2018 summer outlook

winter review 2017-2018

entsoe

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1 Executive Summary

The assessment of electricity security of supply at the pan-European level indicates stable operations in the upcoming summer.

There is no expected risk to Europe's security of supply, even under severe conditions. Estimated availability of generation, market based demand side response (DSR) and interconnections should be sufficient to ensure access to electricity throughout Europe.

There might be some generation curtailment needed in Ireland and in some bidding zones in the southern part of Italy in case of variable generation excess and low demand (e.g. windy night or sunny Sunday).

Situation at hydro reservoirs requires attention throughout summer

The level of hydro reservoirs in the Alpine region is equal or close to the lowest historical values. In France it reached its lowest value ever recorded in April 2018.

If the precipitations remain very limited in the coming months, the situation will need monitoring in case of a heat wave, with a special focus on Austria and Switzerland where hydro generation represents more than half of the generation capacity. However, the significant amount of snow that fell in the Alps early this year should contribute to mitigating the situation. The level of hydro reservoirs in Spain and Norway is higher but still below average.

Regional Security Coordinators (RSC) assess adequacy situation in the week-ahead timeframe and ensure that Transmission System Operators (TSOs) will be ready in case any risks materialise.

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

Winter 2017/2018 was on average mild and windy without any main adequacy issues. However, frequency deviation was experienced due to power imbalances in Serbia, Macedonia, Montenegro (SMM block) and specifically Kosovo*[1] ENTSO-E calls for a political resolution of the dispute that caused the deviations so as to ensure a long-lasting solution to the problem. This will remain a focus area for the association in the course of 2018.

[1] **This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.*

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.[2] The report also covers Kosovo*,[3] Malta and Burshtyn Island in Ukraine, as they are synchronously connected with the electrical system of continental Europe. The data concerning Kosovo* are integrated with the data on Serbia.

System adequacy is the ability for a power system to meet demand at all times and thus to guarantee the security of the supply. The ENTSO-E system adequacy forecasts present the views of the TSOs 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 overview regarding the summer and winter, the seasons in which weather conditions can be extreme and strain the system. ENTSO-E thus publishes its Summer Outlook before 1 June and its Winter Outlook before 1 December. ENTSO-E also publishes an annual mid-term adequacy forecast (MAF) that examines the system adequacy for the next 10 years.

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

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

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

[3] *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'[4] 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 30 May 2018 and 30 September 2018. The Winter Review examines the system adequacy issues registered between 29 November 2017 and 1 April 2018.

The aim of publishing this forecast is two-fold:

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

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

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

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

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

2.2 The European Generation Landscape

The pan-European generation capacity study reveals consistent results of renewable generation capacity expansion compared to previous seasons. At the same time, the phase-out of conventional power plants is observed. Although a gas generation capacity decrease is recorded compared to last Summer Season, gas generation capacity in Europe has increased by approximately 8.5 GW in two years (Summer 2016 to Summer 2018). The same trend was observed in Winter Outlook 2017/2018.

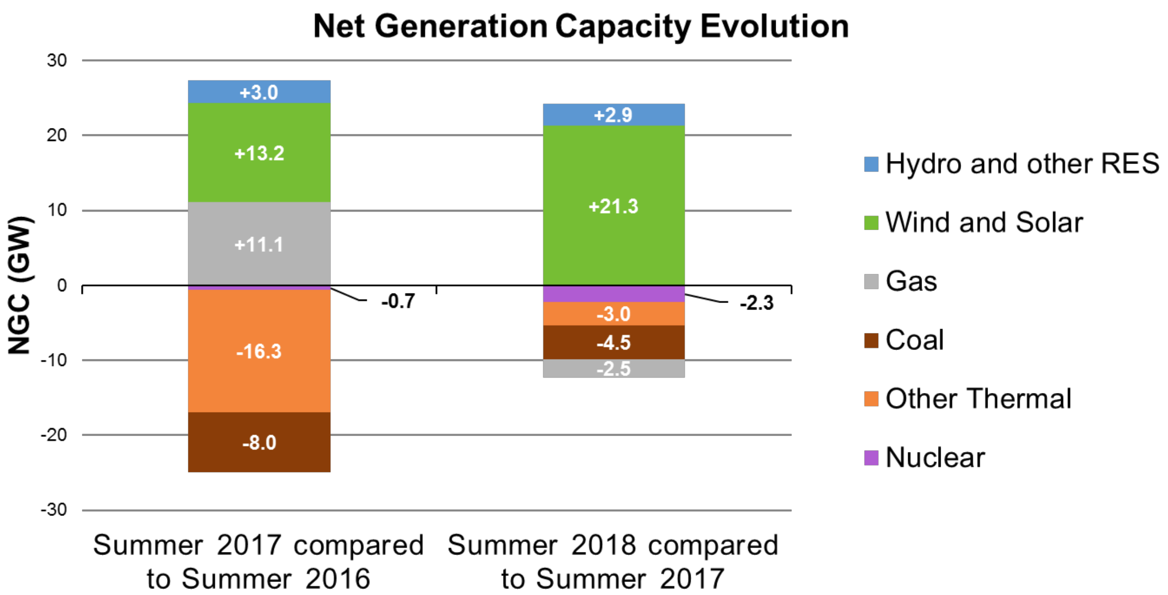

Figure 1: Evolution of net generating capacity per technology.

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

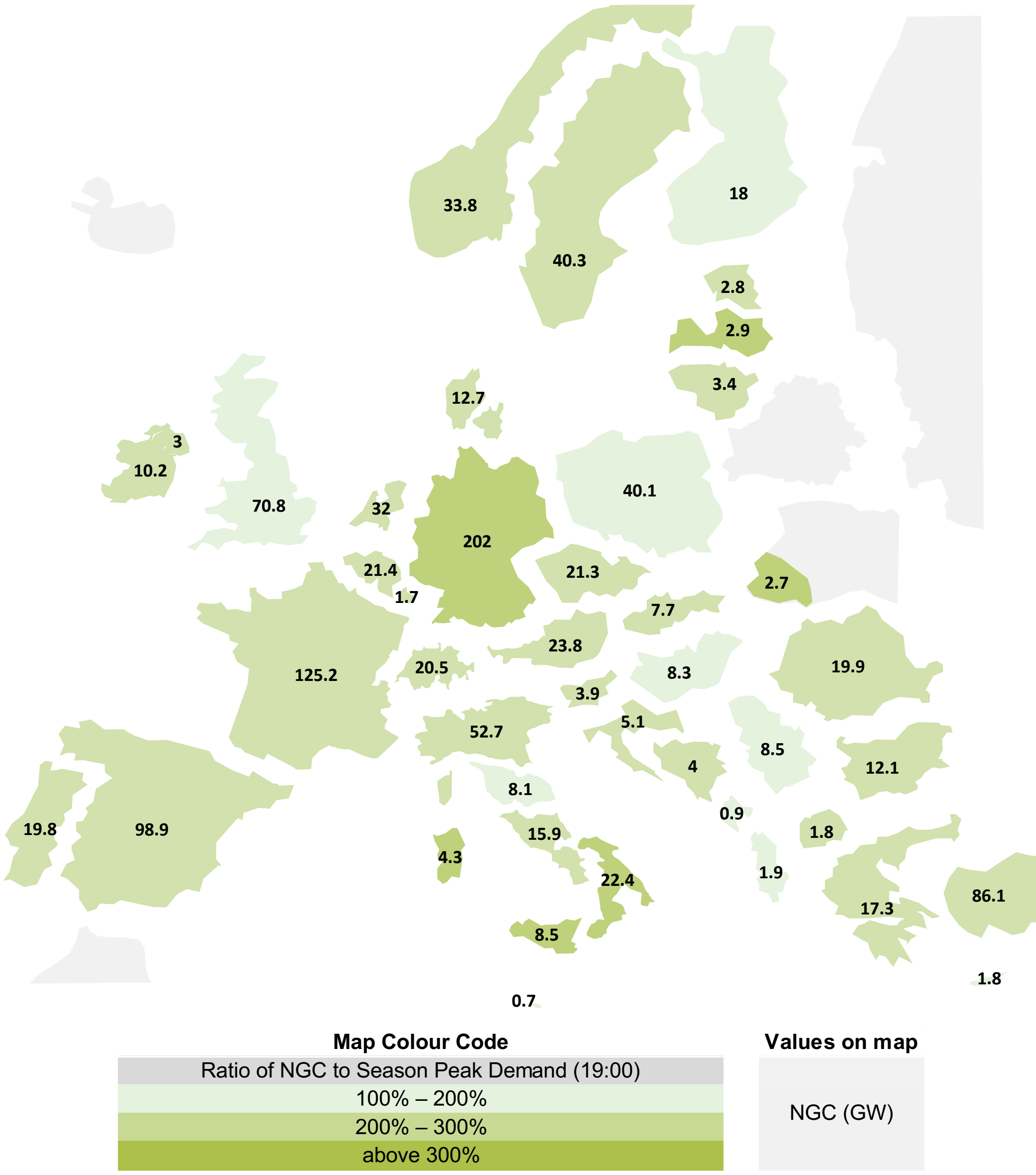

Figure 2: Net generating capacities (in GW) and colour according to its ratio to expected national peak demand in the summer season.

3 Summer Outlook 2018 – Upward Adequacy

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

Following improvements in a previous Summer Outlook, Italy was modelled in six bidding zones—Northern (IT01), Central-Northern (IT02), Central-Southern (IT03), Southern (IT04), Sicily (IT05) and Sardinia (IT06)—in line with other adequacy studies.[5] This has been done to value achieved improvements for highest quality simulations and as a transitory step toward future simulations of pan-European system adequacy with all existing bidding zones (e.g. Sweden, Norway and Denmark).

In contrast to Summer Outlook 2017 and in line with Winter Outlook 2017/2018, strategic reserves (out of market measures: generation and DSR) are disregarded in simulations.

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 only in one reference point of the study period).

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

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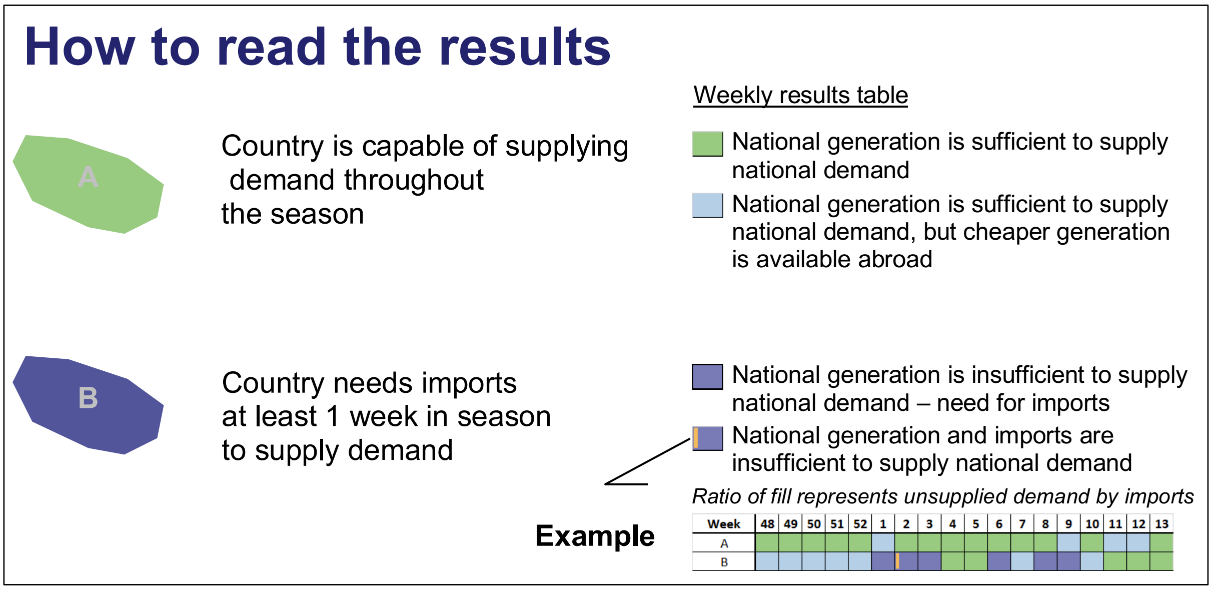
[5] *As in ENTSO-E MAF assessments.*

In addition, a simplified merit-order approach[6] was considered. Countries in specific weeks that do not require imports from an adequacy perspective, but could import from a market perspective, are coloured in light blue.



3.2 Adequacy Under Normal Conditions

Figure 3 reveals generation capacities and the market-based demand-side response to be sufficient in all of Europe to cover demand throughout the summer season under normal conditions with only a few countries requiring import contribution.

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

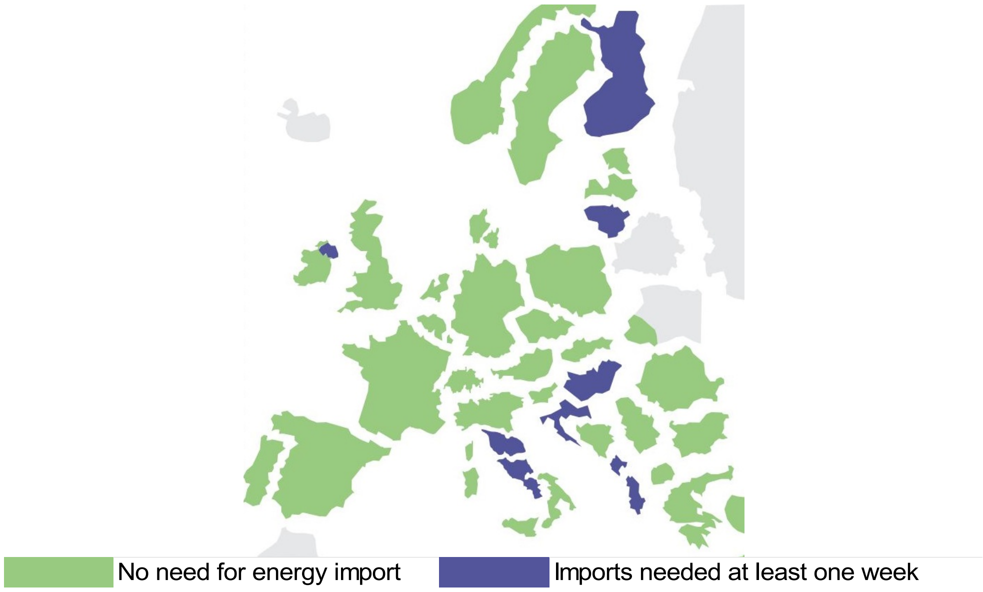
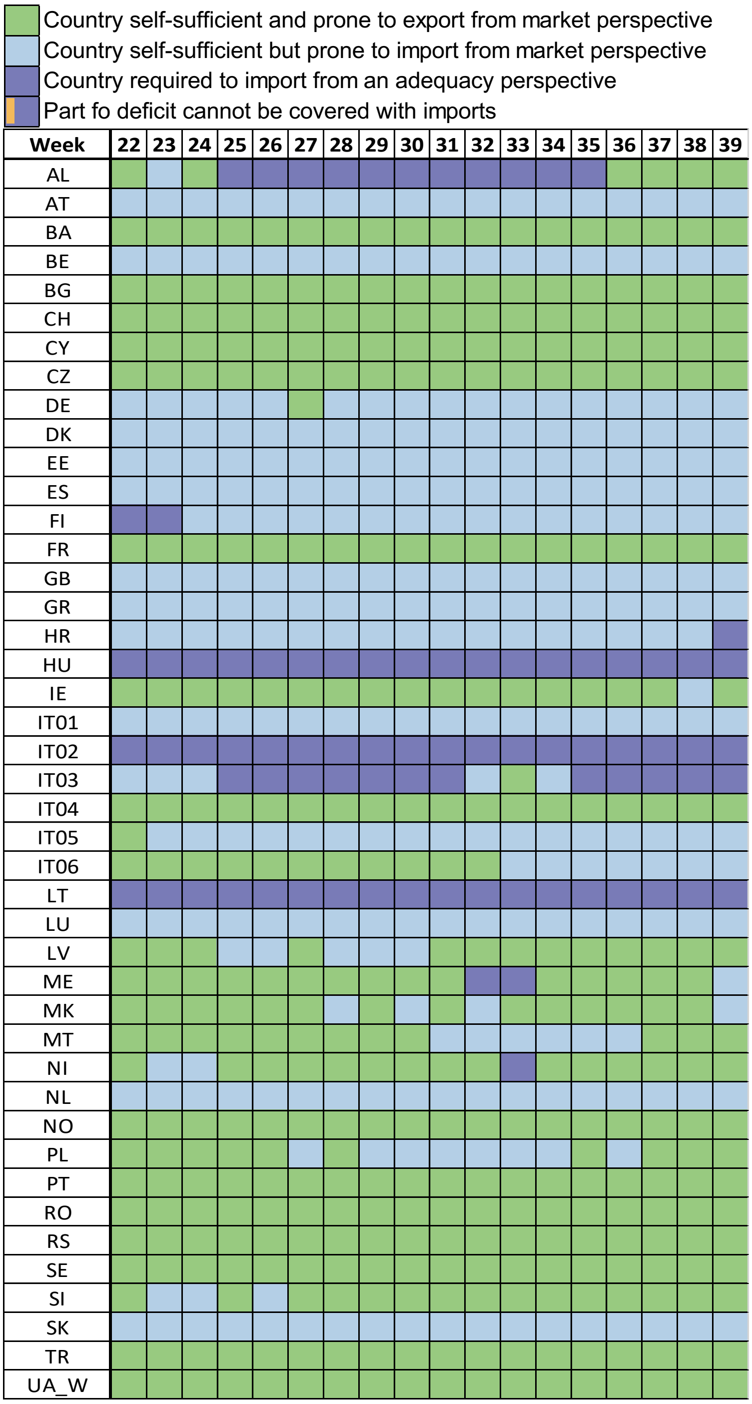


Figure 3: National adequacy under normal condition.

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

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



3.3 Adequacy Under Severe Conditions

Following the January 2017 cold wave and outcomes of its dedicated report,[7] ENTSO-E decided to investigate more severe situations starting with the Winter Outlook 2017/2018. Firstly, all of Europe was assumed to undergo 1 in 20 years' simultaneous extreme weather

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

conditions – cold wave in winter and heat wave in summer. Secondly, all of Europe was assumed to have overall very low wind and solar irradiance conditions – (Percentile P5, cf. Appendix 2:3.1). This Summer Outlook uses the same approach; hence, it could be seen as a stress test for Europe's electricity grid and any comparison with past Seasonal Outlooks should be made in consideration of the aforementioned fundamental changes.

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

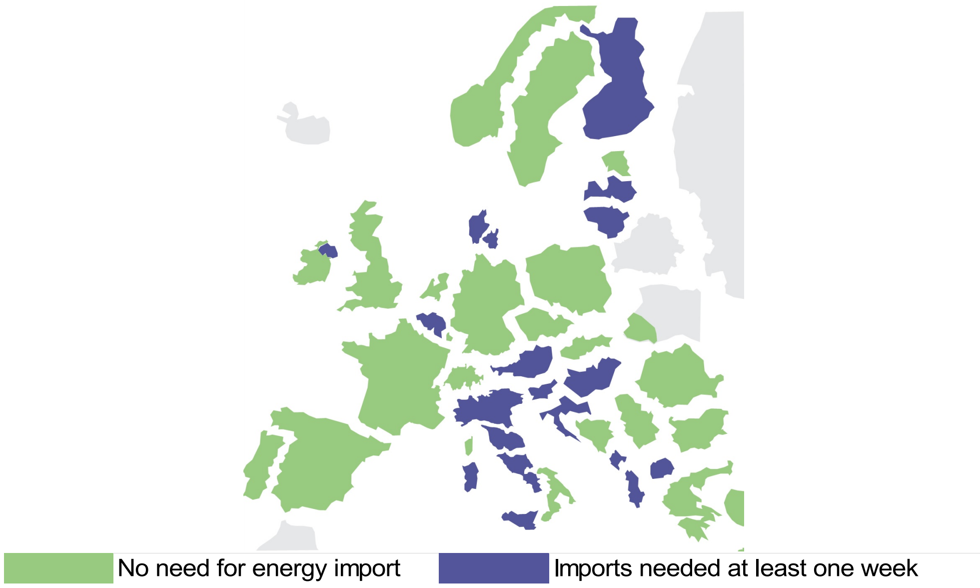
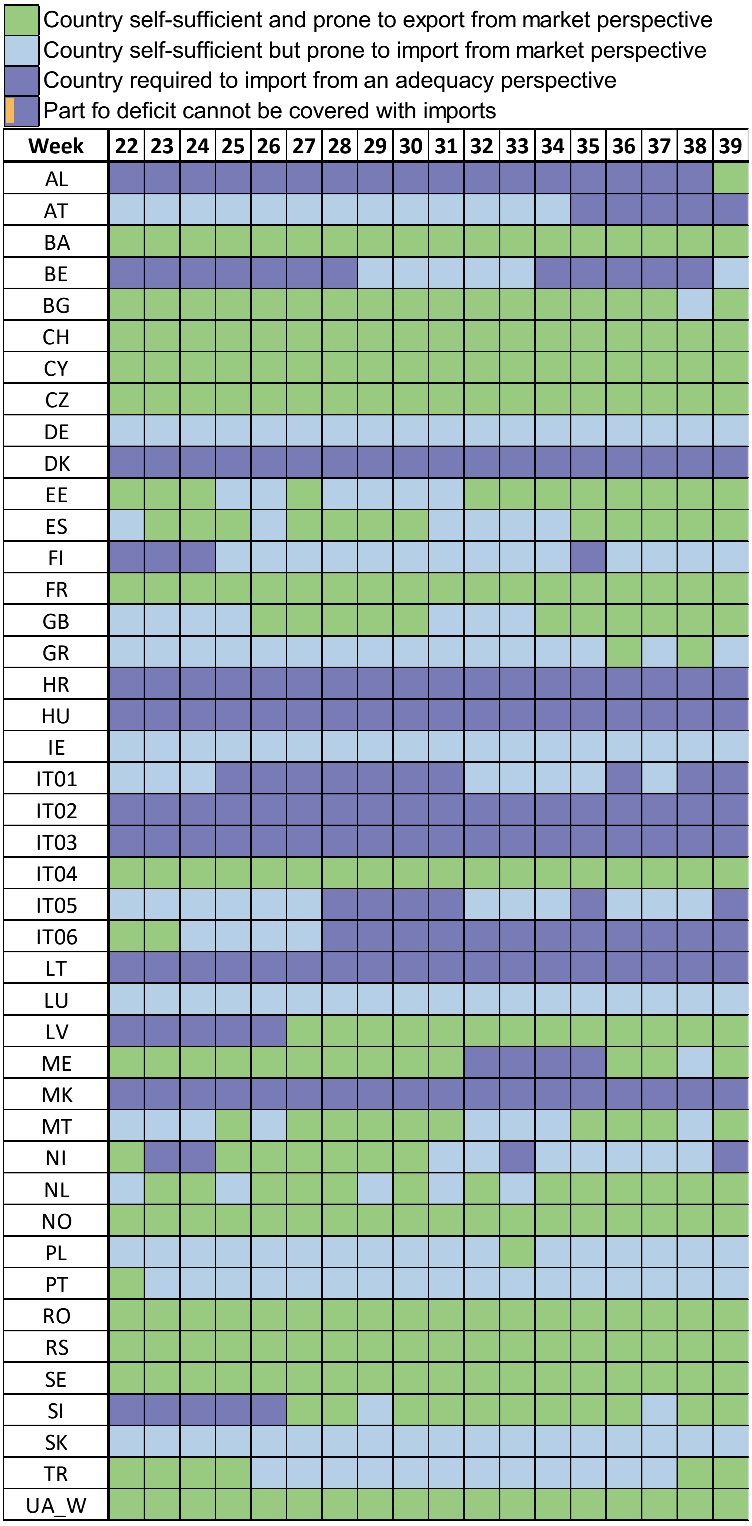


Figure 4: National adequacy under severe conditions.

