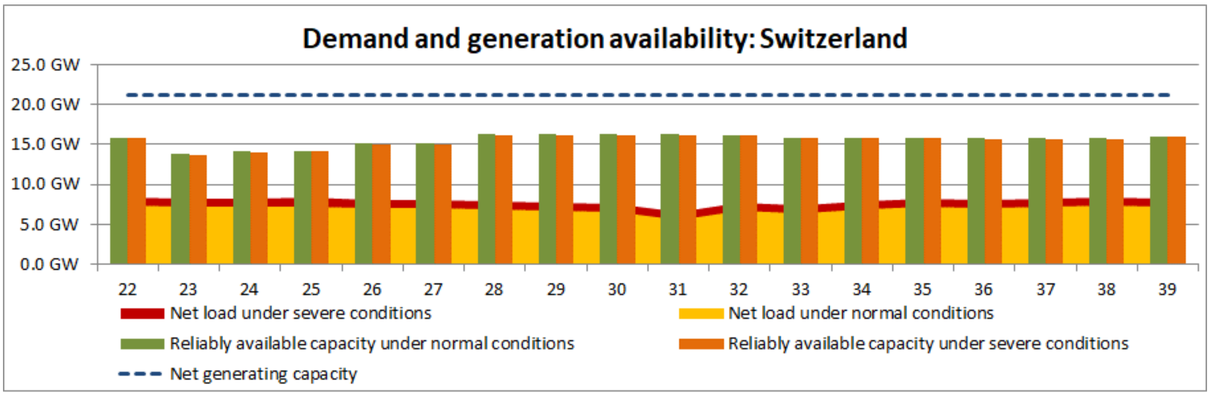
Switzerland: Summer outlook 2019

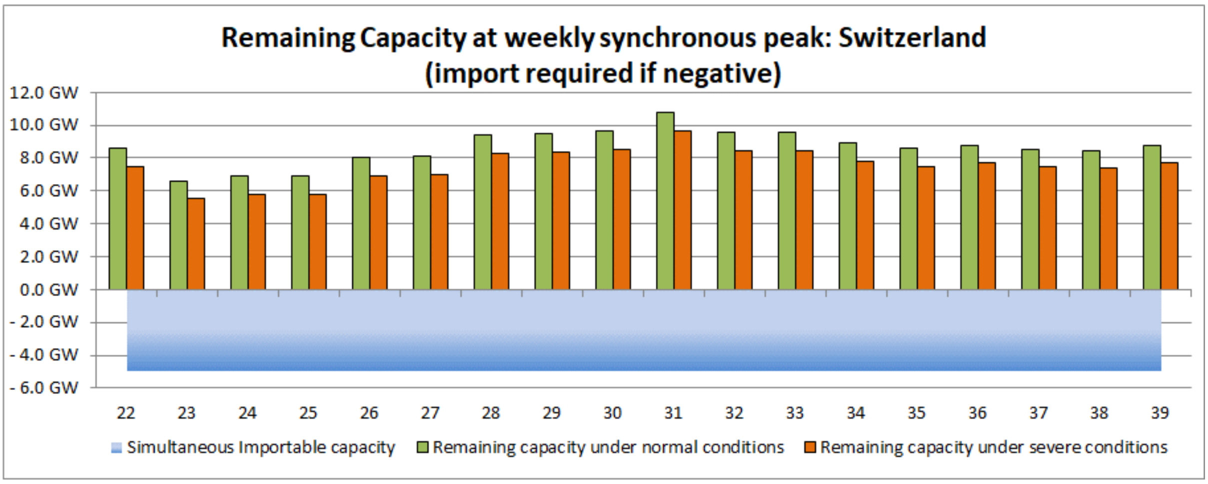
Potential critical periods and foreseen countermeasures