Results on a weekly basis presented in Table 2 indicate that no adequacy risk is identified for the coming summer at pan-European synchronous peak time (19:00 CEST). However, Croatia, Denmark, Hungary, Central-Northern Italy, Central-Southern Italy, FYRO Macedonia and Lithuania are identified as countries which would require imports to avoid supply disruptions throughout the summer season in case of severe weather conditions.

Some countries or bidding zones as Northern Italy, Sicily and Sardinia would need imports in one third of the summer in order to cover their demand.

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



3.4 Probabilistic Sensitivity Analysis

No adequacy risk has been identified even under severe conditions in any of the studied countries, whereas in Summer Outlook 2017, Italy was highlighted as having possible adequacy risks in case of severe conditions. Therefore, a probabilistic analysis has been performed for week 30, identified as the most constraining in 2018 for Italy, to assess if there are any particular circumstances raising adequacy risk.

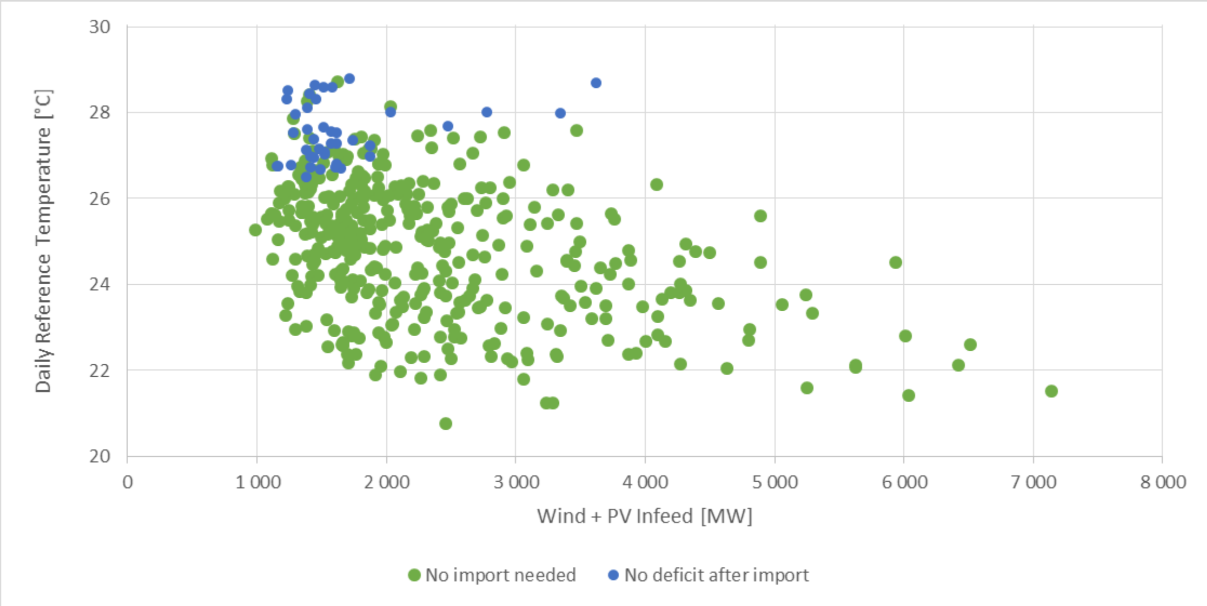


Figure 5 incorporates the results of all bidding zones in a single graph. It suggests that generation capacities and market based DSR in Italy would be sufficient to ensure supply of demand in most of the cases. A combination of high temperature with low wind and photovoltaic (PV) generation may lead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

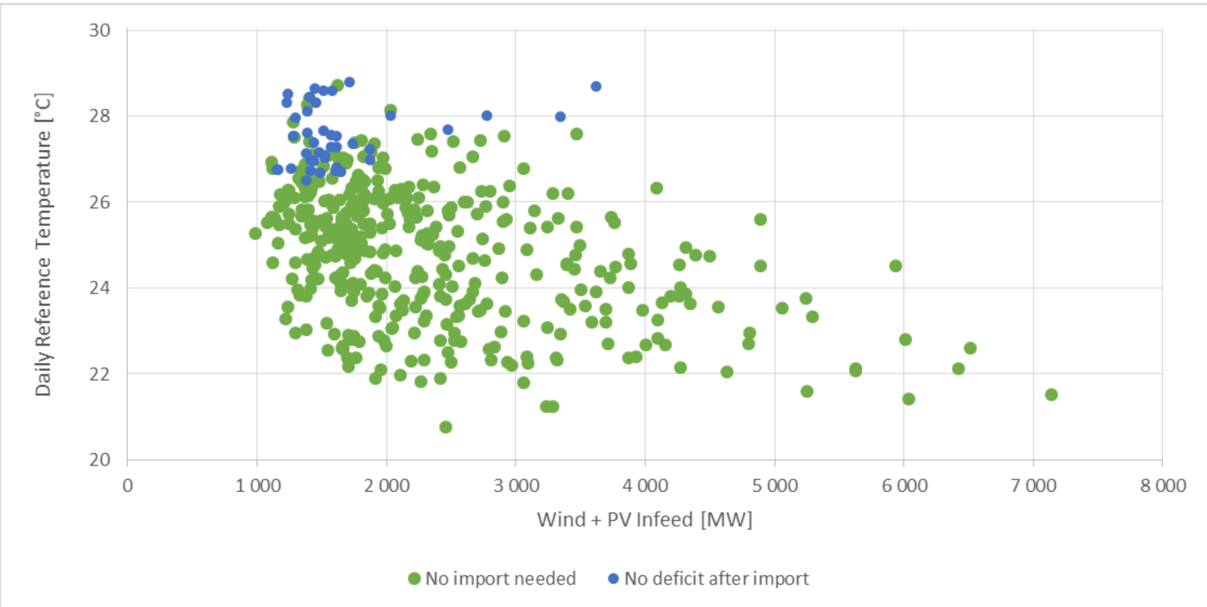


Figure 5: Probabilistic sensitivity analysis – week 30 in Italy

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 by Northern Italy (IT01) and Central-Northern Italy (IT02) bidding zones are shown. These results suggest that the adequacy situation in this area is mainly linked to temperature conditions:

- area needs import from neighbouring bidding zones when average daily temperature reaches 23°C (statistical probability is approximately 58%). Import available from the Southern part of Italy are expected to be sufficient to cope with these situations;
- area needs additional import from neighbouring countries when average daily temperature exceeds 26°C threshold (statistical probability is 15%).

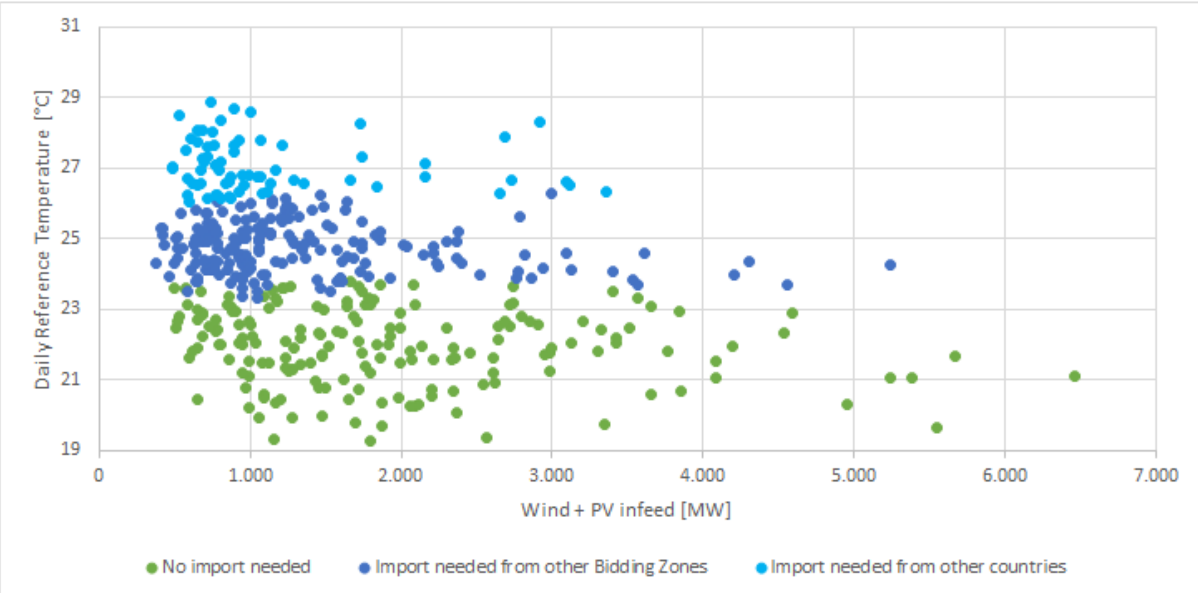


Figure 6: Probabilistic sensitivity analysis – week 30 in Italy (IT01 and IT02)

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, 2018 and represents the importance of interconnection availability for each bidding zone.

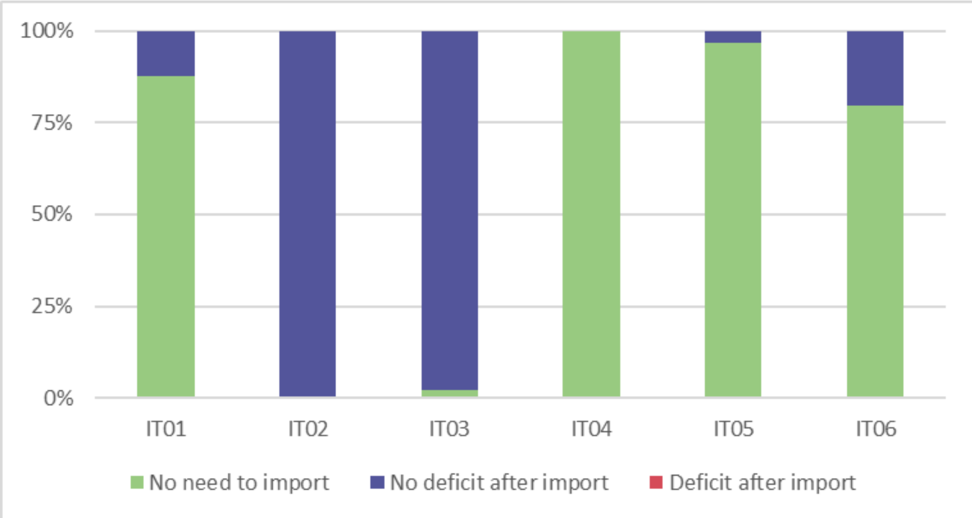


Figure 7: Importance of interconnection - week 30 in Italy

3.5 Investigation of Italy results

NGC availability in summer 2018 in Italy is expected to be higher than summer 2017. This is due to an increase of the conventional generation availability, linked to the reactivation of some power plants that were in a mothballed status last summer. In addition, the maintenance planning of power units was performed in close cooperation with market participants which allowed better maintenance work distribution within the summer compared to summer 2017.

Additionally, ENTSO-E and members are continuously working to improve the data quality used in studies. The following improvements have been achieved:

1. PECD data was reanalysed for each Italy bidding zone individually;
2. Run-of-river generation in Italy assessment methodology was enhanced.

For the Summer Outlook 2018 study, PECD data were indeed reanalysed for each bidding zone in Italy in comparison to one PECD value used last year which was representative for the whole country. This improvement does not lead to a change of total PV or wind generation in Italy, but only to the redistribution of generation within country. However, even a redistribution of generation could relieve tense adequacy situations. This is presented in a case example of Summer Outlook 2017 in Figure 8, the red thick arrows indicating the isolation of part of Italy due to interconnection congestions.

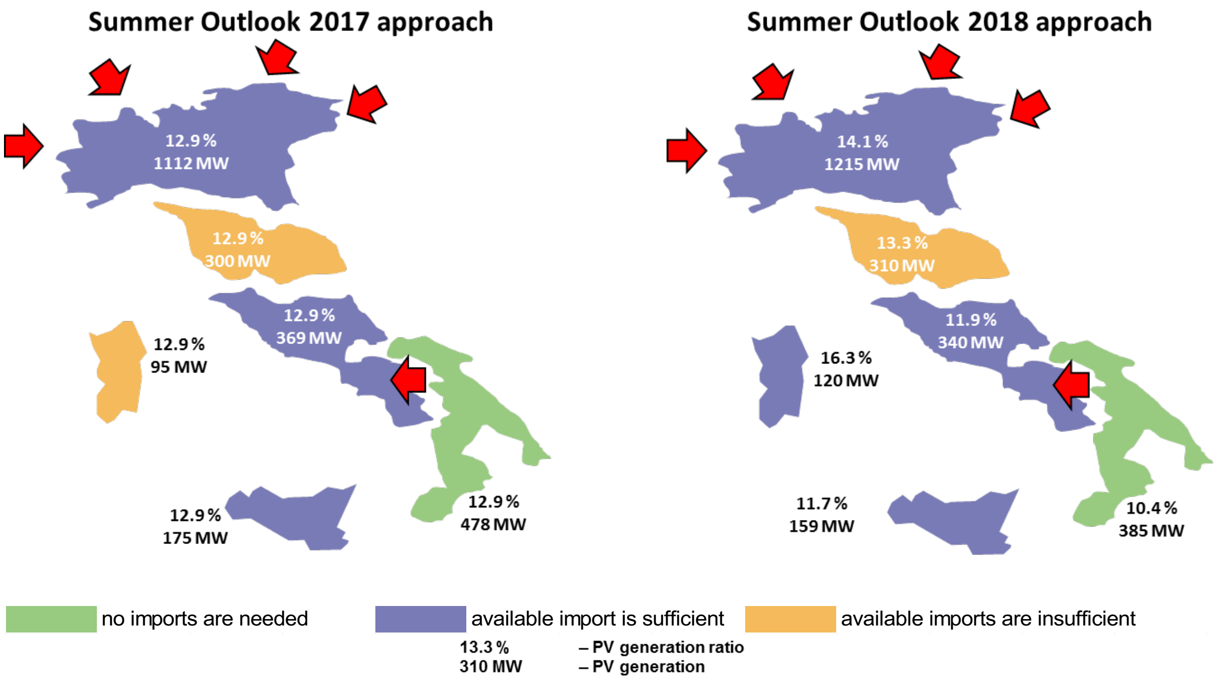


Figure 8: Case example of improved PV generation assessment

Furthermore, for Summer Outlook 2018, the data modelling of run-of-river hydro generation in Italy has been improved, which increased confidence in the delivered data. Higher confidence enables data to be obtained with a lower security margin.

3.6 Unassessed risks and limitation of current approach

Although there is no adequacy risk identified in the upcoming season, it is worth mentioning that risks always persist in case of extraordinary events on generation or transmission assets.[8] Furthermore, results should be interpreted in light of the study characteristics: it analyses adequacy risk at pan-European synchronous peak demand moment. This is limitation to address potential risk during national or regional demand peak moments, as highlighted in the previous Summer Outlook report[9] and especially relevant in Poland. Detailed analysis of Poland adequacy at its peak demand moment is given in Poland country comments found in Appendix 1:. This shows that despite estimated sufficient interconnection availability during local peak demand in Poland, it should be observed if generation would be available in neighbouring countries or if those countries would be able to import from other countries.

Despite its limitations, the current Seasonal Outlook methodology indicates most critical periods within the coming season and provides strong support for system operation planning

[8] Winter Outlook 2017/2018

[9] Summer Outlook 2017

coordination at the pan-European level. Efforts are continuously being made to devise 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.

As a bridge from Seasonal Outlooks, RSCs perform detailed week ahead adequacy simulations in which they use the most recent information and ensure that all realistic risks are addressed in hourly granularity and in a consistent methodology with Seasonal Outlook. Considering RSC study results, TSOs put their efforts into ensuring the reliability of their own system and to assist neighbouring systems in case of need.

4 Summer Outlook 2018 – Downward Regulation Results

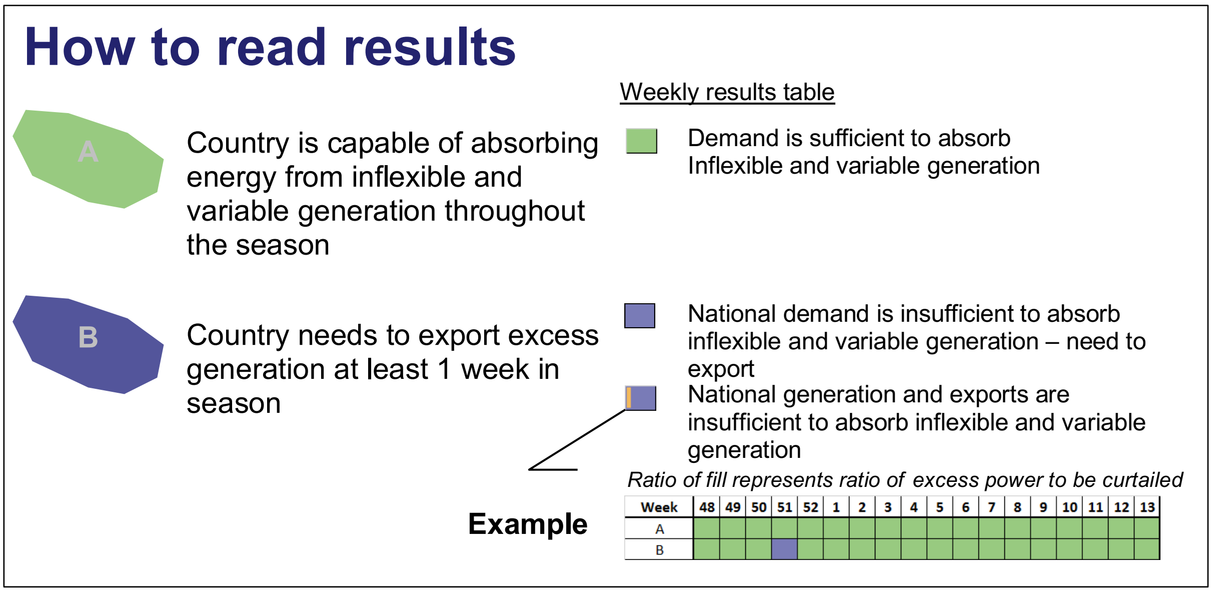
With increasing renewable generation and, in parallel, decreasing dispatchable generation in Europe (cf. Figure 1), the probability of encountering issues relating to an excess of inflexible generation also grows. During certain weeks, some countries need to export excess inflexible generation to neighbouring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

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

4.1 How to Read the Results

The results in figures displaying maps in Section 3.6 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 generation surpasses the expected demand, meaning the country needs to export excess energy for at least 1 week of the season.

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



4.2 Daytime Downward Regulation

Daytime reference time point is considered as 11:00 CEST. The results displayed in Figure 9 suggest that demand is sufficient to absorb the energy generated from variable and inflexible generation in most of Europe throughout the summer season.

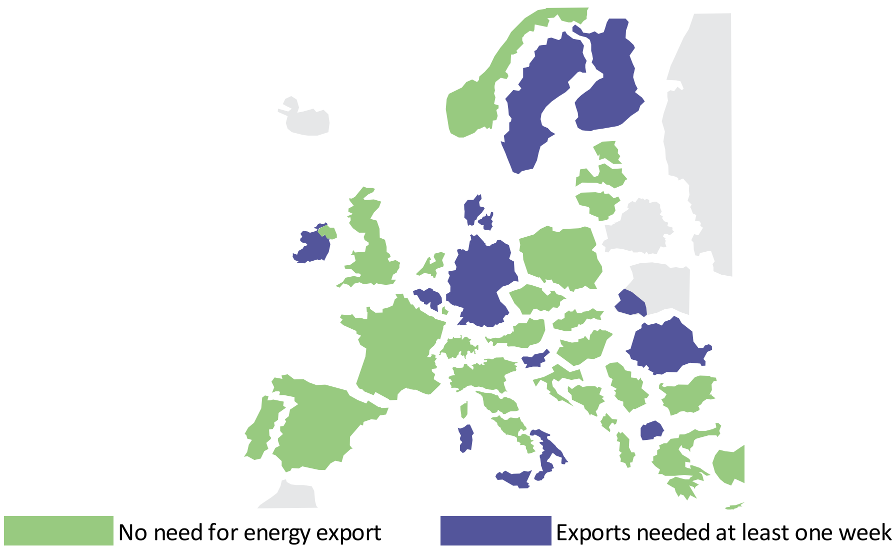
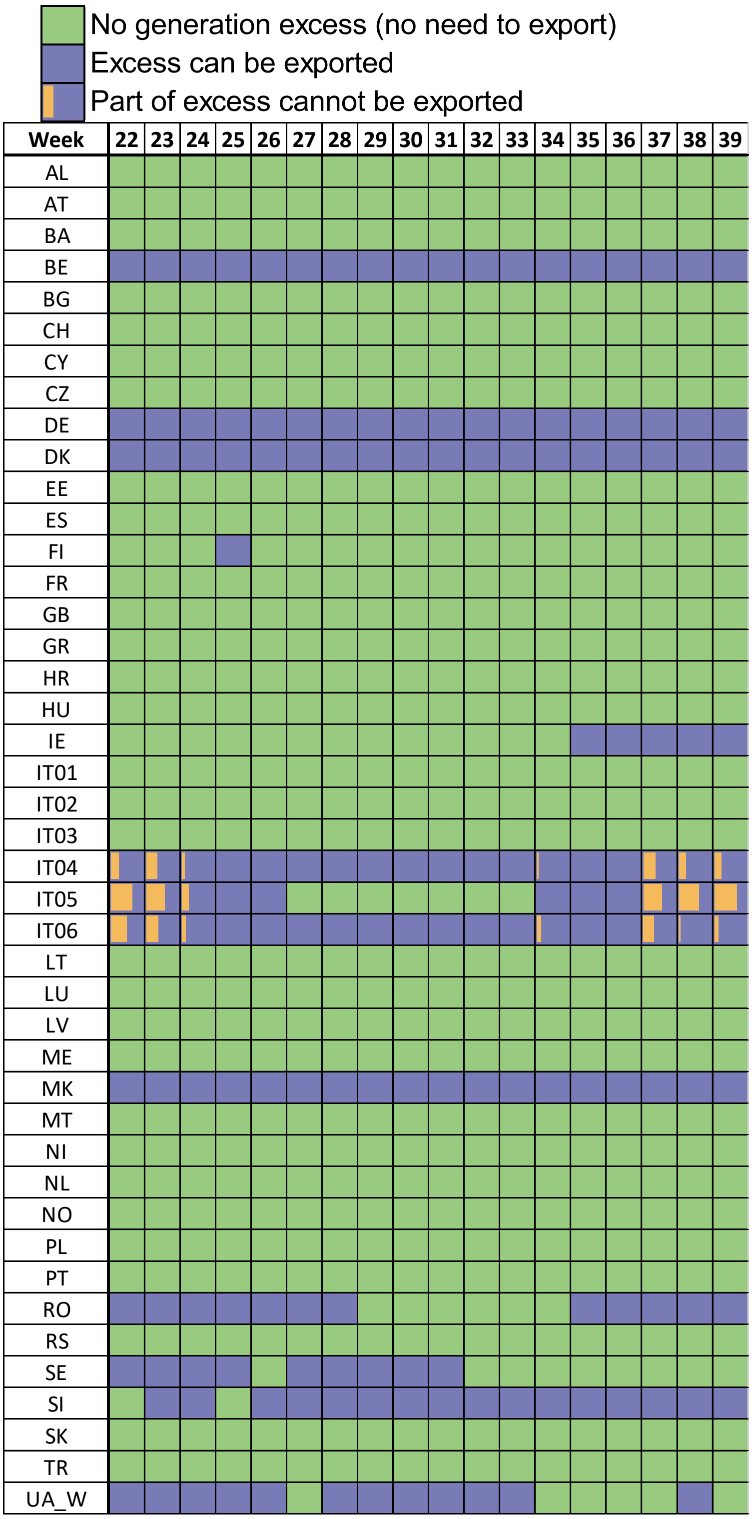


Figure 9: Daytime national downward regulation adequacy.

The weekly results in Table 3 display that most of the countries would be able to export an excess of variable and inflexible energy. However, some excess electricity curtailment might be expected in Italy –Southern Italy (IT04), Sicily (IT05) and Sardinia (IT06)) 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.



4.3 Night-time Downward Regulation

The night-time downward regulation adequacy corresponds to Sunday early morning (5:00 CEST). The results presented in Figure 10 suggest that all countries exposed to a possible excess of energy during daytime would have excess during night-time as well. Some additional countries would need to export an excess of electricity as well: Bulgaria, Czech Republic, France, Ireland, Northern Ireland and Poland.

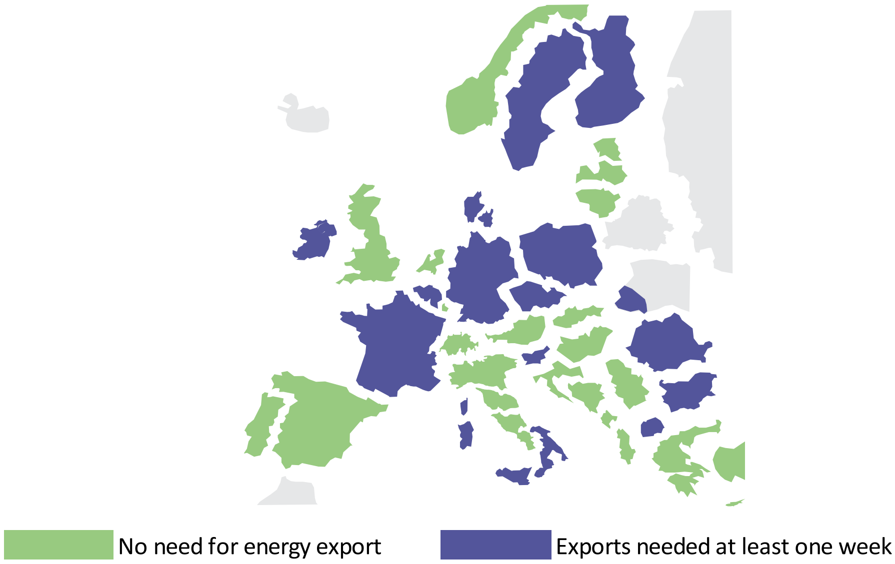


Figure 10: Night-time national downward regulation adequacy.

The weekly results in Table 4 suggest that most of the countries would have the capability to export energy throughout the season. As in the daytime case, some excess electricity could have to be curtailed in the south of Italy. Furthermore, some excess electricity curtailment could be required in Ireland and Northern Ireland in September (week 35 to 39).

Table 4: Night-time downward regulation adequacy.

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

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

5 Overview of Hydro Reservoir Levels

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

Hydro reservoir levels are slightly below average in Spain and Norway, whereas in Austria and Switzerland they are close to the historical minimum. In France, reservoir levels in April 2018 were the lowest ever recorded. The latest data represent reservoir levels at the beginning of spring, typically just before prominent snow melting, and there are currently historical high levels of snow reserves in most of the Alps, which will generate considerable inflows to the lakes. Thus, the situation is not as risky as it seems. Reservoir level should be followed carefully throughout the summer with a focus on Austria, France and Switzerland where hydro generation compromises a reasonable share of respective national generations.

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

In 2018, the reservoir levels in Italy began at historically low levels, as in 2017. However, reservoir levels in March and April 2018 were marked with a slight and steady increase due to melting snow in the mountains.

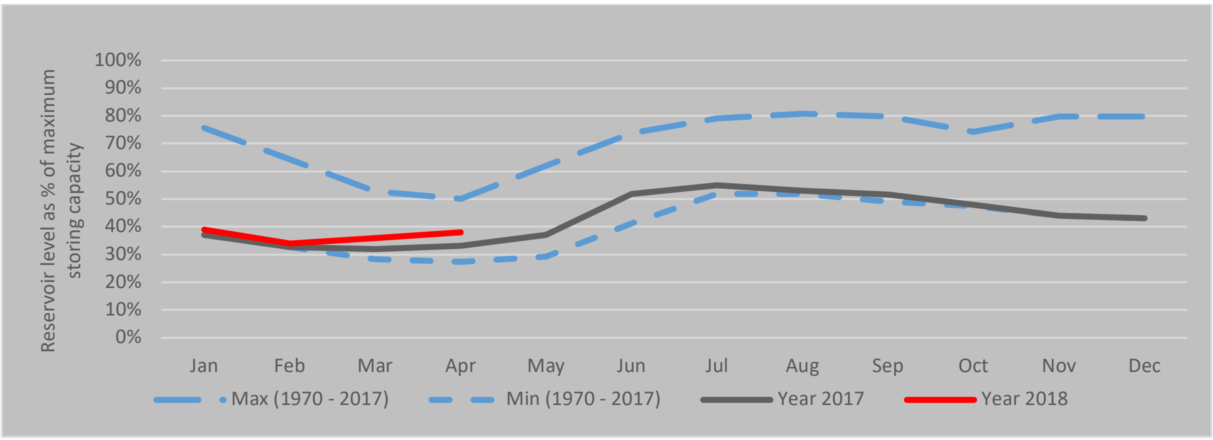


Figure 11: Reservoir levels in Italy.[10]

[10] *Based on data published by Terna.*

In France, the reservoir levels in April were at their lowest historical value for a second month in a row. Even if no adequacy risk is observed this summer, additions of the reservoir levels need to be further monitored, especially ahead of the coming winter.

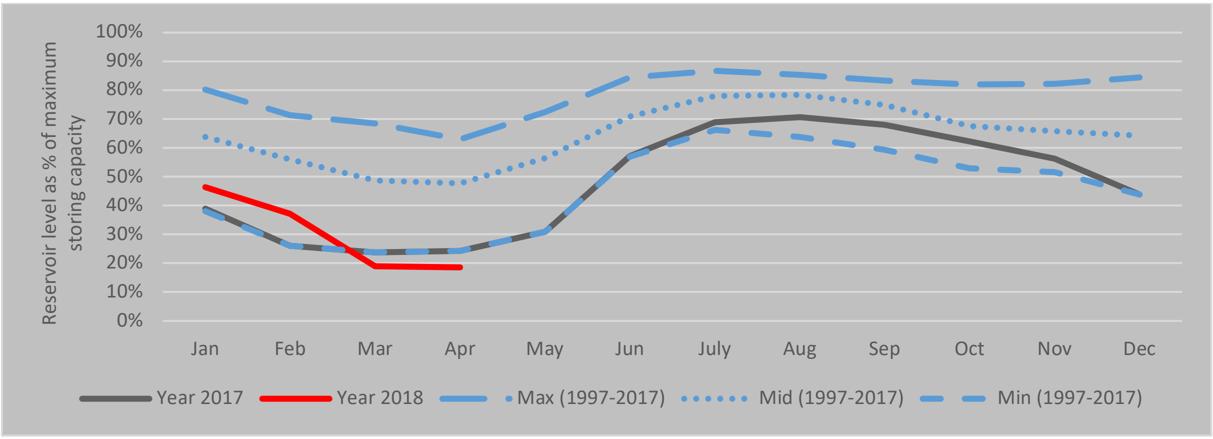


Figure 12: Reservoir levels in France.[11]

Hydro reservoirs levels in Spain are currently approaching the historical average values, as they have sharply increased from the beginning of March, after very drought conditions from mid-2016.

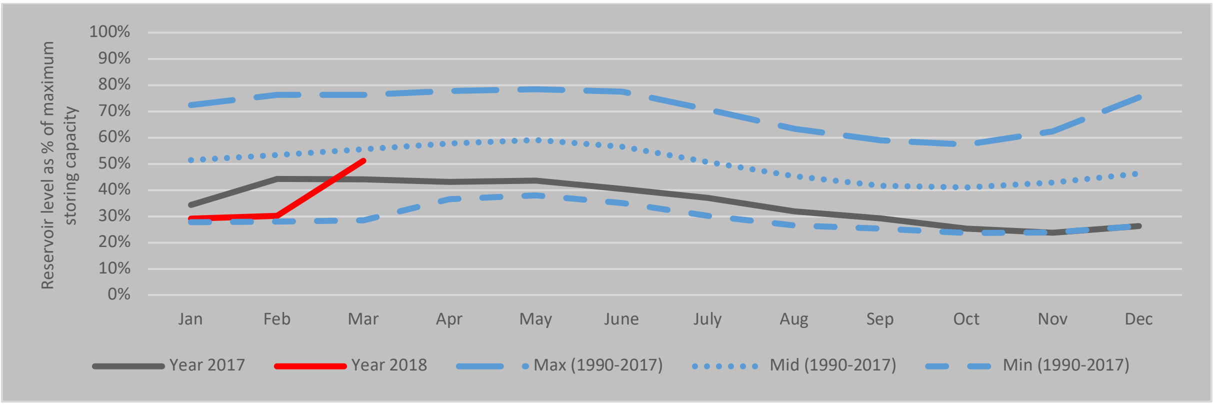


Figure 13: Reservoir levels in Spain.[12]

Reservoir levels in Switzerland, a despite a positive indication in February have notably dropped in March, reaching historical low levels. In April, a slight decrease was recorded but reservoirs settled above the historical low. As hydro generation compromises over 70 % of generation, the resources situation should be carefully followed in Switzerland.

[11] *Procured Based on data published by RTE.*

[12] *Based on data published by REE.*

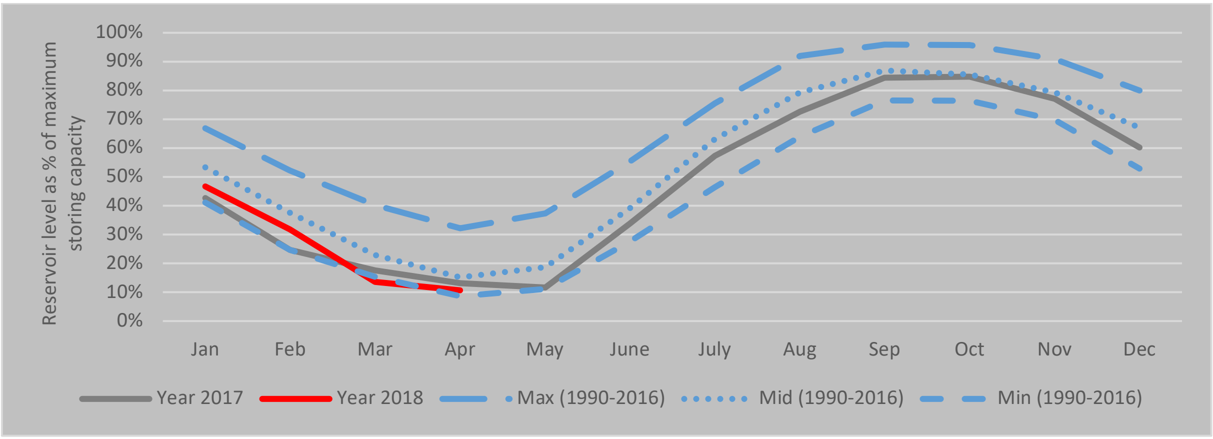


Figure 14: Reservoir levels in Switzerland.[13]

Austria's hydro reservoir levels at the beginning of the year seemed to be in a fair condition, however reservoir levels continuously decreased and reached almost historical low levels in March.

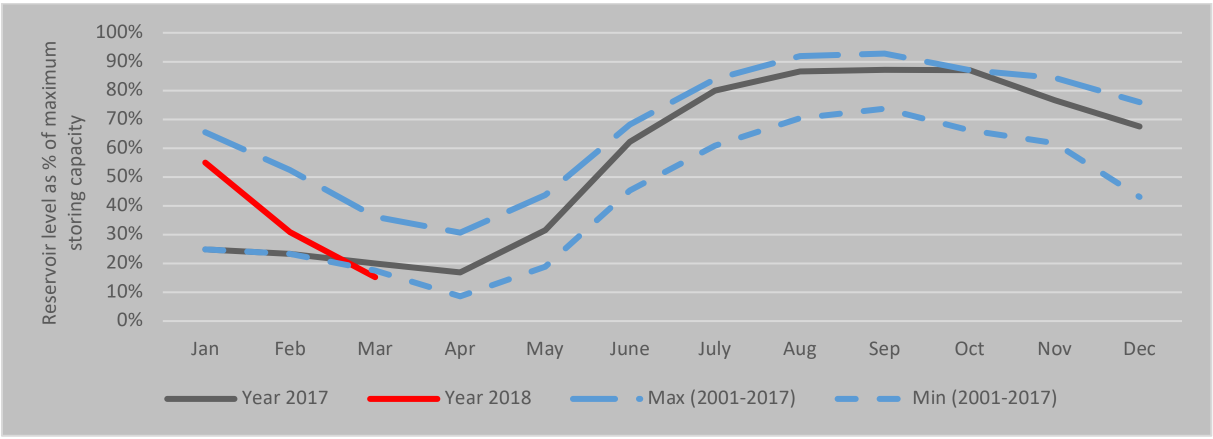


Figure 15: Reservoir levels in Austria.[14]

On the other hand, hydro reservoir levels in Norway were at a historical average since the beginning of year and only in April was a slight fall below the average recorded.

[13] *Swiss Federal Energy Ministry (BFE)*

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

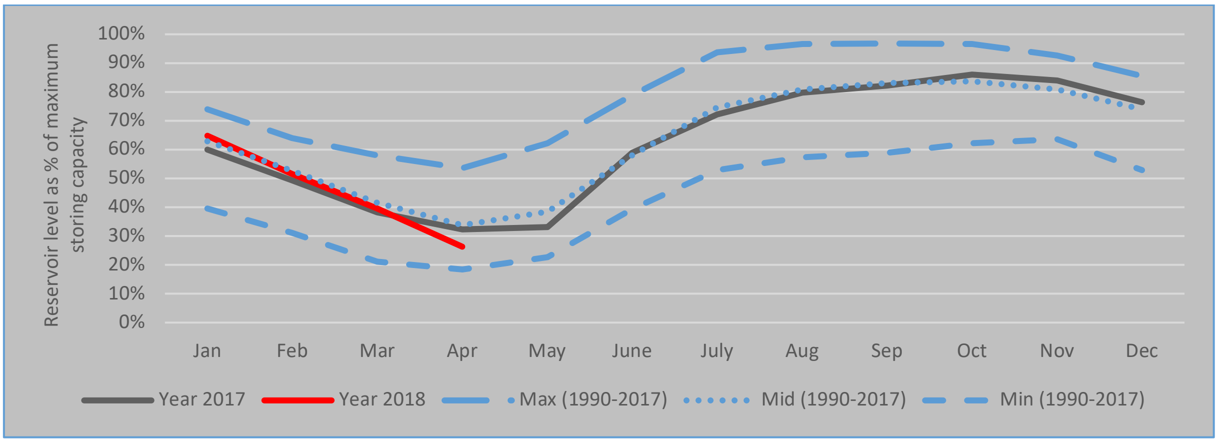


Figure 16: Reservoir levels in Norway.[15]

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

6 Winter Review 2017/2018

The winter review is based on the qualitative information submitted by ENTSO-E TSOs in March 2018 to represent the most important events that occurred during winter 2017/2018 and to compare them to the study results reported in the previous Seasonal Outlook. Important or unusual events or conditions in the power system and the remedial actions taken by the TSOs are also mentioned. A detailed winter review by country appears in Appendix 1:.

6.1 General Comments on Past Winter Climate

Last winter was distinguished by good wind conditions and was on average milder than normal, with some exceptionally mild temperatures in January. Hence, January 2018, assessed with possible adequacy risks in the Winter Outlook 2017/2018, went off without a hitch.

Winter 2017/2018 was marked by volatile weather conditions and several events from December to February:

- December winter conditions with active disturbed passages, cold temperatures at the beginning of the month and the storms ‘Ana’ and ‘Bruno’.
- In January, a succession of very active disturbed passages with several stormy episodes and exceptionally mild temperatures. On 3 January a record for Germany-wide wind generation of 42 GW was registered.
- February ended with an unusually late cold wave that continued in March, especially noticeable in the continental west. In France, on the 27 February temperatures were more than 10°C below normal. In Ireland, very low air temperature was recorded on 1 March at Cork Airport with -7°C, lowest minimum for March since 1962.

6.2 Specific Events and Unexpected Situations During the Past Winter

Several events were monitored last winter:

- Several events in transmission network raising need of exchange reduction on 2 GW France–Angleterre Interconnection (IFA2000) to assure the system’s safety;
- On 27 February and 1 March, the French TSO (RTE) changed its System State on European Awareness System (EAS) to Alert State for a lack of reserve, and to Emergency state on 27 February from 19:15 to 19:30 CET due to the absence of available margin. These actions were necessary because of very high demand due to the cold wave, forced outages of generation assets and volatility on the

exchanges. These situations were managed by RTE's sole actions and margins were progressively recovered;

- On 20 March, the Romanian TSO changed its state to 'Alarm' due to a lack of reserves after exploitation of all restoration reserves which amounted to 1500 MW. The alert state was caused by significant imbalances of wind generation estimations caused by icings on the blades;
- Supply margins in Sweden were stressed on occasions with cold weather condition from the end of February to beginning of March. To ensure system adequacy, the activation time of Swedish peak load reserve (strategic reserve mechanism in Sweden) was reduced. Reduction was applied only to production part of Swedish peak load reserves. In very few situations were they requested to operate on minimal stable operational level to be able to promptly support system adequacy if necessary. Eventually, the need was not observed;
- Frequency deviation was experienced from mid-January to the beginning of March due to power imbalances in Serbia, Macedonia, Montenegro (SMM block) and specifically Kosovo.*[16] Continental Europe TSOs carried collective compensation programme which allowed the situation to be restored to normal by the beginning of April. However, ENTSO-E calls for a political resolution of the dispute that caused the deviations so as to ensure a long-lasting solution to the problem. This will remain a focus area for the association in the course of 2018.

[16] **This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.*

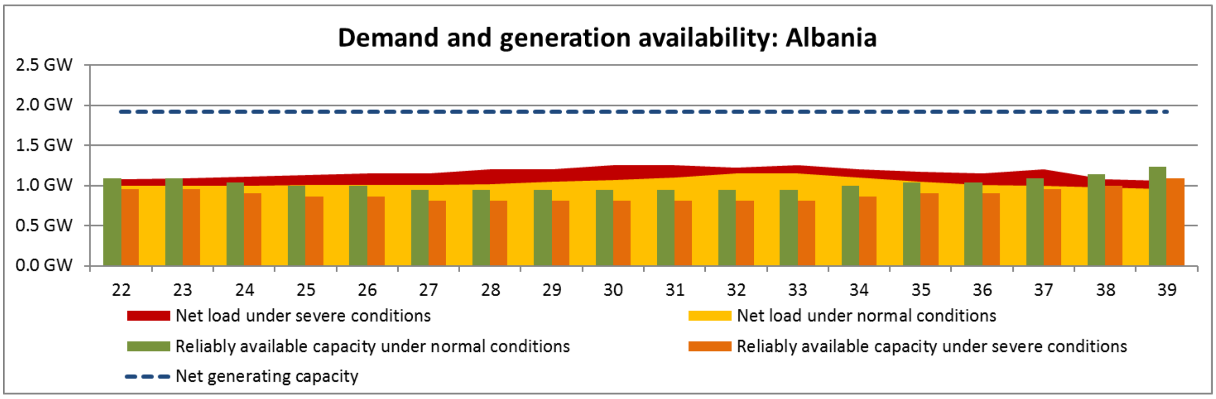
Appendices

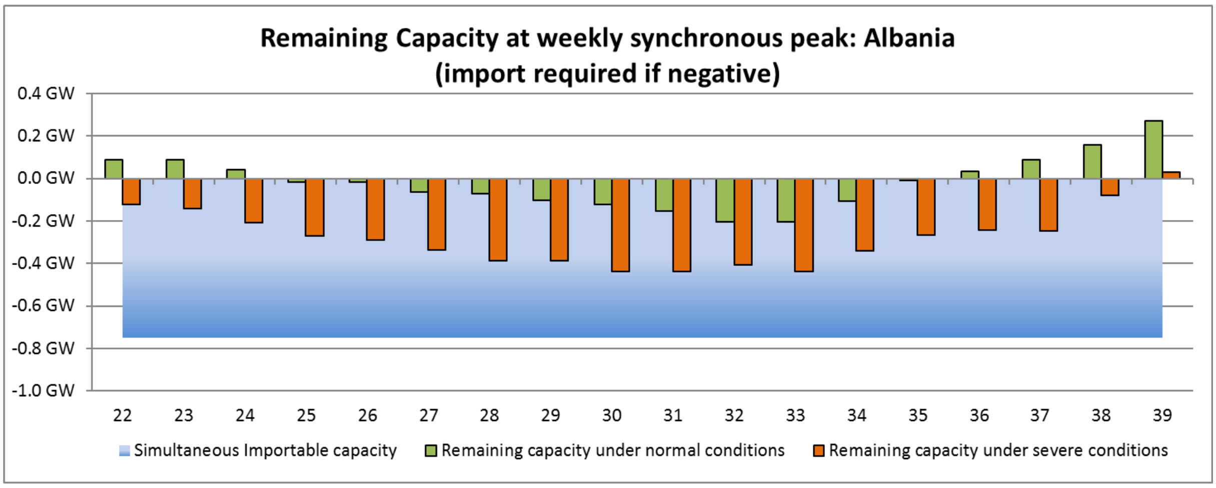
Appendix 1: Individual Country Comments on the Summer Outlook and Winter Review