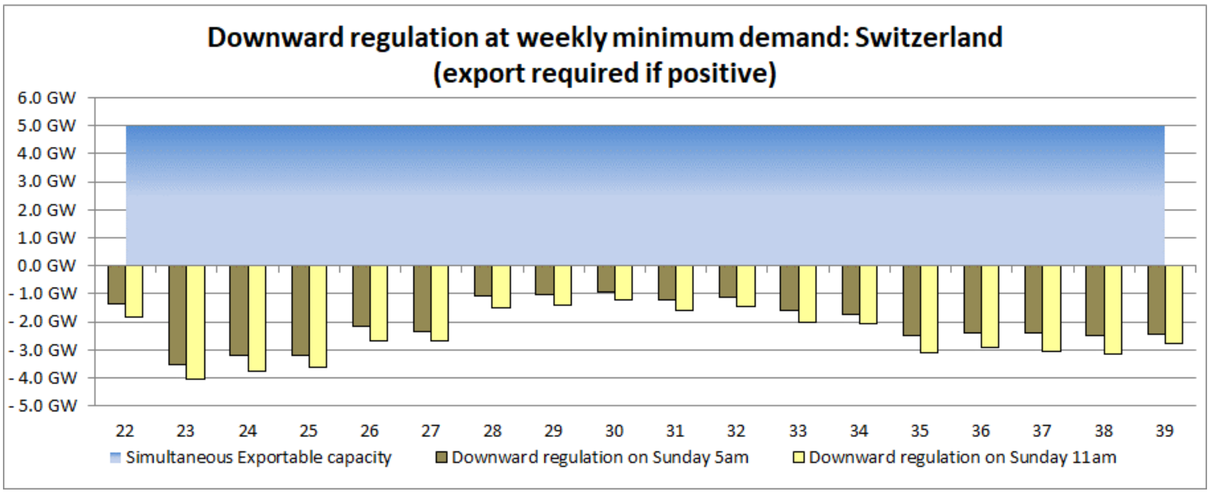
Using the current adequacy methodology, no adequacy or downward regulation issues are expected for the coming season. Deterministic capacity–based assessments cannot reveal potential problems faced by hydro–dominant countries like Switzerland. In particular, for Switzerland it is very important to also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

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

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







Switzerland: Winter review 2018/2019

General comments on past winter conditions

The second warmest winter since 1864 was observed in the plains of the south of the Alps. In the other parts of Switzerland, the temperatures were not particularly high. Abundant precipitation in December and January led to lots of snow in the mountains. February was very sunny.

Specific events and unexpected situations that occurred during the past winter

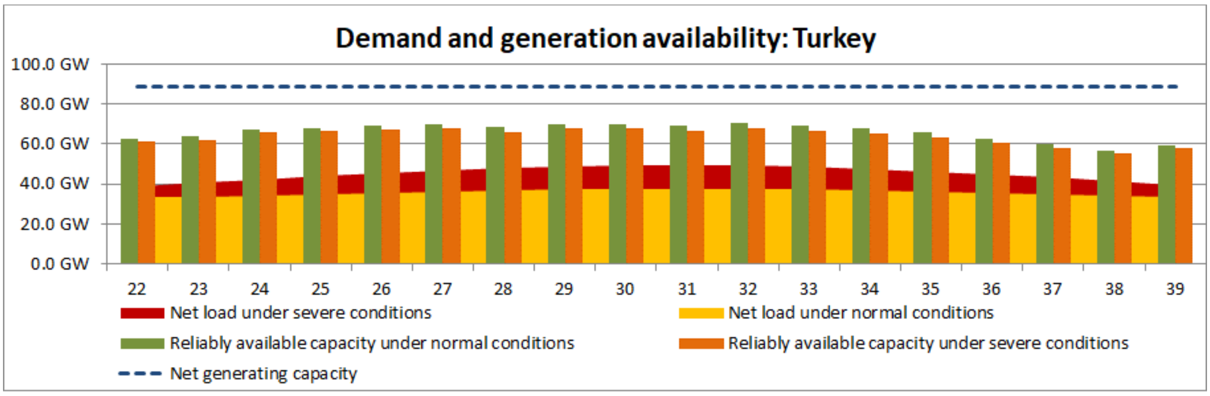
The winter 2018/2019 was challenging for the operation of the transmission grid.