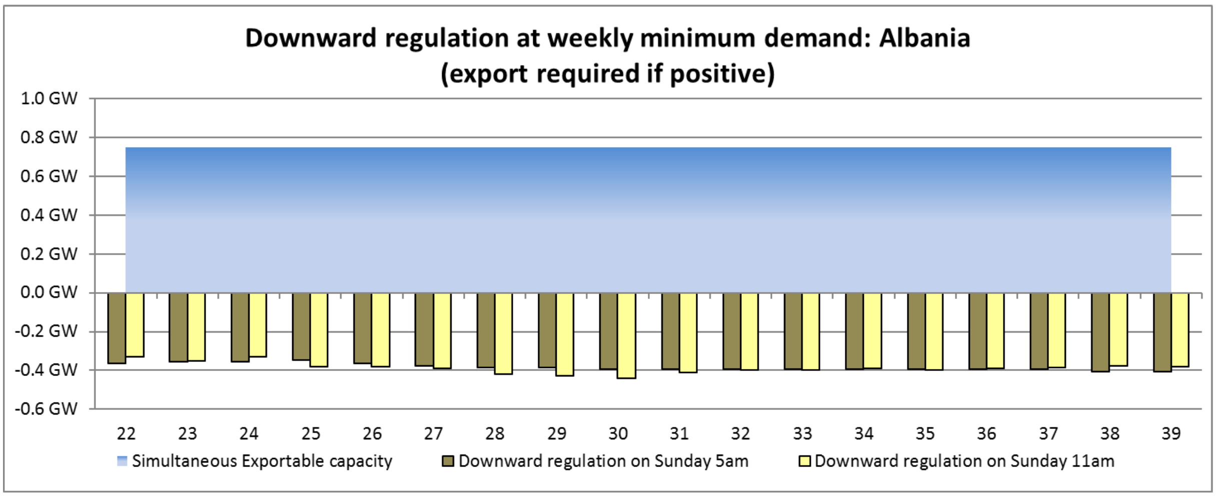
Albania: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







Albania: Winter Review 2017/2018

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

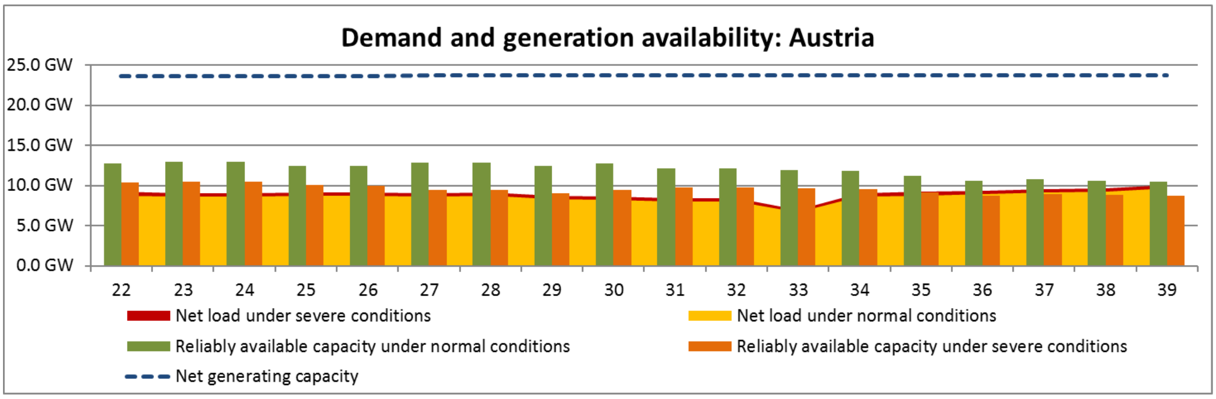
Austria: Summer Outlook 2018

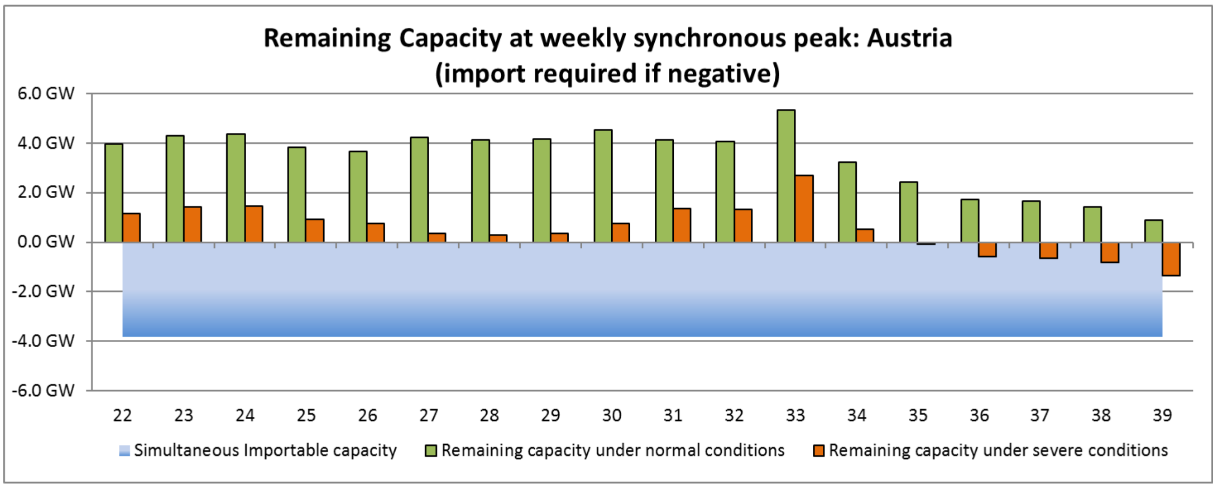
For the upcoming summer, APG assumed an increase of demand of 0.56% compared to summer 2017. Furthermore, APG supposed a rise of demand 'under severe conditions' of 5%. Due to the high amount of stored precipitation in the mountains it is assumed that reservoir levels will rise significantly during spring/summer this year.

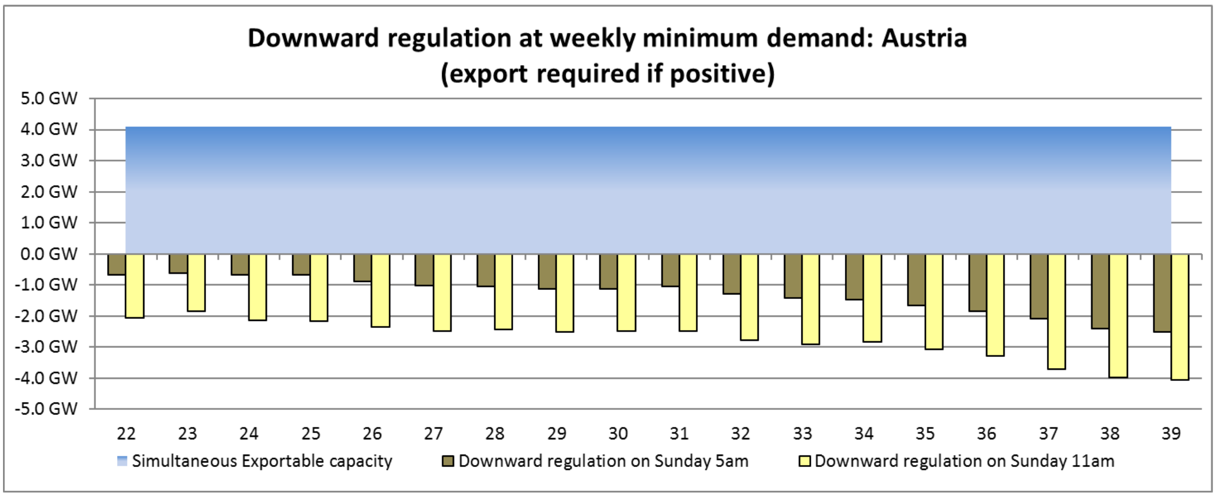
The net generating capacity of the 'Kraftwerksgruppe Obere Ill-Lünersee' (1.7 GW) is assigned to the German TSO TransnetBW and so considered as firm export to Germany.

Most critical periods for maintaining adequacy margins and countermeasures

In September this year, it is assumed there will be the lowest availability of hydro for this summer. Under normal conditions, the remaining capacity should be slightly above zero and 'under severe conditions' a little below zero.







Austria: Winter Review 2017/2018

General comments on past winter conditions

Winter 2017/2018 was characterised by three very different months. December was relatively mild in the valleys but cold in the mountains. January was the third warmest in history followed by a very cold February (in the mountains the fourth coldest winter within the last 32 years). In conclusion, winter 2017/2018 was mild – 0.8 °C above average.

Concerning precipitation, last winter was 25% above average and thus one of the four wettest winter within the last 30 years. Regarding sunshine, last winter was 15% below the average.

Specific events and unexpected situations that occurred during the past winter

During the cold spell in February 2018, the reservoirs of the (pumped-) power storage plants and wind generation were on an average level. Thus, there was no generation adequacy issue in Austria.

Belgium: Summer Outlook 2018

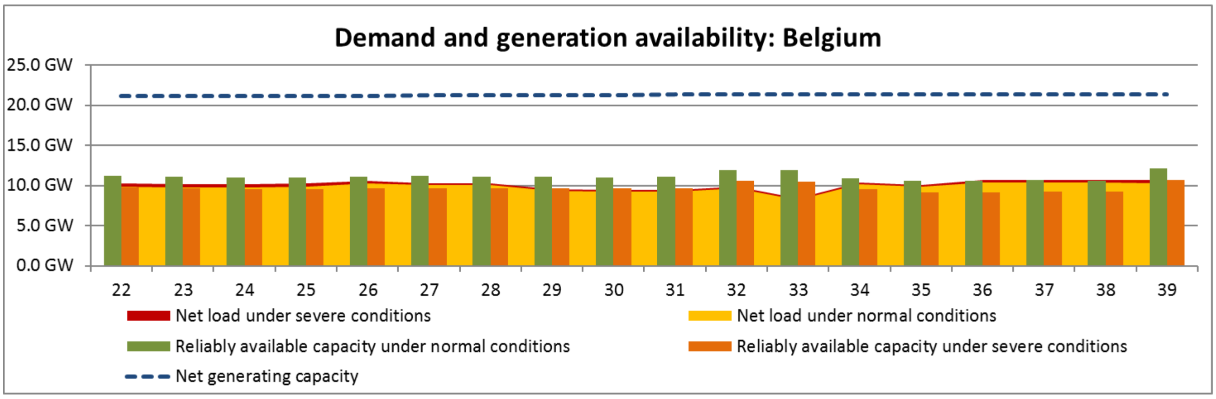
Potential critical periods and foreseen countermeasures

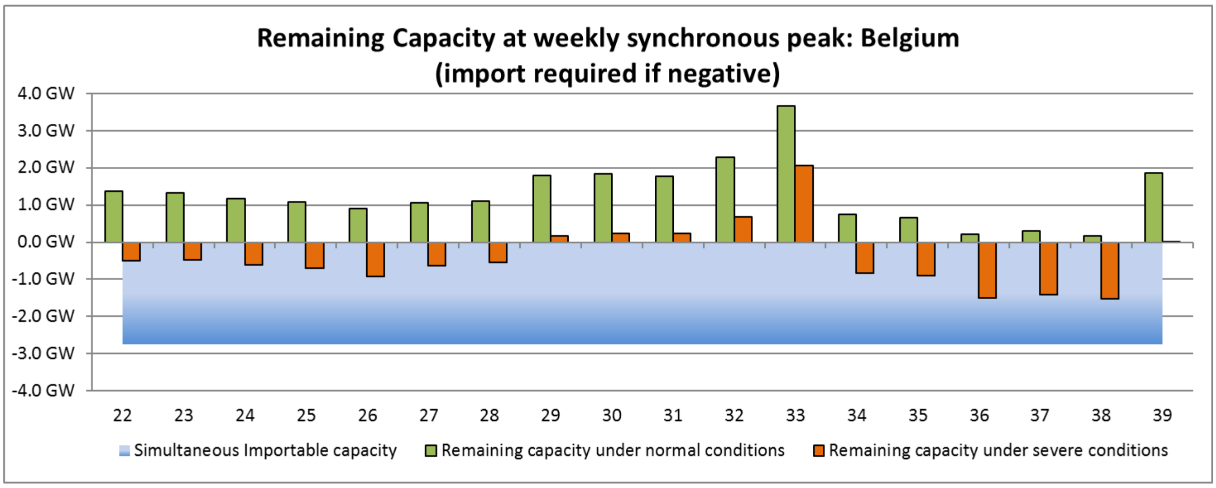
The status of the nuclear generation park has normalised, which reduces the adequacy risk for Belgium. In normal conditions, Belgium has a small positive remaining capacity. In severe conditions, the remaining capacity may become negative, with sufficient import capacity.

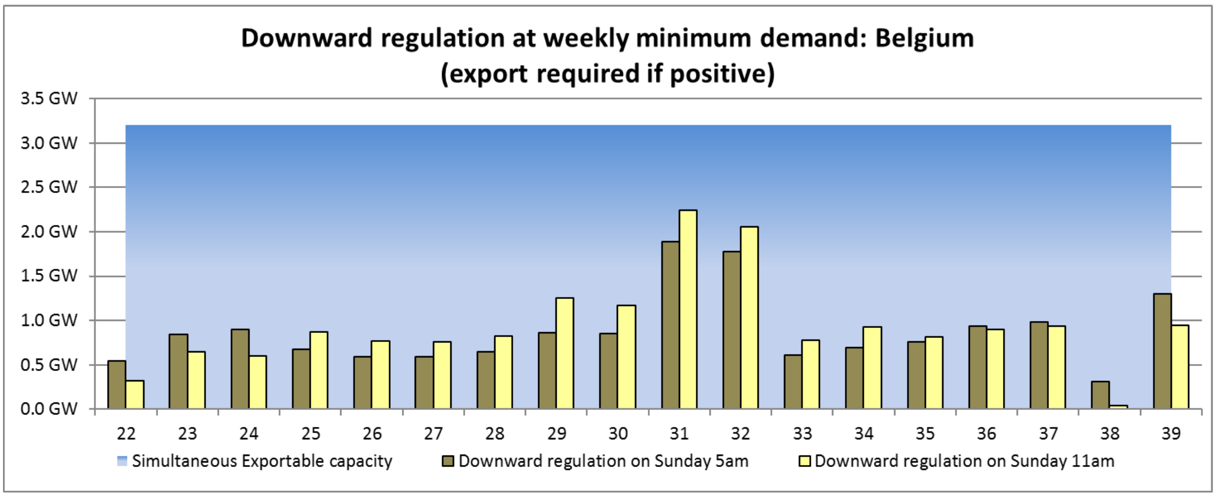
Since the status of the nuclear generation park has normalised, the amount of inflexible generation is high. The high availability of these nuclear units during the summer period in combination with reduced demand and increased solar and wind production, can lead to periods of excess energy.

In the event of normal wind and solar conditions (P50) the excess is mainly limited to weekends and the holiday period. On these occasions, the export capacity should be sufficient.

In the event of high wind and solar conditions (P95) the excess is increasing. 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 needed (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 2017/2018

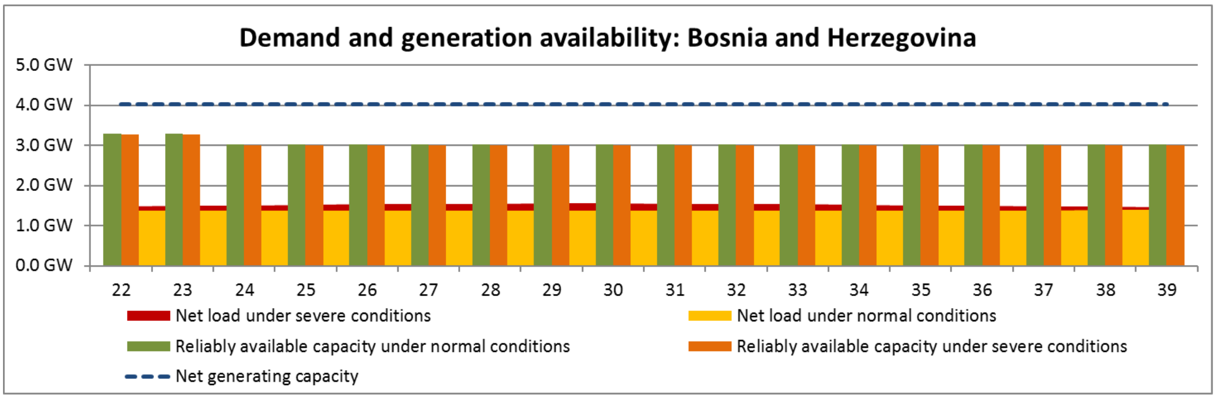
Despite the fact that the status of the nuclear generation park has normalised (except for unplanned outage of Doel 3 (~1 GW)) the Belgian power system strongly depended on imports to cover the demand in severe weather conditions.

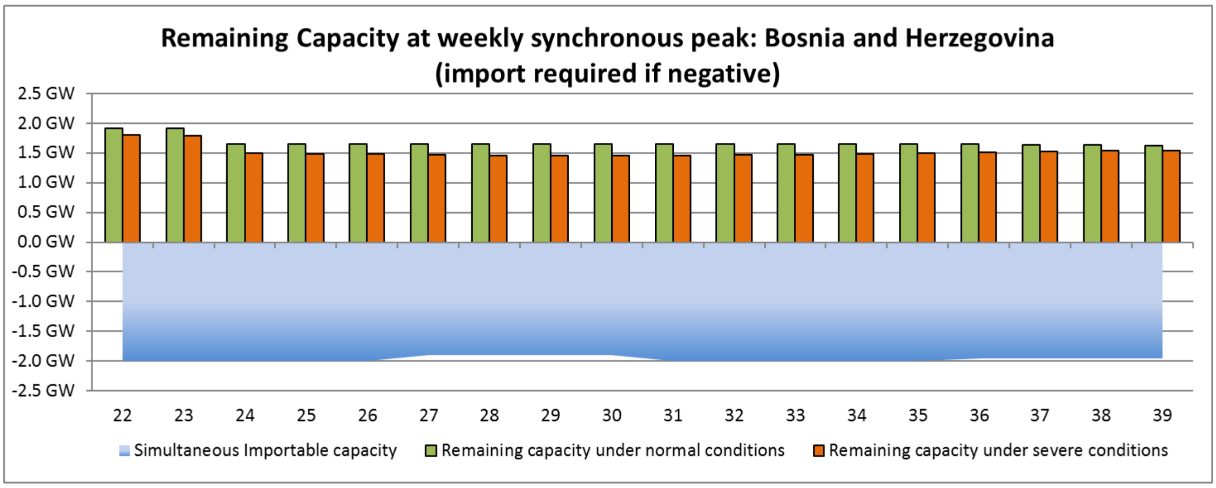
In winter 2017/2018, a strategic reserve capacity of 750 MW was contracted. This additional capacity could be used in order to avoid scarcity situations. However, the import capacities were sufficient and energy was available in neighbouring countries, so activation of the strategic reserve was avoided.

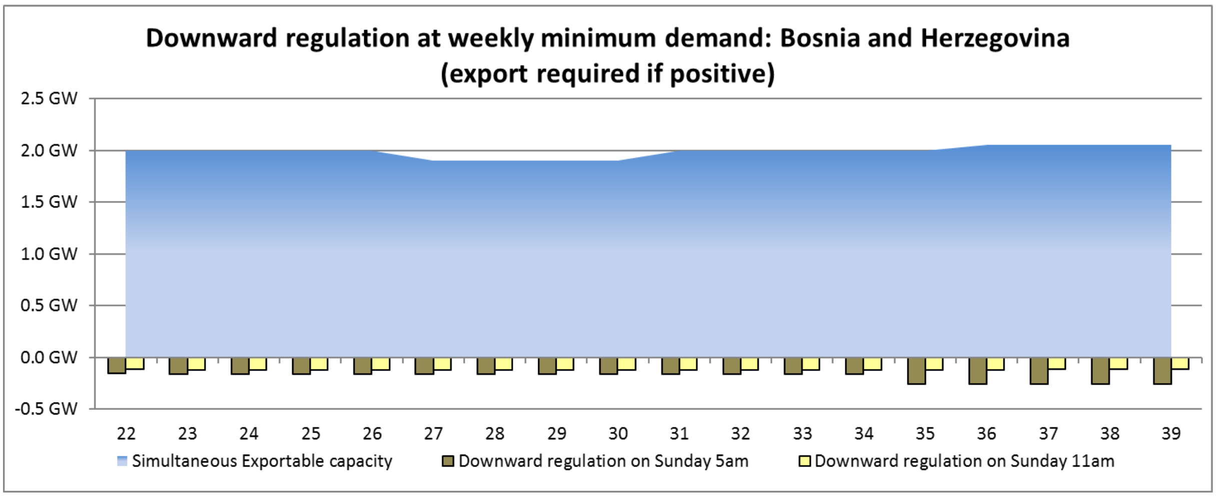
Bosnia and Herzegovina: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

No particular power system adequacy risks, nor increase of national demand is expected in Bosnia and Herzegovina in summer 2018.







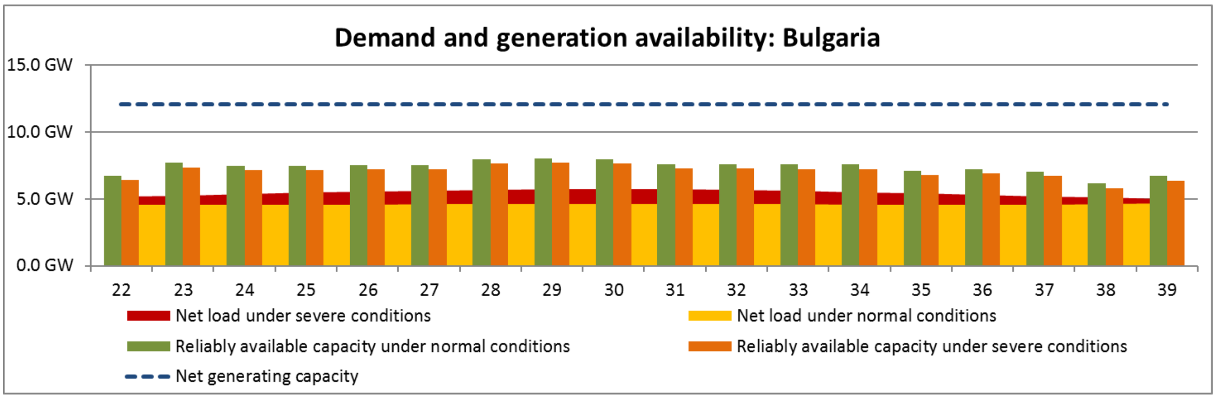
Bosnia and Herzegovina: Winter Review 2017/2018

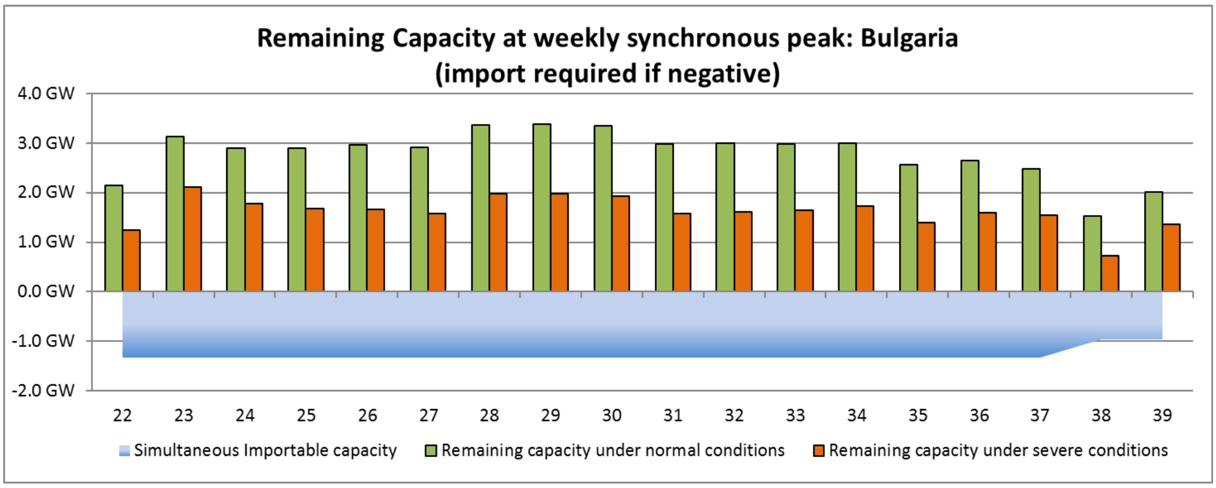
During the winter period 2017/2018, there were no significant unusual events in the electric power system of Bosnia and Herzegovina. The temperatures in December and January were generally lower, and in February and March they were higher than usual. Maximum demand occurred at 19:00 on 28 February, and it was 1992 MW.

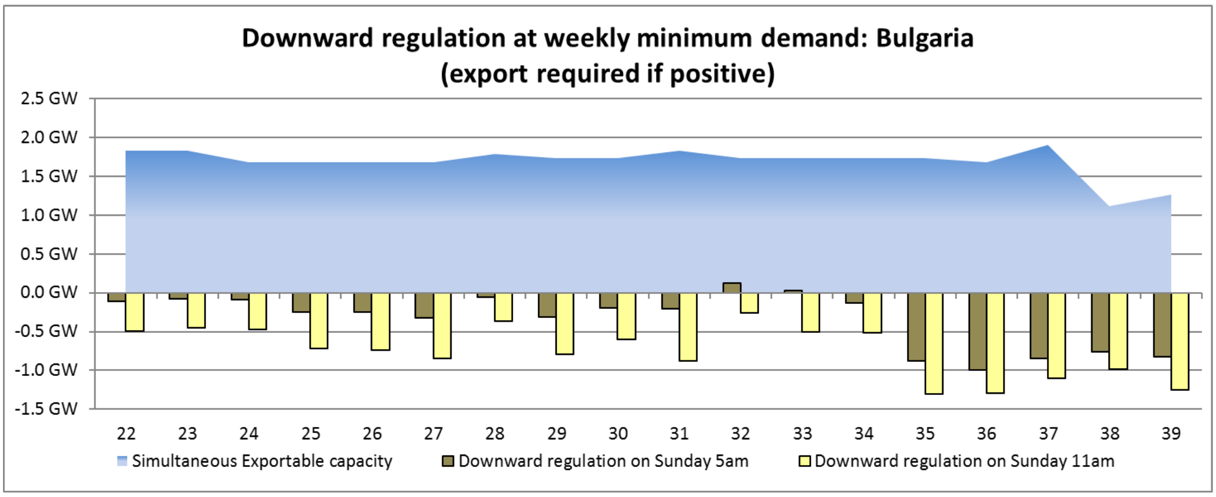
Bulgaria: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







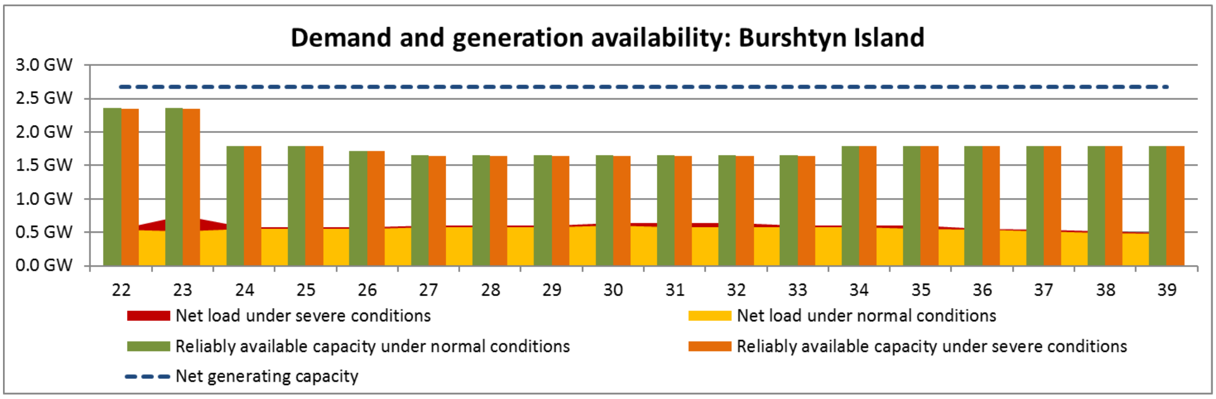
Bulgaria: Winter Review 2017/2018

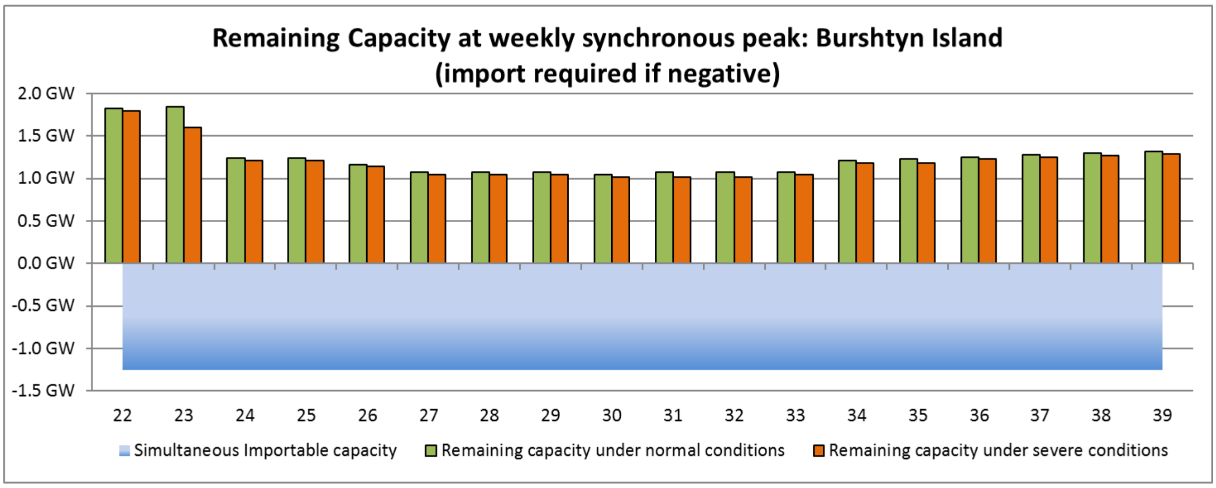
No adequacy or downward regulation issues were identified during the past season.

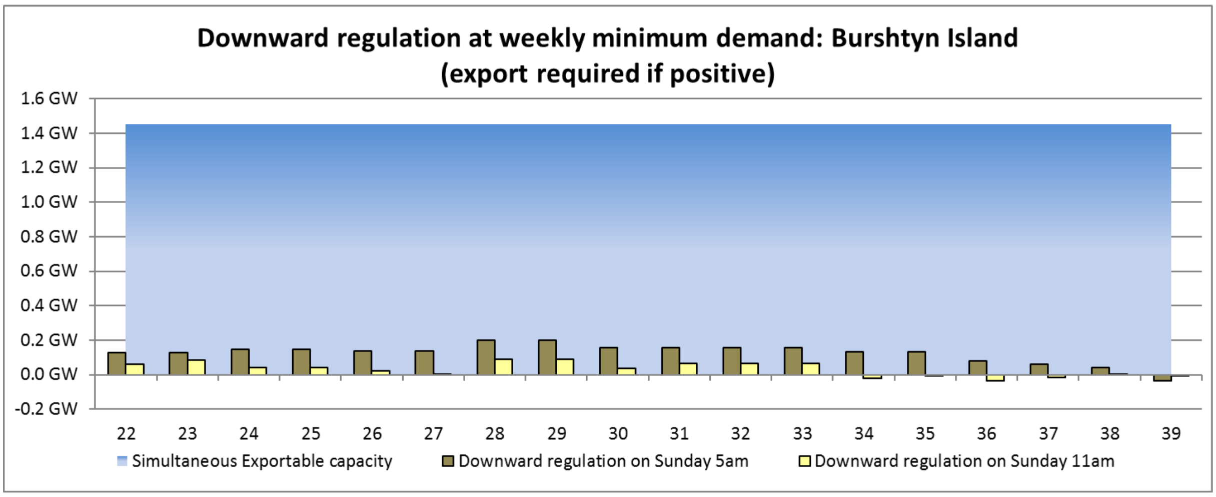
Burshtyn Island: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







Burshtyn Island: Winter Review 2017/2018

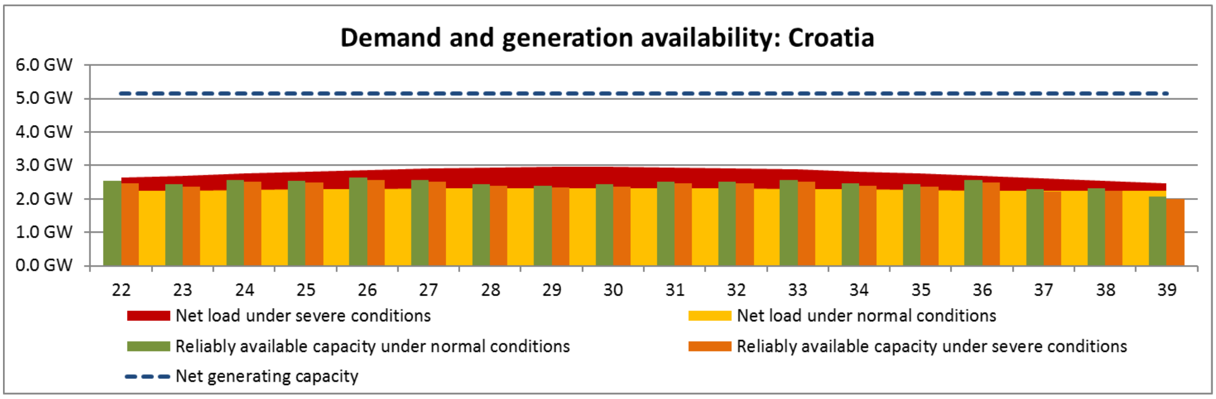
No adequacy or downward regulation issues were identified during past season.

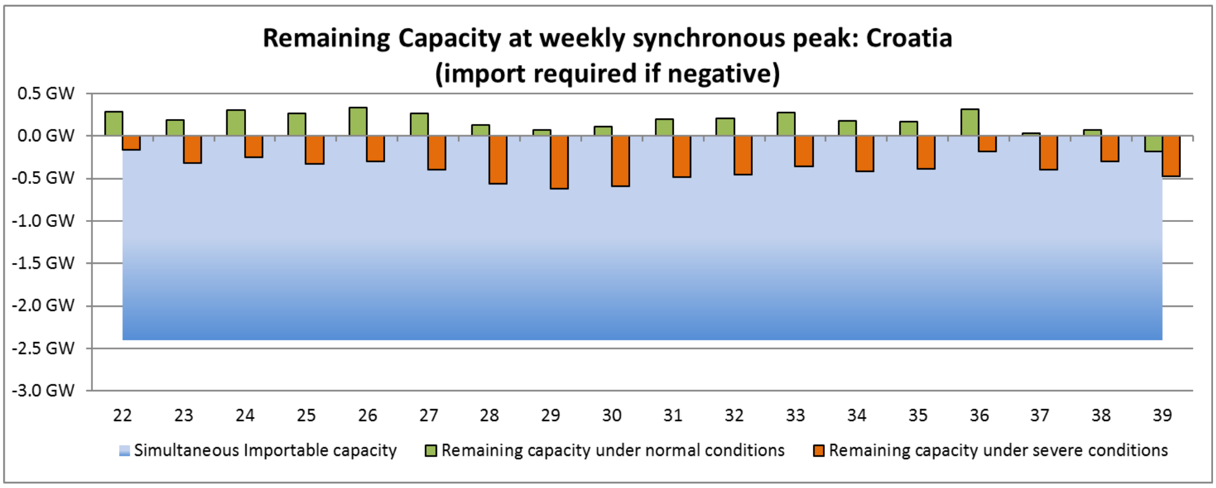
Croatia: Summer Outlook 2018

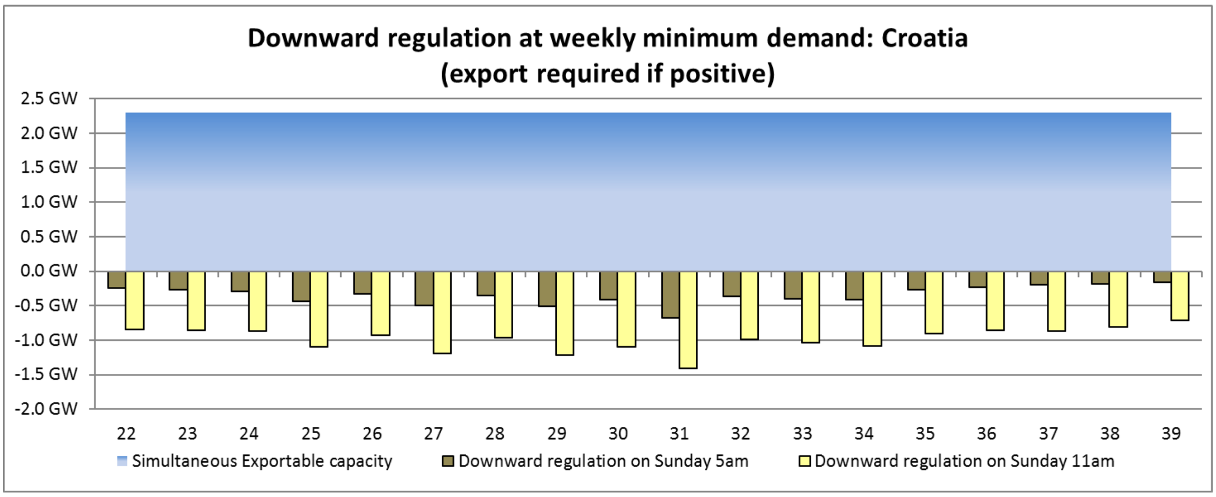
Generally, Croatian TSO (HOPS) does not expect any adequacy issues during the summer 2018.

Potential critical periods and foreseen countermeasures

For the Croatian system, potential critical periods occur in July or in August, when the air temperatures are very high and the generation unit maintenances are performed. The need for electricity imports will vary depending on the situation in hydro reservoirs and presence of wind. No adequacy or downward regulation issues are expected for the coming season.







Croatia: Winter Review 2017/2018

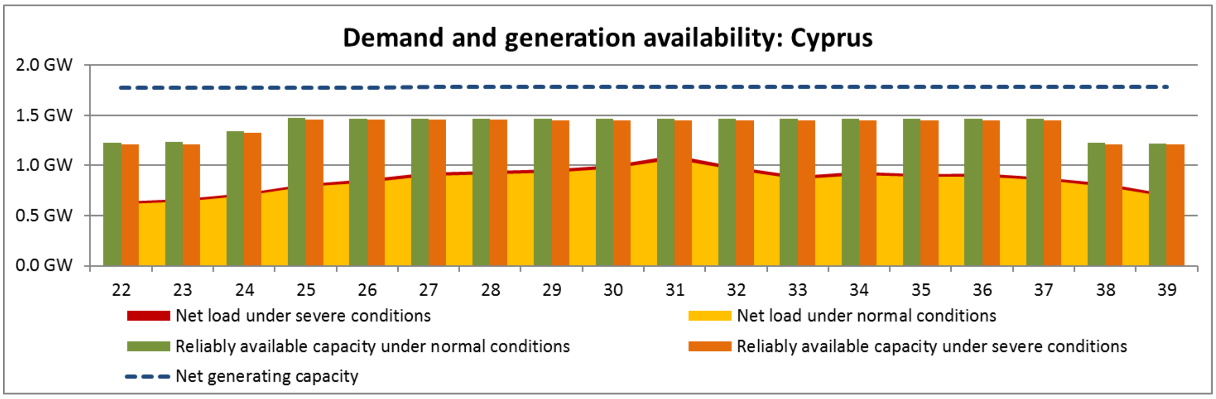
In the first part of the winter period (November-December) a lot of energy was imported due to very low hydro production in Croatia and whole region. Later, the Croatian system was confronted with cold weather, especially at the end of February and the beginning of March when demand increased. There was no significant impact on adequacy, mostly as a result of better hydro production compared to the beginning of the winter. In March, extremely high hydro production caused a lack of downward regulation for a few weeks.

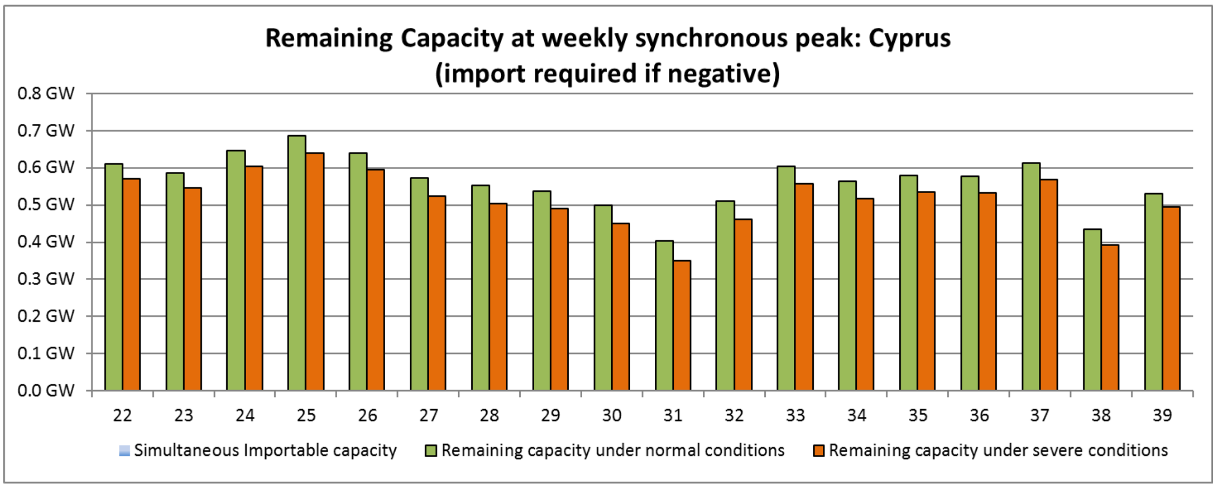
No adequacy issues were identified during the past season.

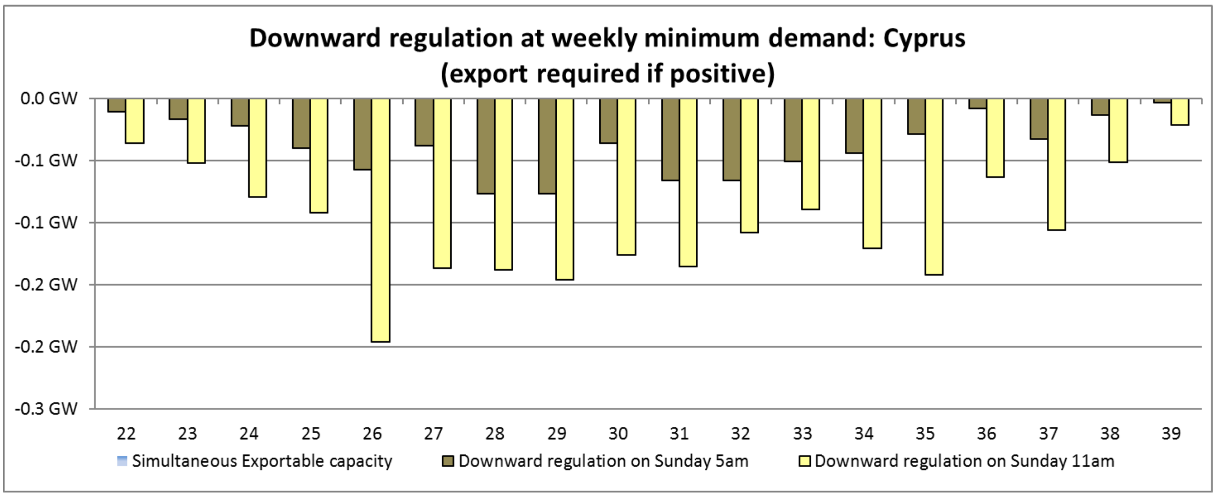
Cyprus: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







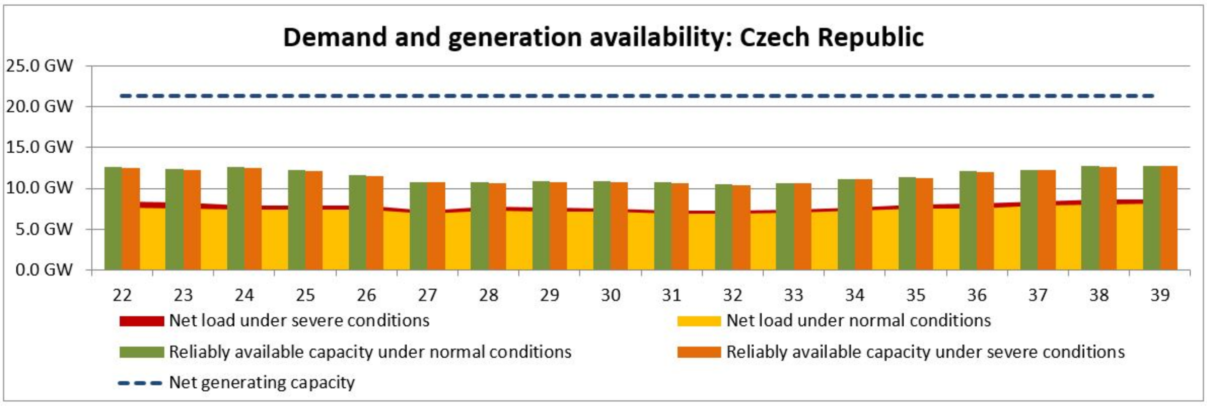
Cyprus: Winter Review 2017/2018

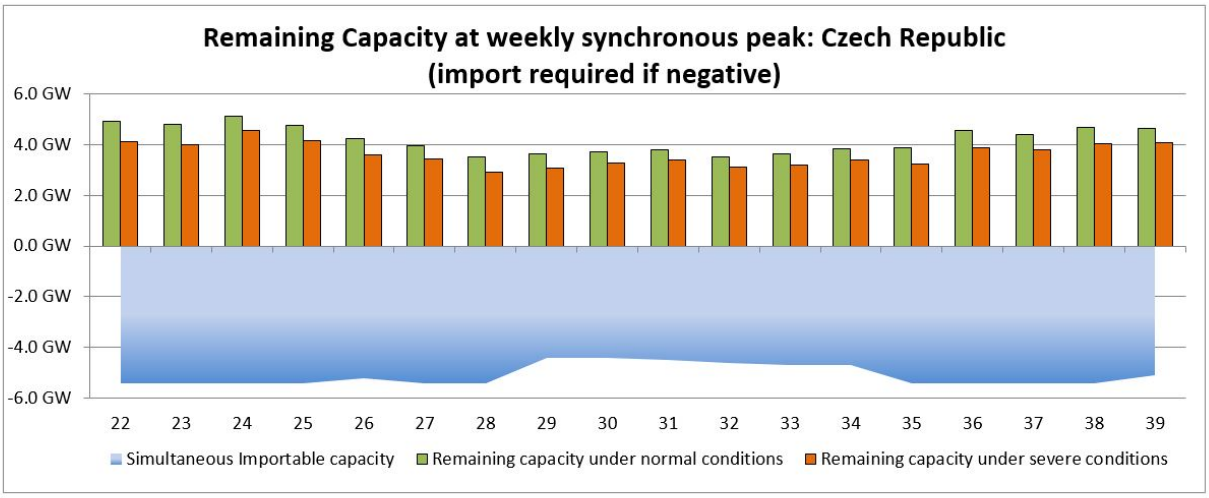
No adequacy or downward regulation issues were identified during the past season.