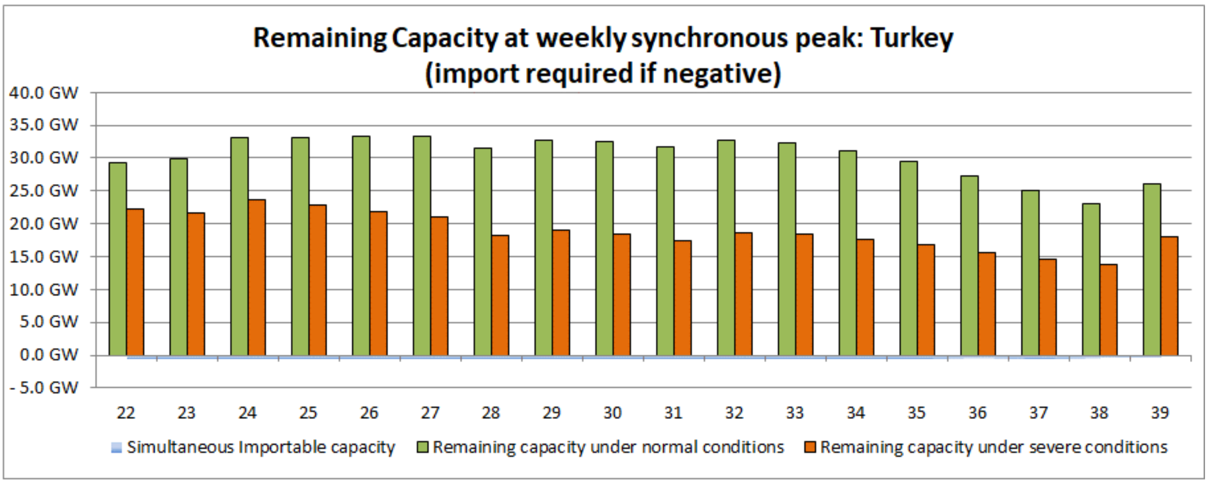
In October 2018, at the beginning of November 2018 and in February 2019 the temperatures were relatively high, therefore during those periods the seasonal maximal current values for the lines could not be used and lower maximal current values had to be used instead.

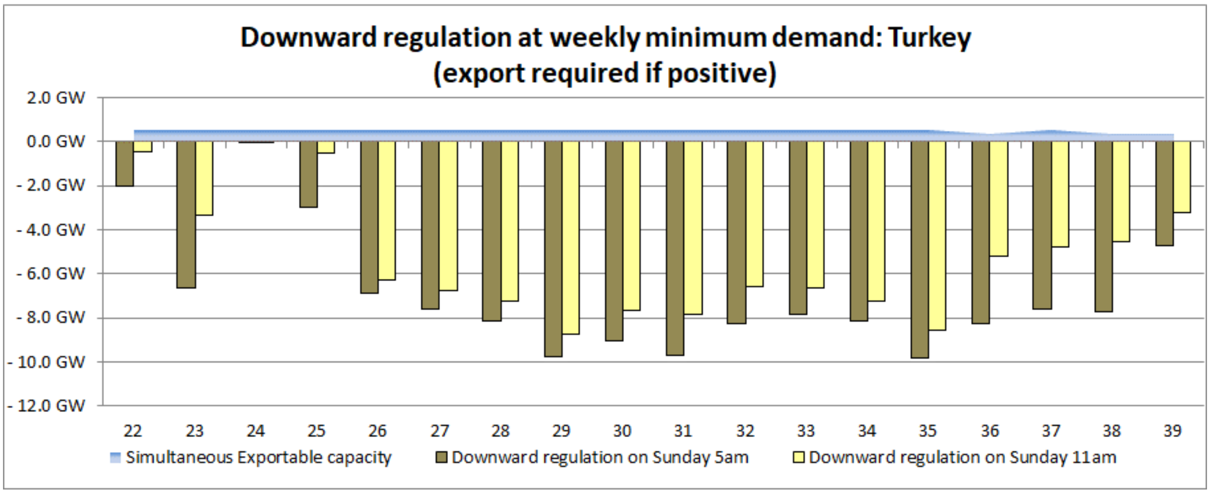
Turkey: Summer outlook 2019

Potential critical periods and foreseen countermeasures

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







Turkey: Winter review 2018/2019

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.*[18]

Despite its limitations, the 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 design advanced methodology to overcome limitations, thus providing additional realistic insight on possible European system operational states during each country's most critical moments. For this purpose, ENTSO-E is currently developing a full probabilistic methodology with hourly calculations at the pan-European level.