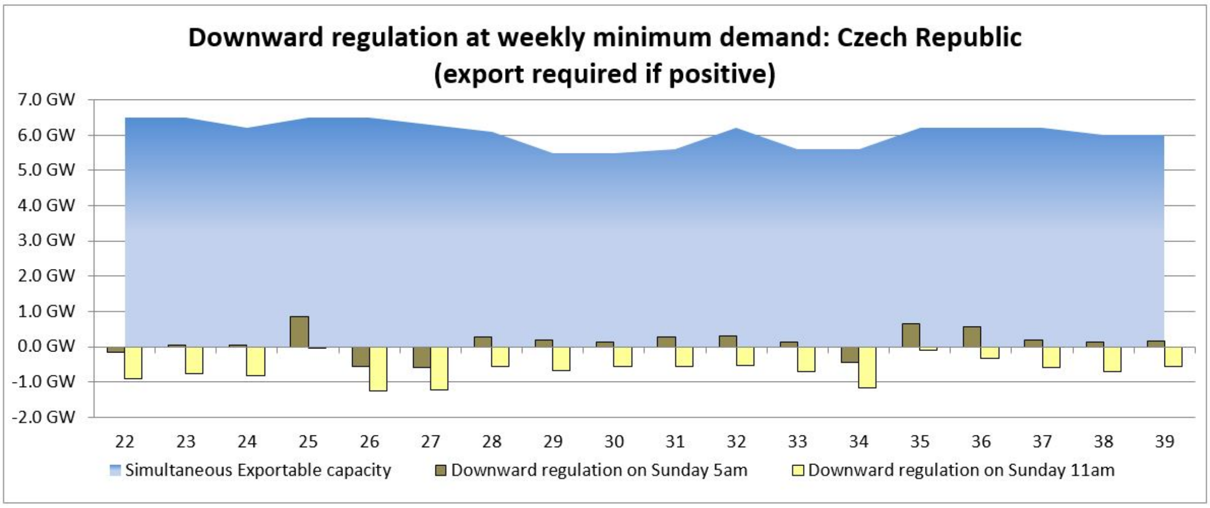
Czech Republic: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







Potential critical periods and foreseen countermeasures

There are several days shown in the chart, implying some excess of energy needs to be exported. However, the values are not significant and can be handled well within exportable capacities and without any risks to the system security.

Czech Republic: Winter Review 2017/2018

The winter season was generally mild in the first half. Later, in weeks of late February and early March, due to very low temperatures, the national demand reached a new historical peak. No adequacy or downward regulation issues were identified during past season. Only some minor international re-dispatches took place on APG/SEPS requests to handle N-1 criterion.

Denmark: Summer Outlook 2018

Energinet expects a stable summer period. Power plant and some grid asset maintenances are planned that affect the available resources, but generally the adequacy situation is fine.

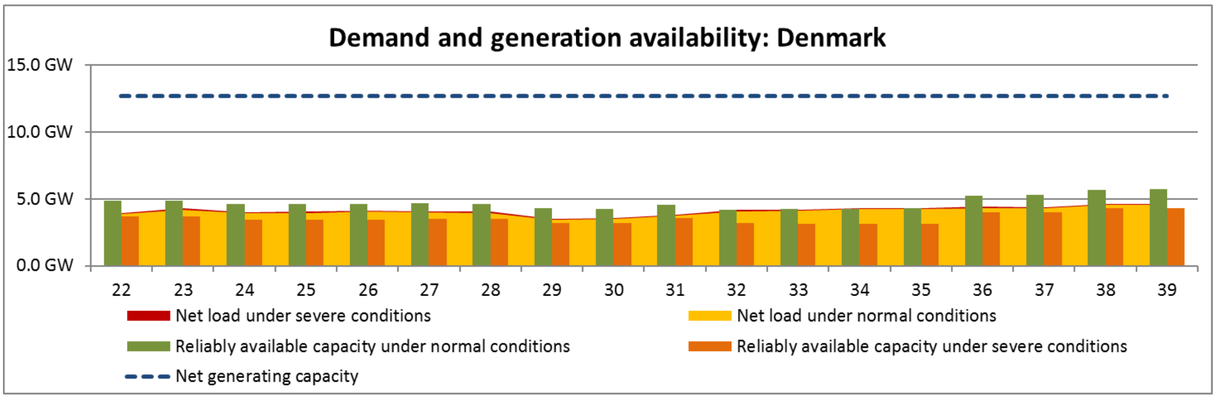
Potential critical periods and foreseen countermeasures

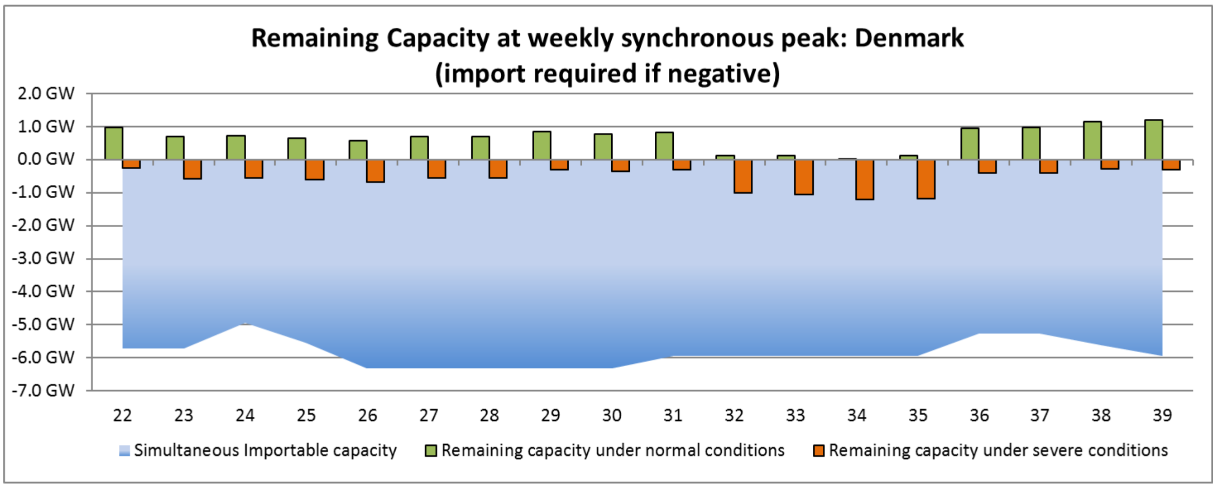
The adequacy in Western Denmark (DK1 bidding zone) and Eastern Denmark (DK2 bidding zone) is expected to be quite fine during summer.

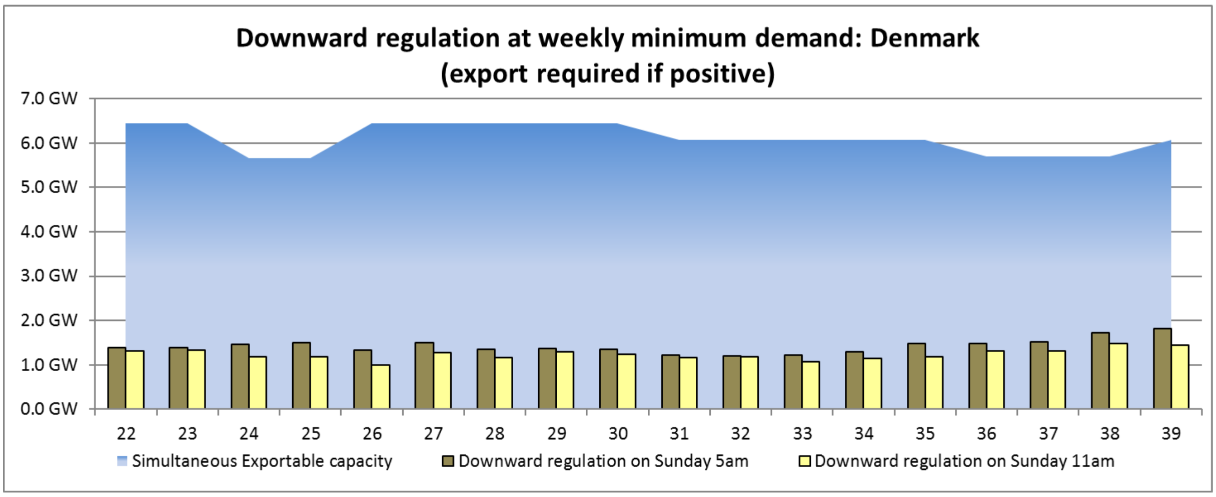
DK1: TenneT Germany will reduce the interconnection capacity availability on the German-Danish border due to necessary work on 400 kV lines in the northern part of Germany. This, combined with a maintenance of the Skagerrak connections, may cause a tight but manageable adequacy situation.

DK2: There will be short periods with limited interconnection capacities on the Swedish-Danish border. This is due to necessary work on the 400 kV lines in the southern part of Sweden.

Energinet does not expect downward regulation issues. However, as a result of the increased capacity between DK1 and Germany, Energinet expects a large amount of countertrade. This is a result of an agreement between The Danish Ministry of Energy, Utilities and Climate and the Federal Ministry of Economic Affairs and Energy of the Federal Republic of Germany, together with the Danish Energy Regulatory Authority and Bundesnetzagentur. The agreement gives a guaranteed capacity to the market. In 2018, the minimum available capacity between DK1 and Germany will be 700 MW. Energinet expects to have sufficient downward regulation resources in DK1 and DK2 to manage the situation.







Denmark: Winter Review 2017/2018

In general, there have been no major disturbances in Denmark this past winter.

The transmission capacity between Denmark and the other Nordic countries has been limited in periods due to planned maintenances and other grid limitations.

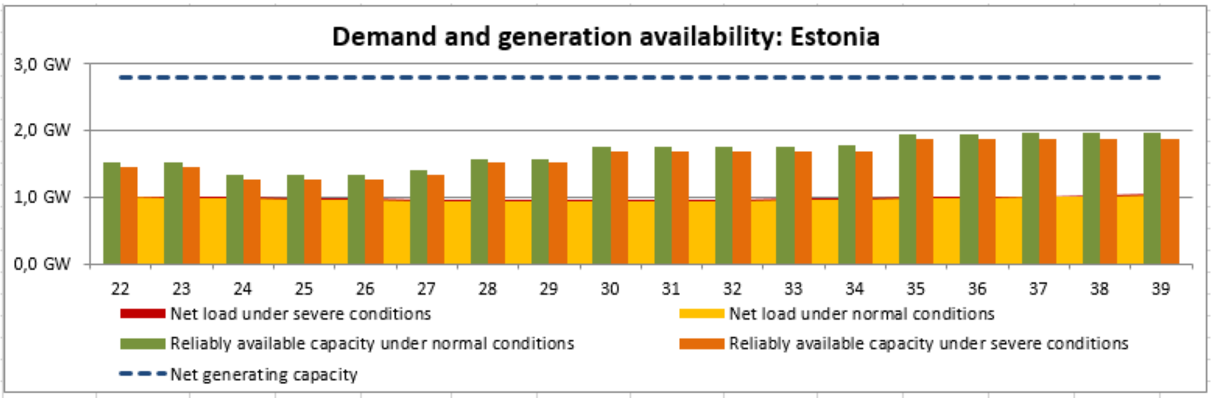
The transmission capacity between DK1 and Germany has increased notably compared to last winter due to the German-Danish agreement. As expected, the increased capacity between DK1 and Germany led to an increased amount of countertrade resulting in downward regulation in DK1.

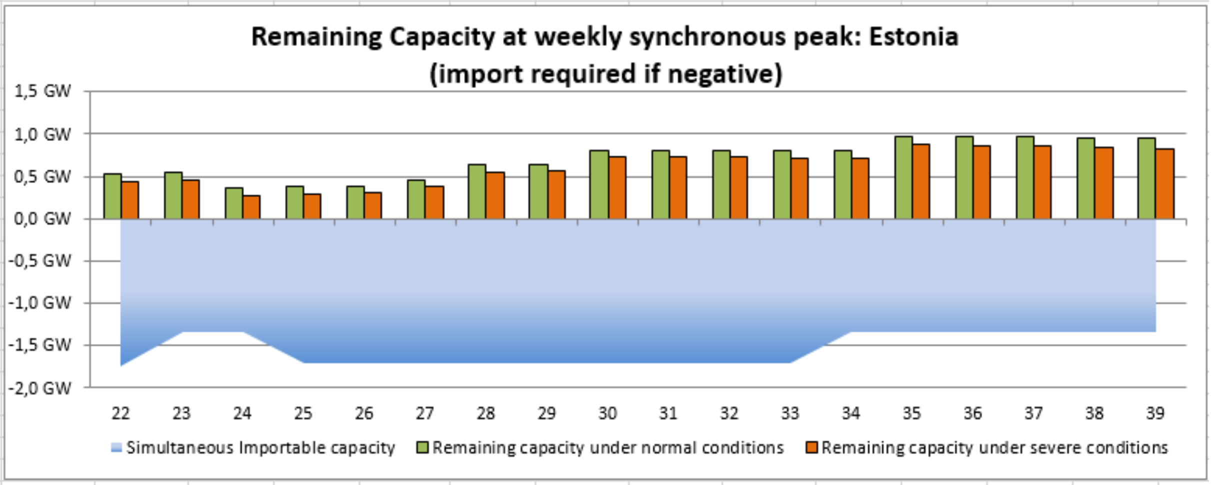
The wind production in Denmark has been high this winter and combined with export capacity limitations and high wind production in the surrounding areas, this led to more hours with negative prices compared to last winter.

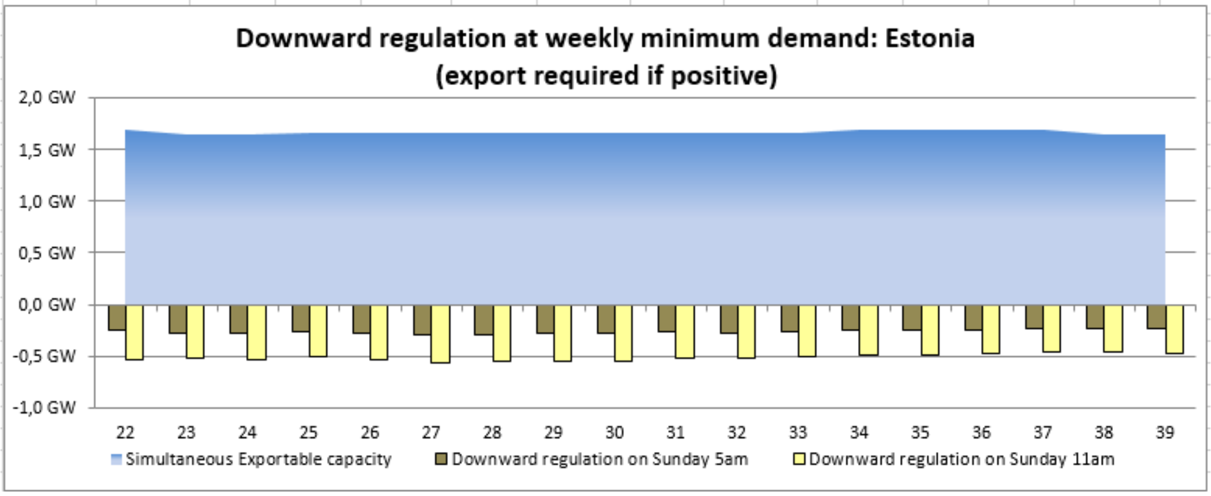
Estonia: Summer Outlook 2018

Elering does not expect any adequacy issues in the Estonian system this summer. There will be enough of production over the summer to cover peak demand. The forecasted peak demand is approximately 1 GW. The lowest import/export capacity on Estonian Latvian cross-border will be in weeks 23, 24 and 28. Estlink 1 annual maintenance is planned in week 23. No interconnection capacity reductions on Estonian Finland cross-border are foreseen.

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







Estonia: Winter Review 2017/2018

The first half of winter season was quite mild. The temperatures were around 0°C. The temperatures only began to drop by 2018 and stayed low until the end of February – beginning of March. The national peak demand was 1.55 GW (compared to an all-time record of 1.59 GW). Most of the time, Estonian system had enough capacity to cover peak demands and was exporting.

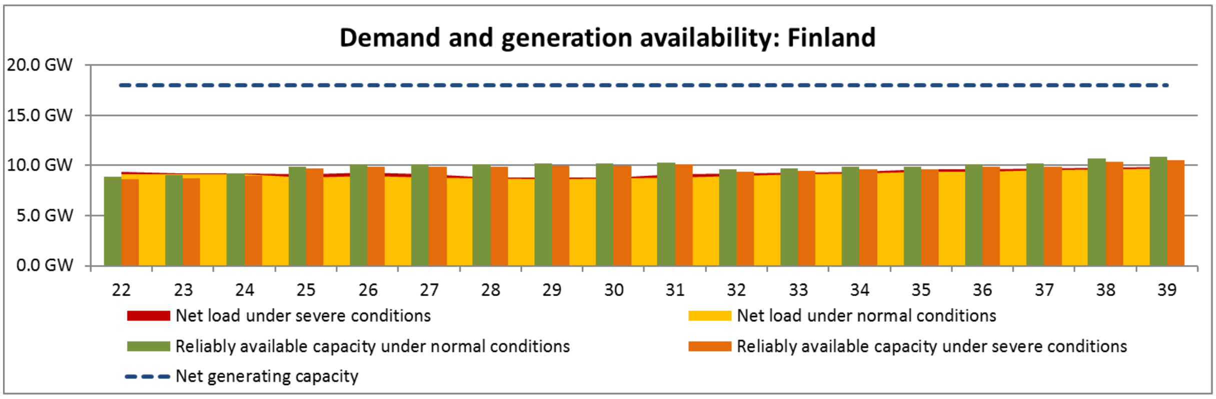
No adequacy or downward regulation issues were identified during the past season.

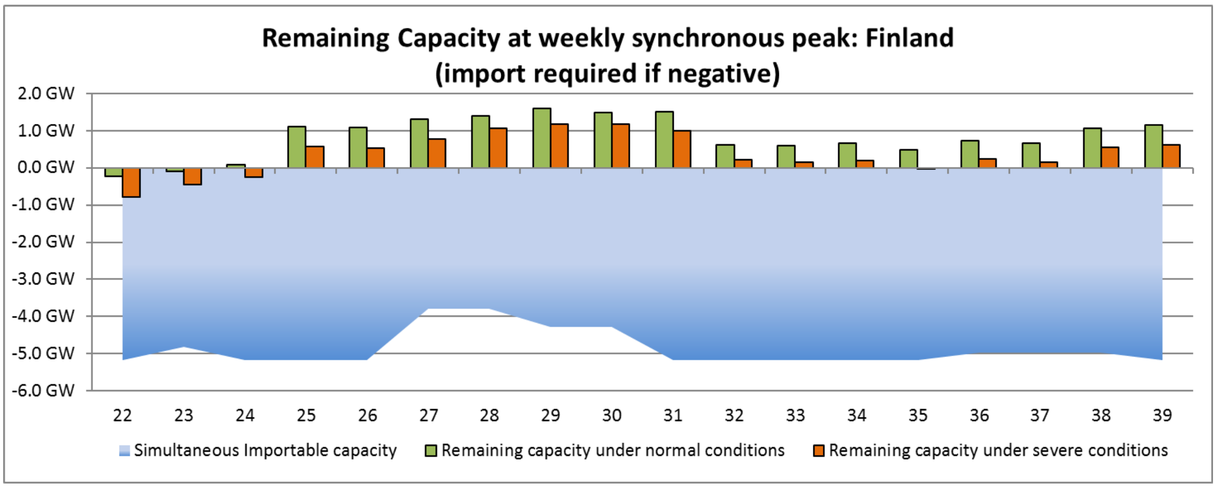
Finland: Summer Outlook 2018

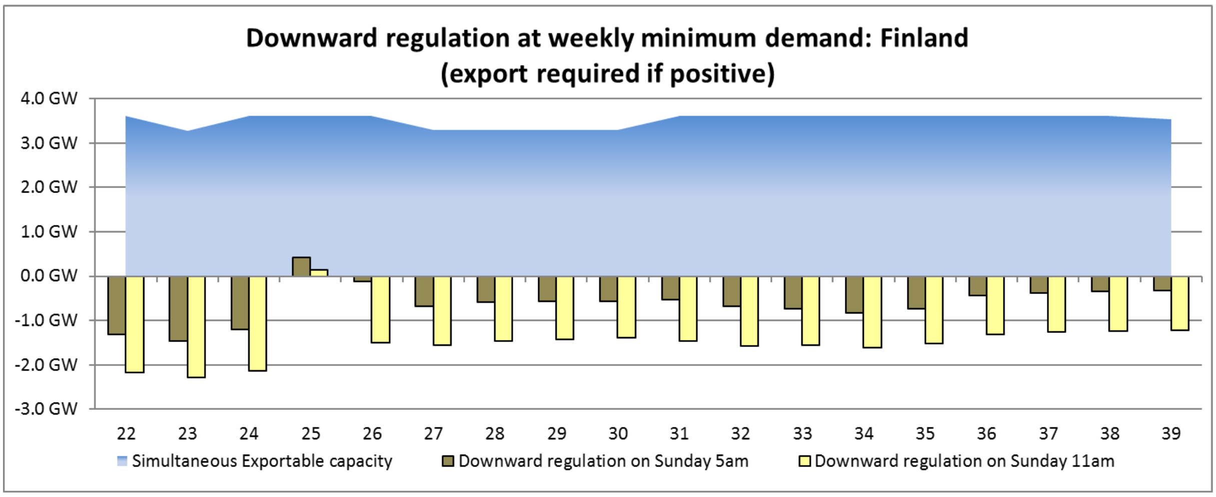
Typically, summer peak load in Finland is 60% to 70% of the winter peak load and therefore summer is not as critical from the adequacy perspective as winter. However, summer is high season for power plant maintenances and overhauls and that is why there is less generation capacity available in summer 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.