1. Upward Adequacy and Downward Regulation Definitions

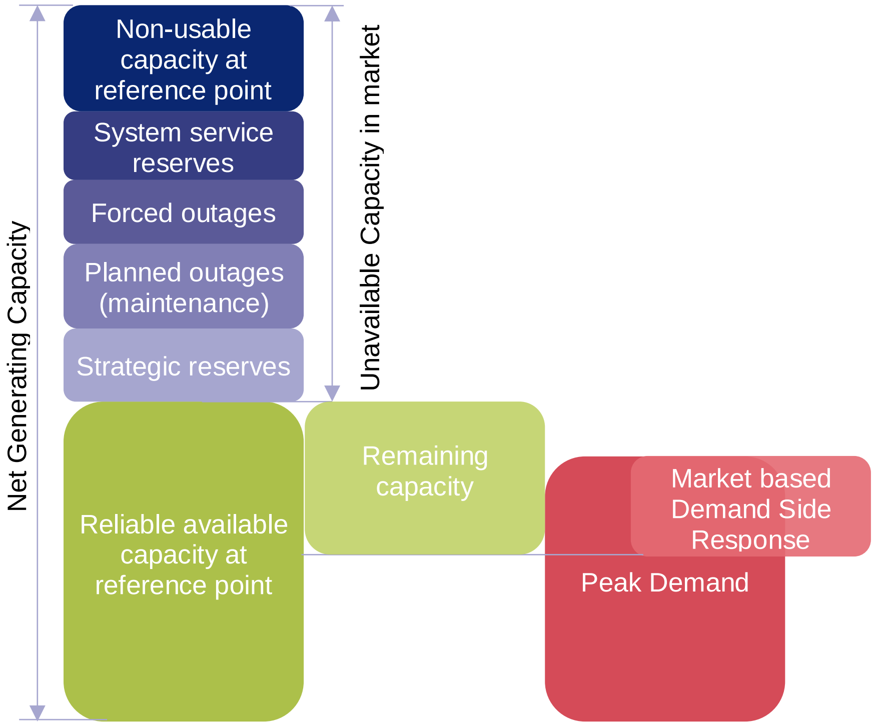
The **upward adequacy analysis** consists of identifying the ability of generation to meet the demand by calculating the ‘remaining capacity’ (RC) under either normal conditions or severe conditions.

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

The analysis is the same under normal or severe conditions, and is schematically depicted in the figure below:[19]

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

[19] *Definitions may be found in the Glossary provided 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.

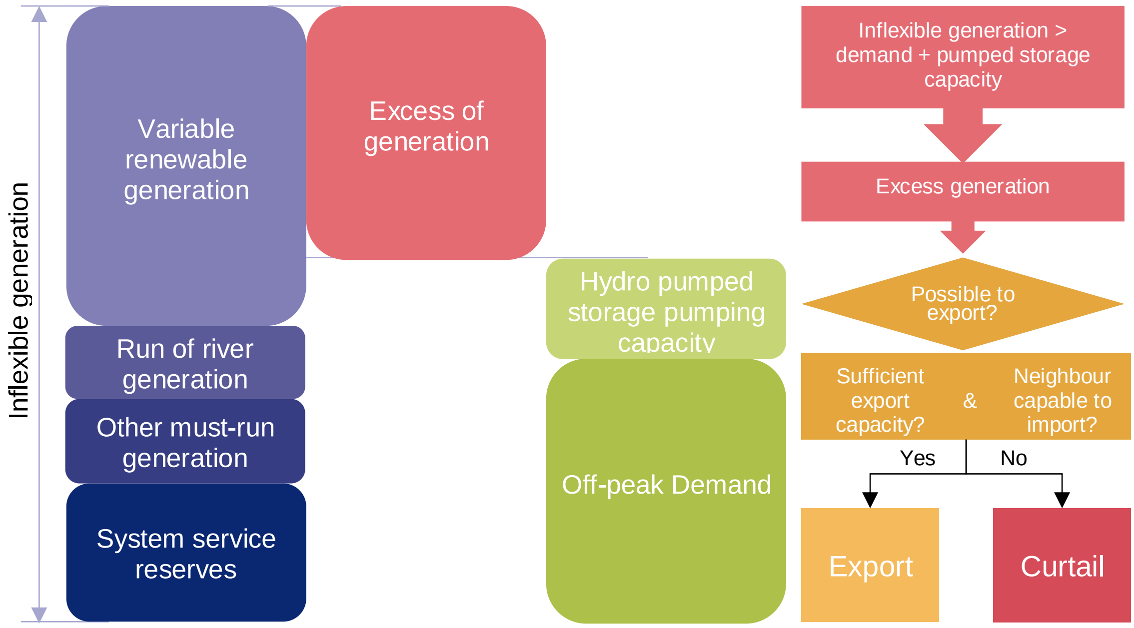
One synchronous point in time is collected for all countries to allow for a meaningful pan–European upward adequacy analysis when determining the feasibility of cross–border flows. The most representative synchronous point in time for the upward adequacy analysis is Wednesday 19:00 CET during wintertime 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 demand is identified in a database of historical data. At 11:00 CEST, the total demand is higher, but for some countries, the combination with high solar irradiation is more constraining.

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

2. Upward Adequacy and Downward Regulation Methodology

2.1 Pan-European analysis

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

The pan-European analysis consists of several steps. The **first element** that is checked is whether, in individual countries or modelled regions, there is enough power capacity to cover the demand. Here, all RC is added, and when the result is greater than zero, there should be adequate capacity theoretically available in Europe to cover all countries' needs. There should be no problems with this approach, either for normal or severe conditions. As this method does not consider the limited exchange capacity between countries, it is too optimistic to draw final conclusions based on it. In the **second step,** the pan-European analysis is based on a constrained linear optimisation problem. The problem is modelled as a linear optimisation with the following constraints:

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

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

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

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

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

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

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

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

2.2 Probabilistic analysis for regions or countries at risk

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

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

For every reference time point, the collection of hundreds of records[20] is used to run numerous simulations. The following high–level methodology is applied to build each one of those simulations:

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

- As a starting point, the qualitative data provided by the TSOs for severe conditions are used;
- Next, the severe–condition demand is replaced by the normal condition average demand 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 demand is scaled using demand–temperature sensitivity relations. The difference between reference temperature and the temperature of the concerned record is translated into 'increase/decrease' of demand, 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 three 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.

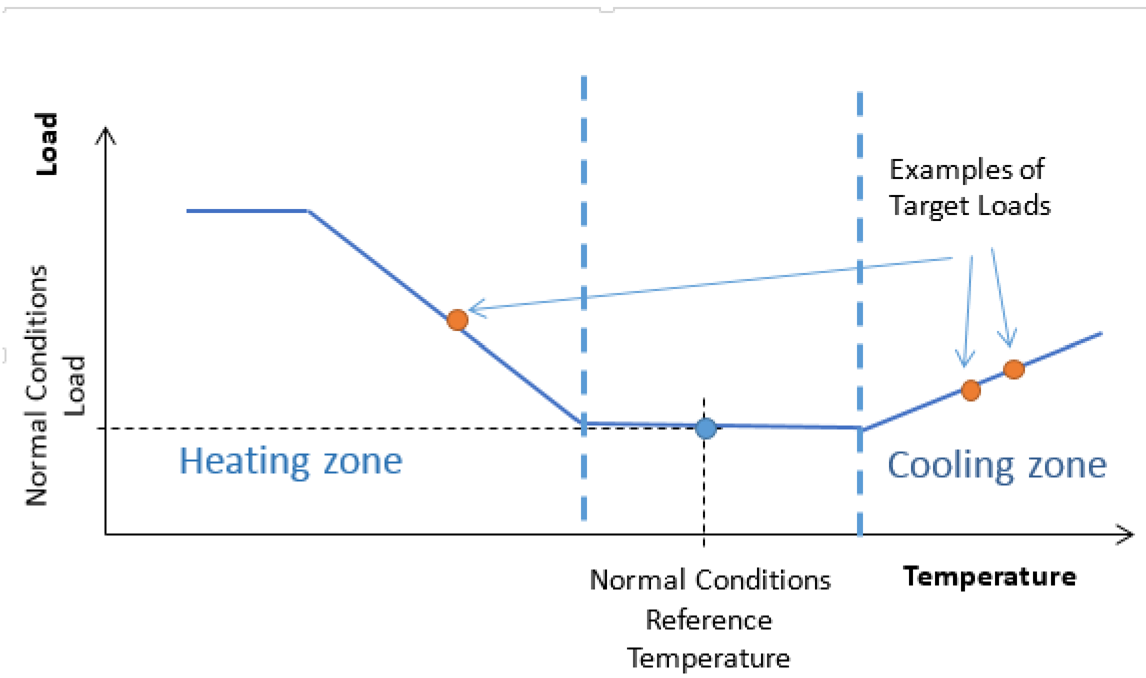
Regarding the downward adequacy analysis, the same approach is used, but using the 95th percentile value (that is exceeded only by 5% of records in collection).