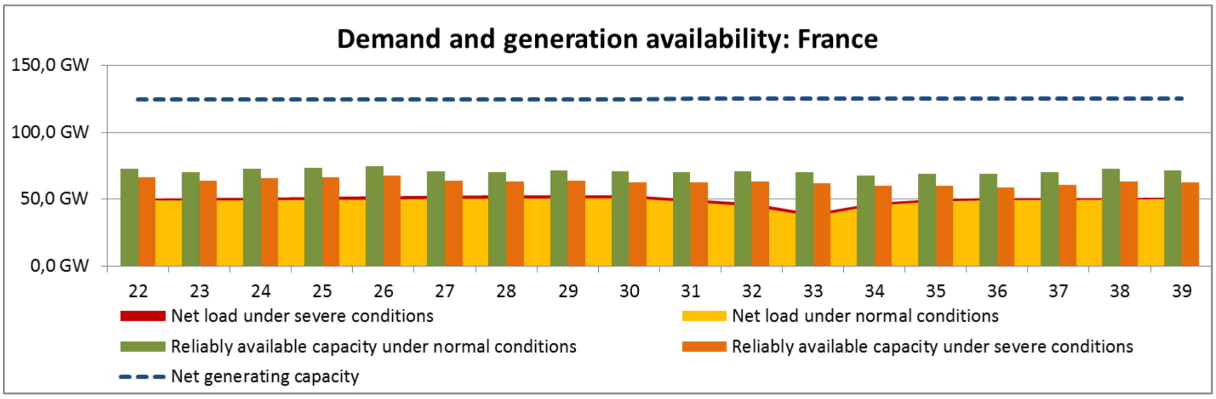


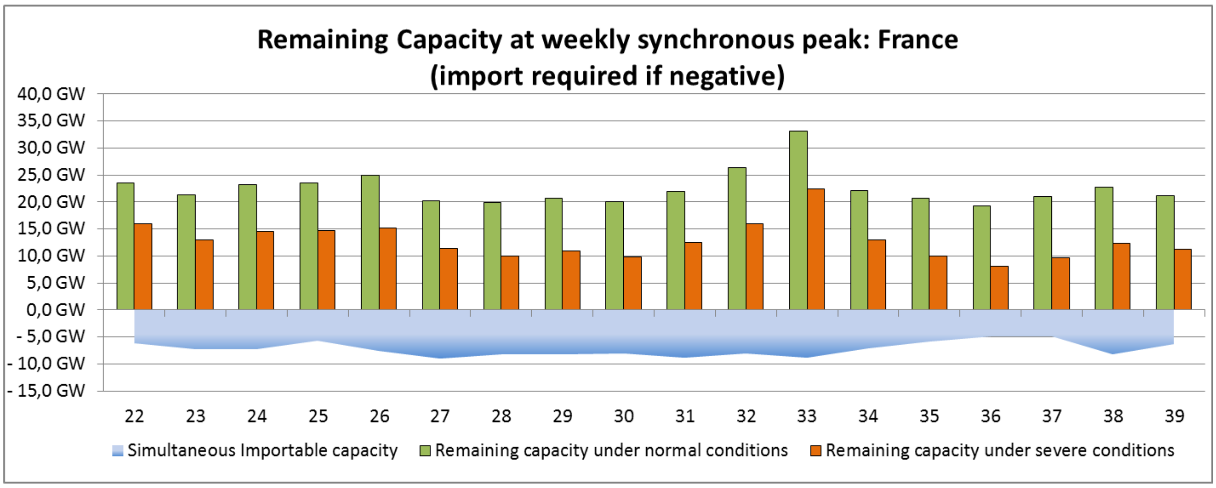
Finland: Winter Review 2017/2018

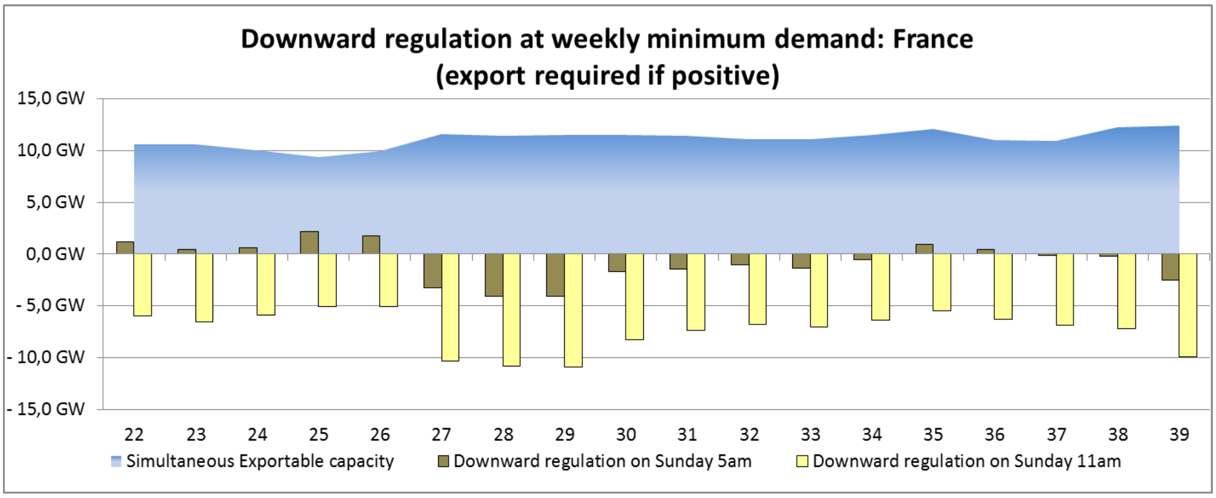
December and January in winter 2017/2018 were generally mild in Finland but a period colder than average started in February and continued through March. Winter peak demand was recorded on the last day of February (14.1 GW). Due to rather late sunset (in late February there are more sun light hours compared to January when peak loads are traditionally recorded in Finland), the peak load in winter 2017/2018 remained quite low.

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

France: Summer Outlook 2018







Potential critical periods and foreseen countermeasures

The most constraining period for severe conditions is week 36, with a high level of nuclear maintenance, combined with the availability of nuclear plants which are non-usable during a hot wave. However, upward margins should remain positive all over summer, with no need to import power for adequacy reasons.

The most critical period for downward regulation should happen in June, due to numerous nuclear power plants that must run close to their maximum power, with around 2 GW of exports needed, which is compliant with an exportable capacity of 12 GW. In case of an excess of power in the whole area, some of these nuclear plants should be able to completely stop during low consumption periods and weekends in particular – as is the case every summer.

France: Winter Review 2017/2018

General comments on past winter conditions

Winter 2017/2018 has been marked by volatile weather conditions and several events from December to February:

- In December, winter conditions with active disturbed passages, cold temperatures at the beginning of the month and the storms 'Ana' and 'Bruno'.
- In January a succession of very active disturbed passages with several stormy episodes and exceptionally mild temperatures
- In February temperatures remained cold throughout the country except for a mild warmth in the middle of the month. February ended with an unusually late cold wave from 26 February to 1 March. Over the month, the average temperature of 3.5 °C was below normal by 2.2°C, and on the 27 February temperatures were more than 10°C below normal.

Compared to 2017, demand decreased by 17.8% in January and increased by 13.4% in February. Following the stormy and windy conditions, wind energy was exceptionally high through the winter – compared to 2017, increase of 87.9% in January and 9% in February was recorded. Despite a low reservoir level at the beginning of winter, Hydraulic energy has also highly contributed to adequacy:

- in January, due to important rainfalls France produced 7.2 TWh of hydraulic energy, while preserving a stable hydro reservoir level;
- in February, hydro generation increased by 56.3 % compared to 2017, due to high demand and late cold spell.

Specific events and unexpected situations that occurred during the past winter

This winter has been marked specially by 2 events:

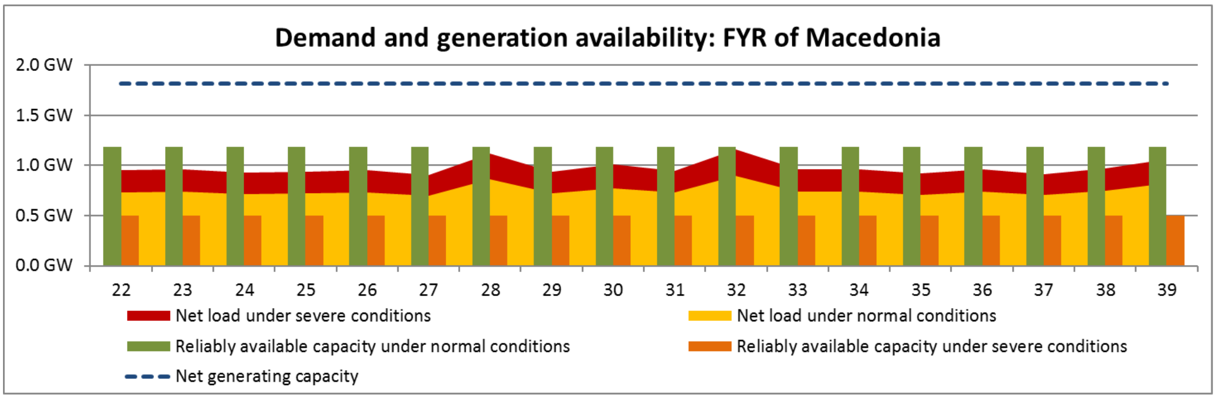
- In December, the storm 'Ana' caused the outage of three 400 kV lines in the north of France, requiring reduction of exchanges on France-England interconnection to ensure the system's safety.

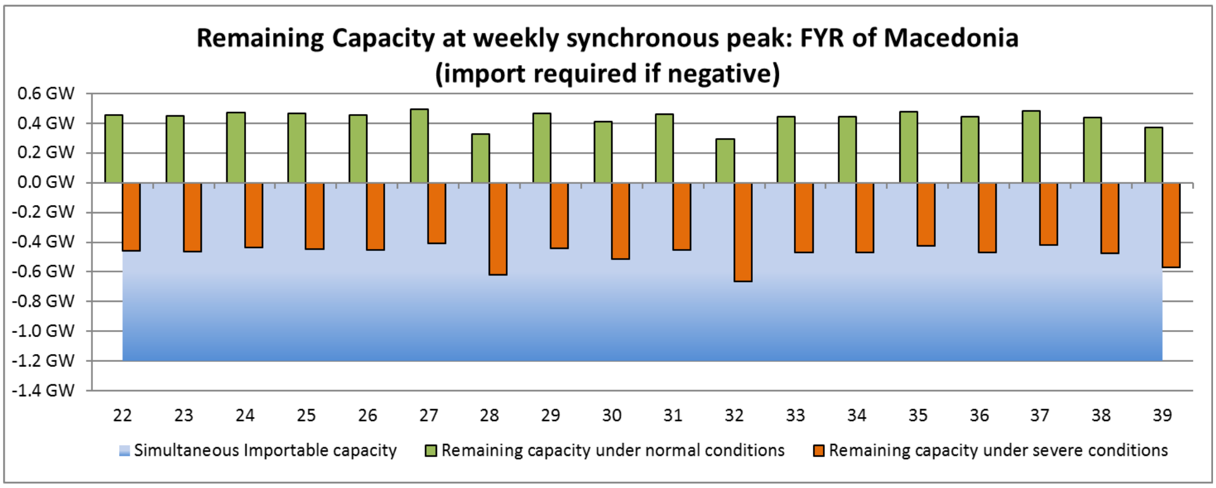
- On 27 February and 1 March, RTE changed its System State on European Awareness System (EAS) to Alert State for a lack of reserve, and to Emergency state on 27 February from 19:15 to 19:30 CET due to the absence of available margin. This event was mainly caused by very high demand due to the cold wave conditions and forced generation outages. This issue was kept under control on RTE's side and margins were progressively recovered by the actions of the market participants.

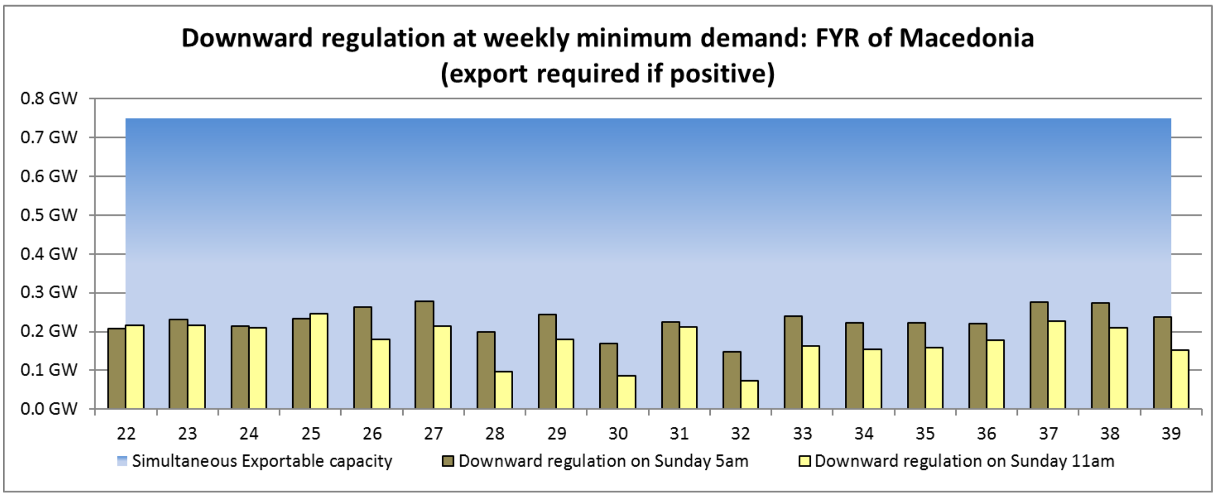
FYR of Macedonia: Summer Outlook 2018

This summer is expected to be warmer than typical, so it is possible that some issues will be faced in the transmission system. During the winter there were no extreme low temperature or low precipitation periods. At the end of the winter there was one period with intense snowfalls in the higher altitudes, but low temperatures did not last long, and production of hydro power plants increased in the spring. Interconnections would have a key role in the summer period due to the large transit in the north-south direction.

Cross-border transmission capabilities of the Republic of Macedonia are sufficient to handle all cross-border exchanges of the Republic of Macedonia, while maintaining the unobstructed transit of energy across the region.







FYR of Macedonia: Winter Review 2017/2018

During the winter there were no extremely low temperature or low precipitation periods. At the end of the winter there was one period with intense snowfalls in the higher altitude locations. Due to the sharp increase of the temperatures, inflows and production of hydro power plants were increased in the spring. There were no unexpected situations during the winter period. The operation of the power system was secure and reliable over the entire winter period.

Germany: Summer Outlook 2018

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, Germany is therefore not expected to be dependent on imports to maintain adequacy.

The pumped storage powerplants (PSPs) of the 'Kraftwerksgruppe Obere Ill-Lünersee', which are installed in Austria, but are assigned to the German control block, are again considered by the German TSOs and included in German dataset. The affected amount of power is approximately 1.7 GW.

Potential critical periods and foreseen countermeasures

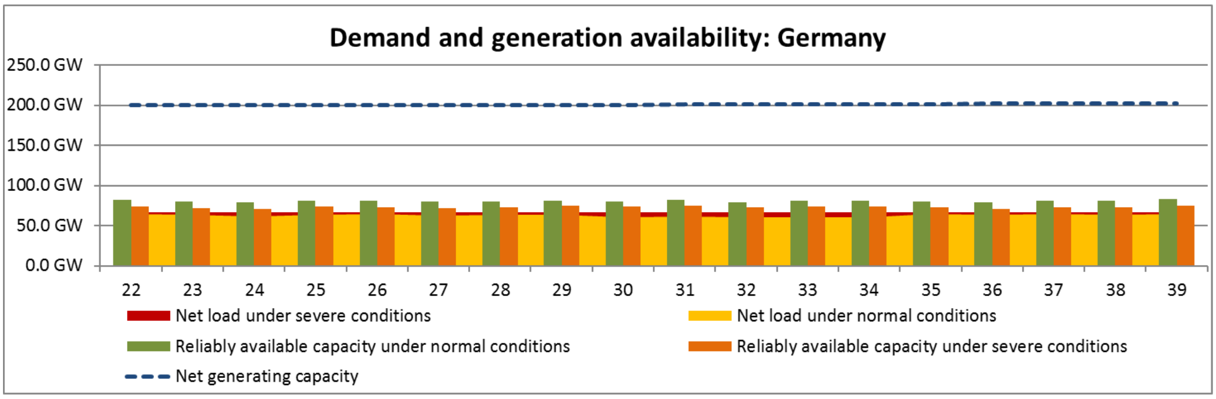
A heat wave (longer hot and dry period) could constrain power plant availability because of problems with cooling water supply or fuel transporting problems due to low river levels.

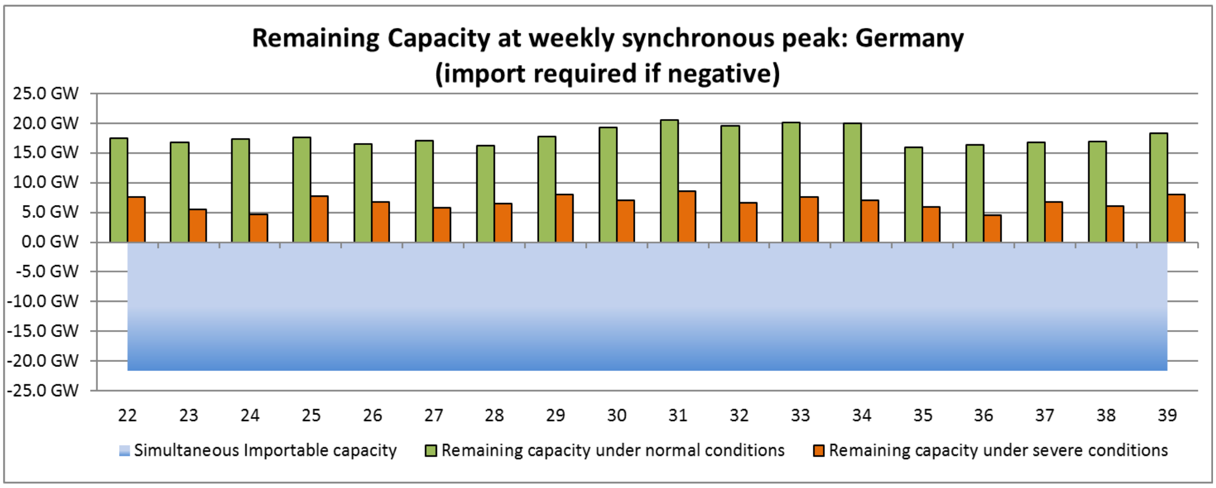
Extensive conventional power plant unavailability abroad can also have effects on the situation in Germany.

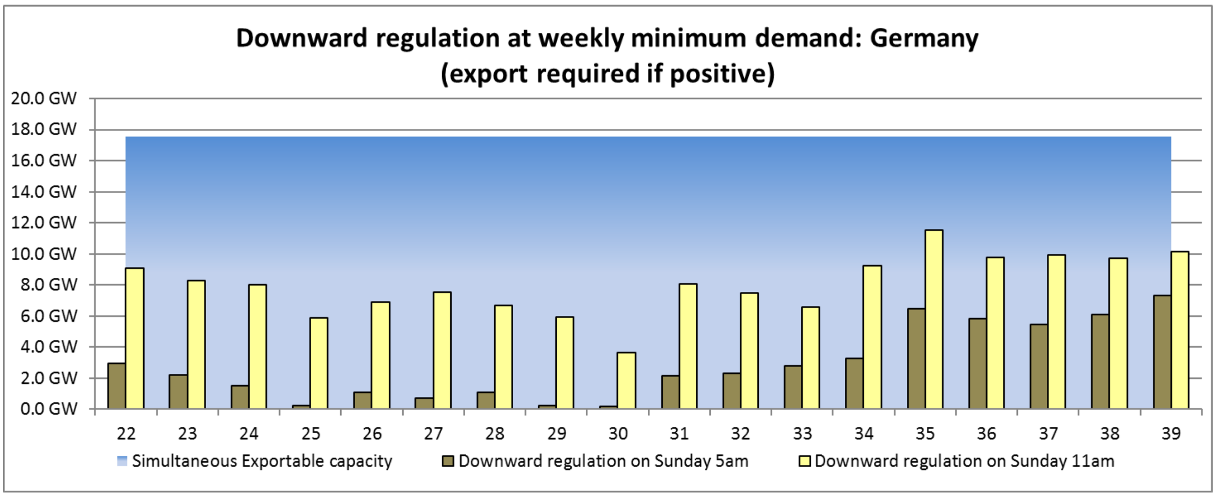
No critical periods for maintaining adequacy are expected.

Potentially, the increasing PV generation could lead to unexpected 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 unexpected 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 marked-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. Still, no critical situations are expected.







Germany: Winter Review 2017/2018

According to the German Weather Forecast Service (Deutscher Wetterdienst, DWD), December 2017 in Germany was generally comparatively mild, with high precipitation and little sun compared to average values. January was even milder (some metering stations did not register temperatures below zero degrees Celsius), especially in the Southwest which was also more wet and with very little sun compared to the average. Winter storms ‘Burglind’ on 3 January and especially ‘Friederike’ on 18 January caused damage and traffic problems, but did not significantly affect the Extra High Voltage (EHV) grid. However, on this day Exceptional Contingencies on a tie-line between Amprion and Tennet Germany had to be activated. On 3 January a record for Germany-wide wind generation of 42 GW was registered. Due to the generally windy winter, a huge amount of infeed management measures was necessary to prevent local overloads. Besides market-based redispatch, the activation of grid reserve power plants in Austria was also necessary to maintain system security during periods of high power flow from North to South. In November and December 2017, high power flows from Germany to Switzerland temporarily occurred, which caused Cross-Border-Redispatch measures.

Great Britain: Summer Outlook 2018

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 37.9 GW on 26 September 2018 (week 39).