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

4. Future Improvements

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

- Investigate how to implement full probabilistic hourly calculations based on the Mid-Term Adequacy Forecast (MAF) experience[21], considering Seasonal Outlook specificities regarding data and model requirements. For example, hydro reservoir modelling assumptions define expected reservoir content at end of period. The very limited time available for each Seasonal Outlook calculation (around one month) shall also be considered. ENTSO–E will, in a stepwise approach, build consistent databases at hourly resolution and run tests in market modelling tools, The goal is to get the probabilistic methodology operational by Winter Outlook 2019/2020.
- Prepare the future implementation of the Clean Energy Package, especially Risk Preparedness Plan regulation, through coordinated methodology development with the week–ahead adequacy project.

[21] *MAF reports*

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

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

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

1. Collect data for the number of population ($\mathbf{NP_{country}}$) based on the latest census of each country.[22]

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:[23]

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

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

---

22 *City Population is the source for city populations*

23 *Climatology database of the World Meteorological Organization (WMO) is the source of average temperatures*

$$CPWNMAT_{ij}$$

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 $CPWNMAT_{ij} = CPWNMAT_j$

to the dates corresponding to the middle of each month:

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

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

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

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

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

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

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

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

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

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

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

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

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

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:

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

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

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

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

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

2. Methodology for load sensitivity calculation

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

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

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

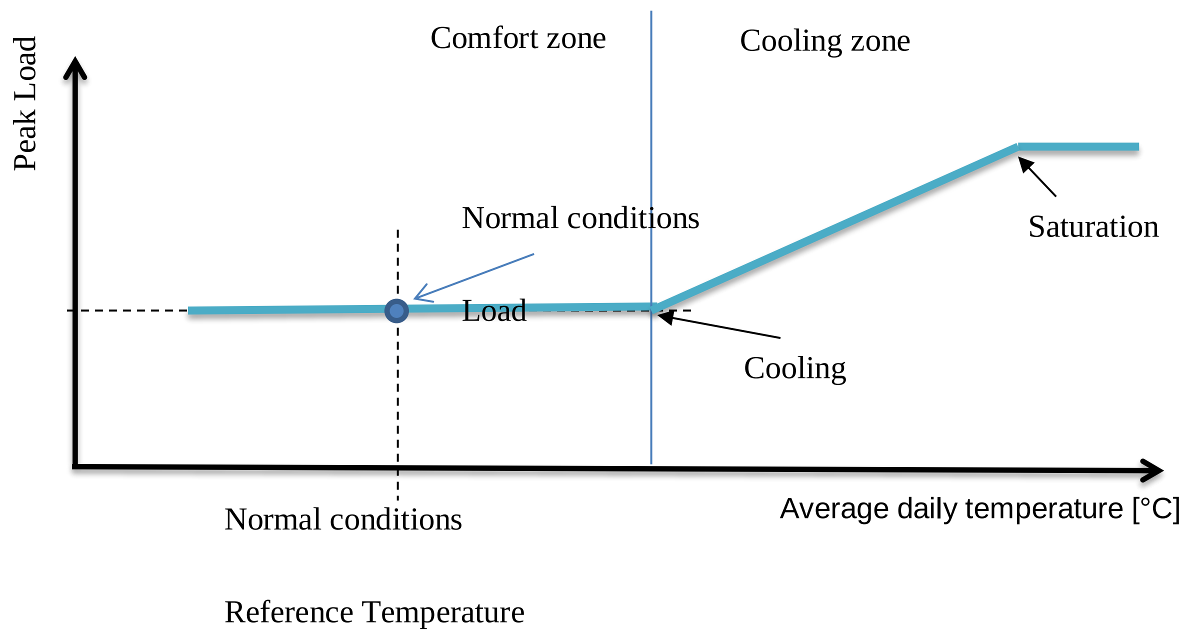
5. Model the relation between the peak load and the daily average temperature in the range $\mathbf{T_{start} - T_{satur}}$ by simple linear regression:

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

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

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

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



Appendix 4: Questionnaires Used to Gather Country Comments

1. Seasonal Outlook Questionnaire Template

Individual country comments: general situation
Overview about the general situation, also compared to previous years, and highlighting specifics such as: - *high levels of maintenance in certain weeks;* - *low hydro levels;* - *low gas storage;* - *sensitivity to decommissioning of generation* - *any event that may affect the adequacy during the period.*
Most critical periods for maintaining adequacy, counter–measures adopted and expected role of interconnectors.
Most critical periods for maintaining upward adequacy, countermeasures adopted and expected role of interconnectors.

A short description of the assumptions for input data
Please describe concisely: 1) *which assumptions were taken for calculating NORMAL and SEVERE conditions (e.g. if an average daily temperature for normal conditions different from population weighted daily values provided) and how the outage rates have been calculated;* 2) *how the values of NTC have been calculated;* 3) *Treatment of mothballed plants: under what circumstances (if any) could they be made available?* 4) *Issues, if any, associated with utilising interconnection capacity e.g. existence of transmission constraints affecting interconnectors for export or import at time of peak load (such as maintenance or foreseen transit or loop flows);* 5) *Are there any energy constraint issues particularly for hydro based systems or any other fuel supply issues which could affect availability (e.g. gas supply issues)?*

2. Seasonal Review questionnaire template

General commentary on the conditions of last period: recalling main features and risk factors of the Outlook Report, please provide a brief overview of the last period:
General situation highlighting specifics such as: - *main trends and climatic conditions (temperatures (average and lowest compared with forecast), precipitation, floods/snow/ice);* - *etc.*

Specific events that occurred during the last period and unexpected situations:
Please report on specific events that occurred during the last period and unexpected situations, i.e.: - ***generation conditions:*** *generation overhaul (planned, unplanned), gas/oil/availability, hydro output, wind conditions (above or below expectations, extended periods of calm weather), specific events or most remarkable conditions (please specify dates)* - ***extreme temperatures****;* - ***demand:*** *actual versus expectations, peak periods, summary of any demand side response (DSR) used by TSOs, reduction/disconnections/other special measures e.g. use of emergency assistance, higher than expected imports from neighbouring states;* - ***transmission capacity/infrastructure:*** *outages (planned/unplanned), reinforcement realised, notable network conditions (local congestion, loop flows etc.);* - ***interconnection capacity/infrastructure:*** *import/export level, reliance on imports from neighbouring countries to meet demand (you can refer to http://www.entsoe.net/); commentary on interconnector availability and utilisation; and* - ***gas shortages*** - ***voltage issues (only if relevant):*** *please list voltage regulation issues you had (e.g. too low voltage at peak or too high at off–peak times)*

Appendix 5: Glossary

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

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

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

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

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

Distribution system operator (DSO): Responsible for providing and operating low, medium and high voltage networks for 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. ENTSO–E produced, in 2016, a new version of the database covering 34 years (1982–2015) instead of 14 years. More neighbouring countries of the 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): The 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 and medium–term adequacy (SMTA): Week ahead to day ahead adequacy calculations currently in implementation, and to be performed by the RSCs.

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

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

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

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

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

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