These are the interconnector outages planned for this summer:

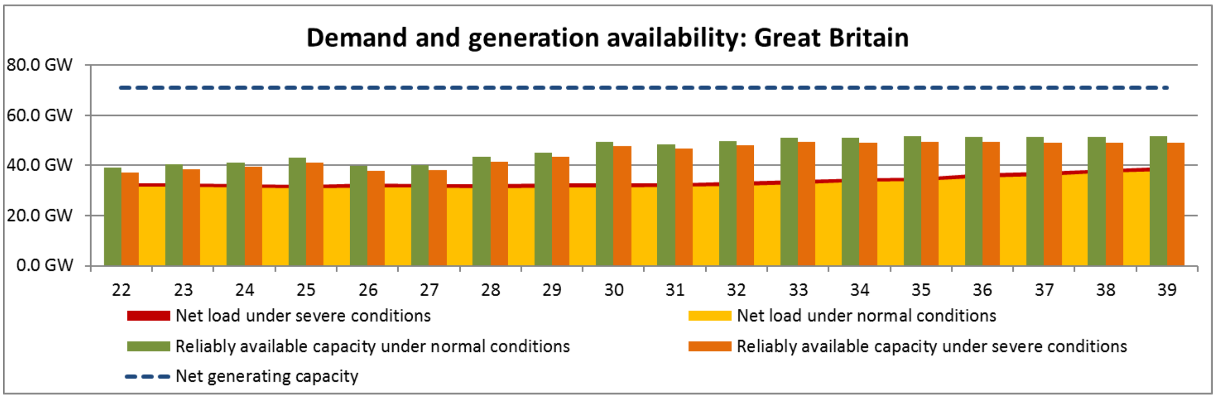
- We expect Interconnector France–Angleterre (IFA) to be reduced from 2 GW to 1 GW, from 18 June to 29 June (week 25 to 26) and 3 September to 14 September (week 36 to 37).
- BritNed Interconnector will be on maintenance for 5 days, from 17 September (week 38).
- There are no maintenances planned on the East West Interconnector (EWIC) or the Moyle interconnector this summer.

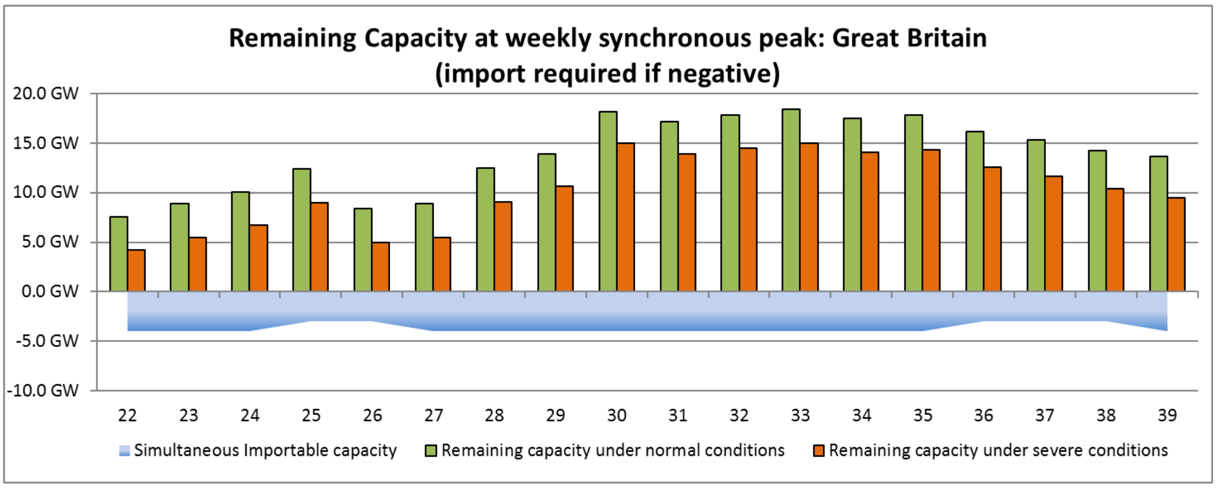
For normal condition, our forecasted lowest operational surplus is 7.6 GW on 30 May (week 22). Even during this week, we expect to be able to export full 4.0 GW on the interconnectors if necessary to do so.

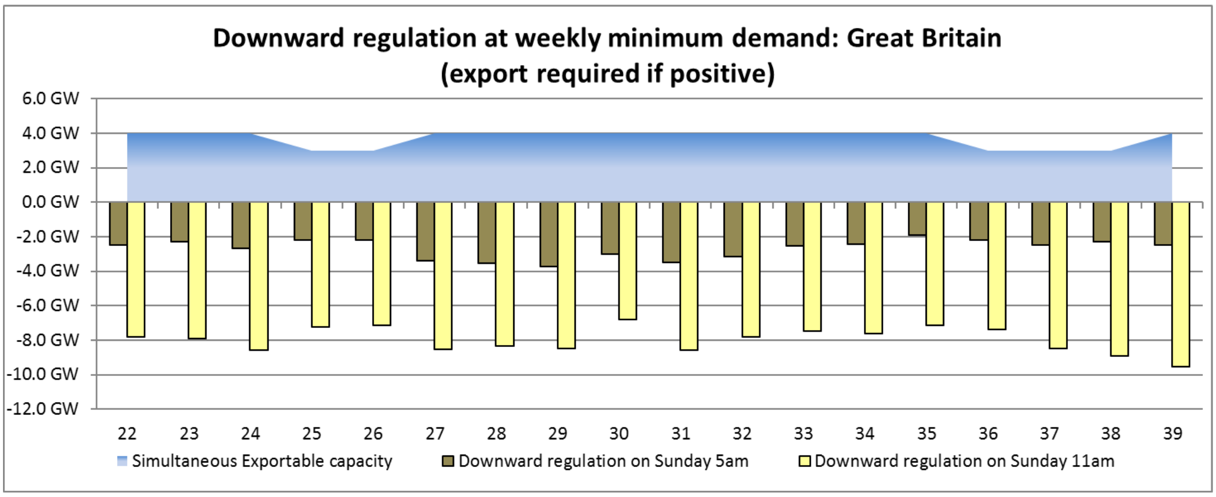
Using severe condition factors, the lowest margin is 4.2 GW on 30 May (week 22) where we would still be able to export full 4 GW on the interconnectors if necessary to do so.

We currently expect there to be sufficient generation and interconnector imports to meet peak demand this summer. According to the latest operational data, we are able to meet normalised demand and our reserve requirements throughout the summer.

The increase in distribution connected generation, for example wind and solar PV, has contributed to downward trend in demands. Solar PV continues to impact the daily demand profile because the daytime demand we see on the transmission system is supressed by it. This can make forecasting difficult. Solar PV and wind generation connected to the distribution networks have increased to 12.9 GW and 5.7 GW respectively.







Most critical periods for downward regulation and countermeasures

Minimum demand is expected to be 17.0 GW on 24 June (week 25) and 1 July (week 26). Lowest downward regulation capacity is expected to be 1.9 GW on 2 September (week 35). Downward regulation capacity is expected to be below 3.8 GW throughout summer.

Increased supply and demand variability caused by these periods of low demand and high levels of renewable generation can create operability challenges such as Negative Reserve Active Power Margin (NRAPM) and Rate of Change of Frequency (ROCOF) issues. As a result, we may need to take additional actions and to curtail generation and possibly instruct inflexible generators to reduce their output in order to balance the system.

Great Britain: Winter Review 2017/2018

General comments on past winter conditions

Great Britain has had reliable generation supply this winter and transmission system demand broadly similar to forecast. There was an additional cold spell at the end of February into early March which resulted in peak transmission system demand of 51.2 GW on the 1 March 2018 which is outside of our Triad period (1 November to 28 February). Triads are the three half-hours of highest demand on the Great Britain electricity transmission system between November and February which are at least 10 days apart. The Triads are part of a charge-setting process.

Specific events and unexpected situations that occurred during the past winter

Overall, transmission system demand has been broadly in line with expectations. Temperatures were lower than average by around 0.8°C, with an additional cold spell at the end of February until early March 2018. This resulted in a peak transmission demand of 51.2 GW on the 1 March 2018. Peak demand normally occurs in December or January. Over other peaks in the winter TRIAD period (1 November to 28 February) there were up to 2 GW of customer demand management; this was in line with forecast. Peak demand on 1 March 2018 was outside the Triad period and so there was no evidence of customer demand management on this day.

For generation, breakdowns have been in line with expectations. Sizewell (1260 MW nuclear unit) was due to return from outage early November 2017. Due to steam generator defects, it extended the maintenance to early February 2018.

Flows through interconnections from France to Great Britain were lower than expected and there were even a few days of Great Britain exporting to France due to delayed French nuclear maintenance and cold weather in France.

Average wind at daily demand peak has been 4.2 GW, with a minimum of 0.3 GW and a maximum of 8.4 GW. Highest wind recorded was 10.9 GW on 17 March 2018 at 12:30.

There were a number of short pole or bipole forced outages on the French interconnector, plus a longer pole outage from 12 March 2018; this is expected to return to operations on 30 April 2018.

EWIC to Ireland was on breakdown from 28 February 2018 till 28 March 2018.

The Moyle interconnector between Northern Ireland and Great Britain and BritNed interconnector between Netherland and Great Britain was available throughout the winter.

Greece: Summer Outlook 2018

The Greek system is expected to be in balance in the upcoming summer period (2018). The level of indigenous national generation, the good estimated hydraulic storage of hydropower stations ensures the adequacy and security of the Greek interconnected System, which is not threatened under normal and severe weather conditions and there are no large maintenances planed during this summer. Moreover, the water reserves are expected to be at least at last year's level.

In very warm periods during the summer, fire events can affect the transmission capacity.

Until 20 June 2018 there will be limitations in using Natural Gas for electricity production, due to necessary works at the installations of the Liquid Natural Gas station at Revithousa.

Potential critical periods and foreseen countermeasures

The most critical period during summer is the first half of July, due to highest expected demand as a result of the typically highest annual temperature.

The role of interconnectors for the forthcoming summer period is important for generation adequacy in case of an increase of the demand.

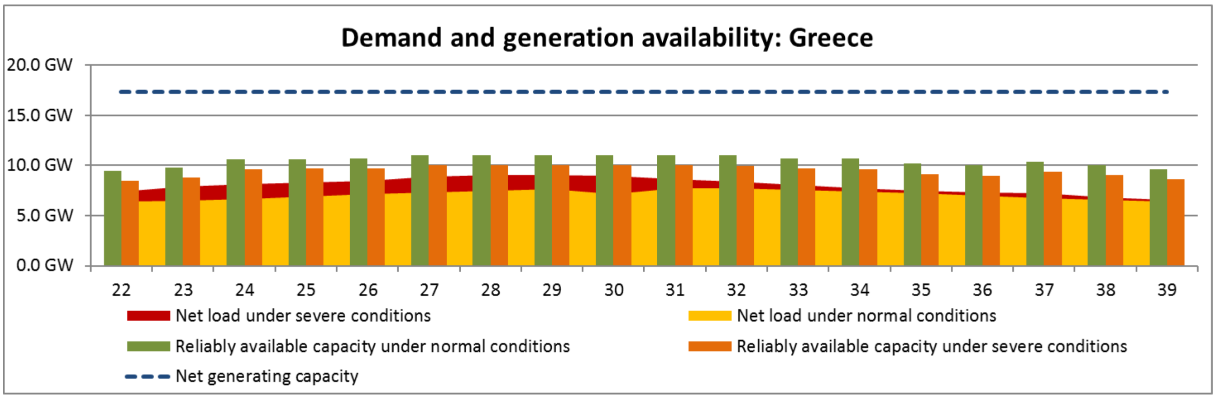
The interconnections can play a significant role, especially in periods with large variations of demand. In these cases, IPTO could export or import energy to/from other countries depending on the market prices.

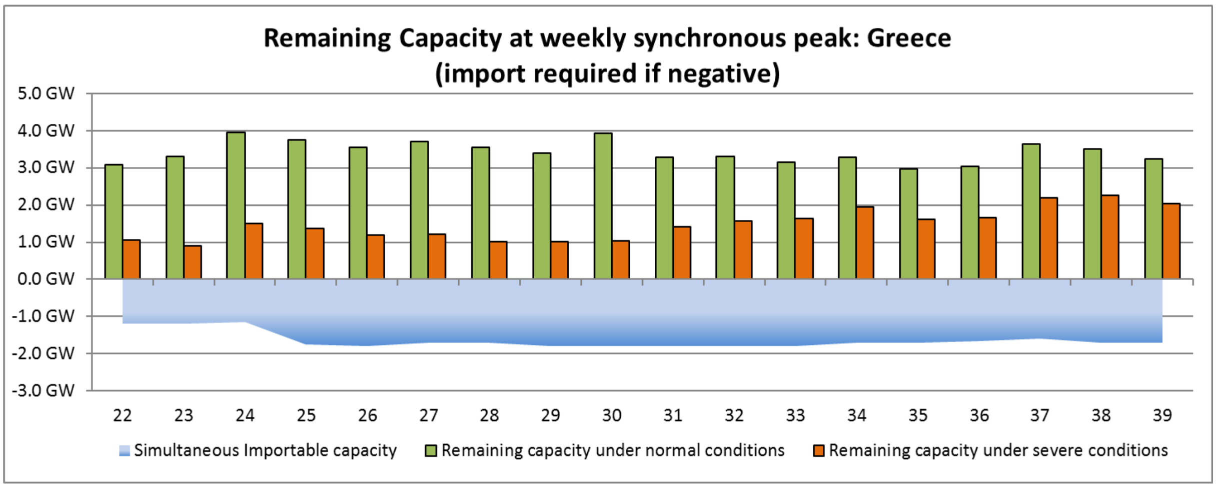
The most critical periods for downward regulating capacity are usually from 00:00 to 06:00 (due to low demand) and from 11:00 to 17:00 (due to high PV production).

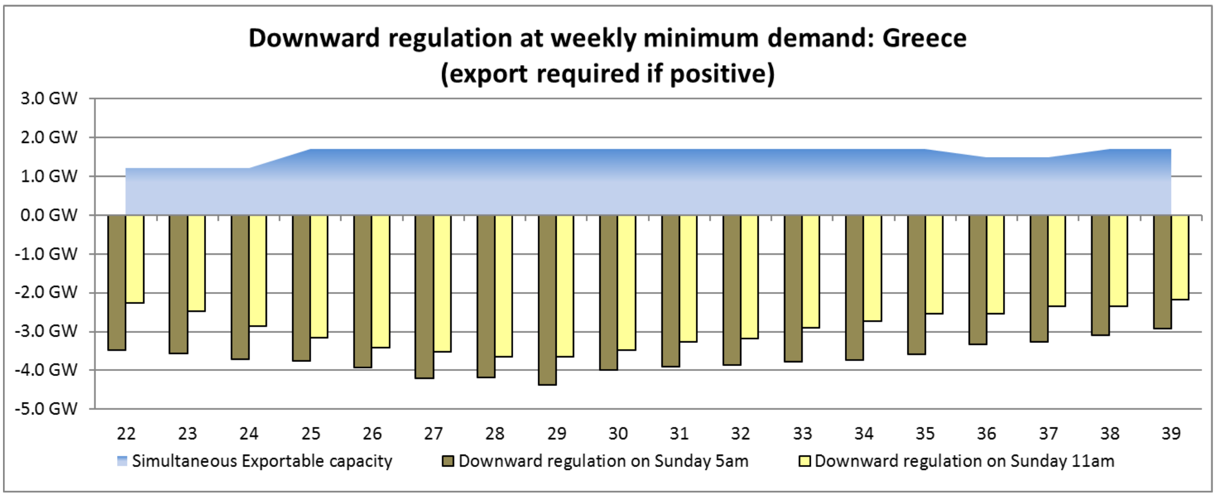
The countermeasures adopted are:

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

The interconnectors are not used for reserve exchange.







Greece: Winter Review 2017/2018

Last winter there were normal climatic conditions and the temperatures were around normal level for the season.

During last winter there were no specific events causing adequacy issues. However, the HVDC Link GR-IT interconnection was out of operation for weeks, but this did not affect the power supply. Moreover, the hydraulic storage of hydropower stations was used to ensure adequacy.

Finally, there was an increased demand of natural gas, which led to gas supply limitations but did not cause problems for residential and industrial consumers as well as for the electricity production sector.

Hungary: Summer Outlook 2018

As a result of the constantly growing demand, there is no period of time when the imports could be ignored. The unavailable capacity has remained at a high level, which strengthens 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 may be caused by the severe weather conditions in June and July, since the generation units are temperature-dependent.

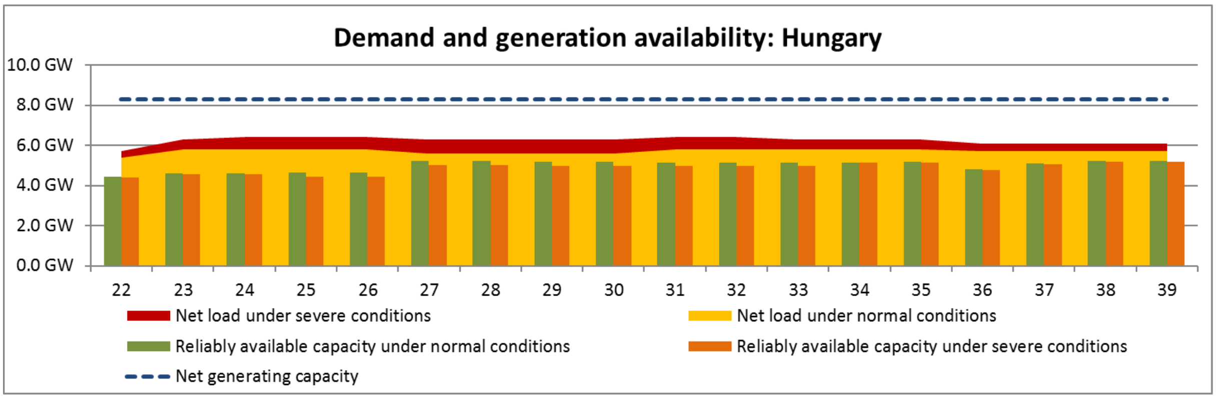
A high increase of PV installed capacity is expected in the near future, but the procured amount of system reserve can mitigate the risk of balancing problems.

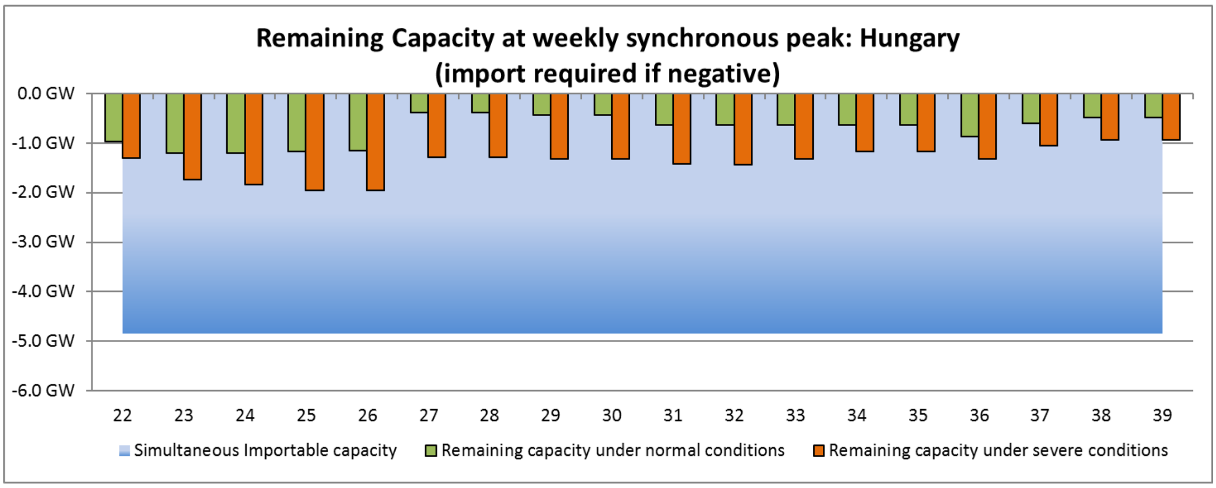
Most critical periods for maintaining adequacy margins and countermeasures

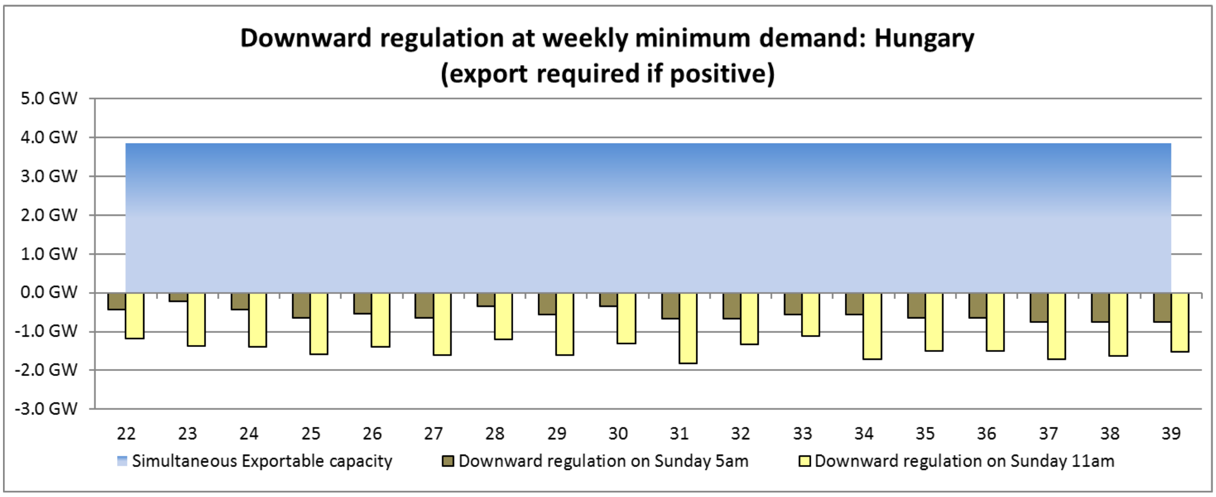
The level of maintenance is normal during the summer. It is mainly between 0.2 GW and 1.0 GW. The most critical periods are the first five weeks of summer, when the level of maintenance is approximately 1 GW.

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 2017/2018

General comments on past winter conditions

During the winter, the demand level of the Hungarian system was a little bit lower compared to the historical data of the last year. The main reason was the mild winter, with demand only in the last week of February, which was higher than expected. In this time period, outages of generators were rather low despite the hard weather conditions. The Hungarian power system experienced a new record for peak demand on 2 March with 6825 MW.

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. No major issues concerning cross-border exchange occurred during the past winter.

Specific events and unexpected situations that occurred during the past winter

There was no critical event last winter.

Iceland: Summer Outlook 2018

The generation capacity in Iceland is expected to be sufficient to meet peak demand this summer under normal as well as severe conditions. The margin has increased somewhat, due to the commission of a new 90 MW geothermal power plant at the end last year. Landsnet does not anticipate any particular problems in the isolated Icelandic power system.

The installed generation capacity connected to the Icelandic transmission system is approx. 2.8 GW, of which 76% is hydro based and 24% based on geothermal energy. No new generating units are expected this summer.

Long term Generation Capacity Assessment and Load Forecast for the Icelandic power system are made by Landsnet every year and reported in the Transmission System Development Plan and Energy and Power Balance report. For short term assessment, studies are made by Landsnet on a weekly basis for Generation Capacity, Reserves and Demand Forecast.

Potential critical periods and foreseen countermeasures

Most critical periods to maintain adequacy is late winter and early spring.

Iceland: Winter Review 2017/2018

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

Ireland: Summer Outlook 2018

EirGrid does not expect any capacity or demand issues on the Ireland system this summer. According to the latest analysis, there will be sufficient capacity to meet the demand over the summer period. There is sufficient spare capacity to deal with a reasonable level of unexpected forced outages.

Interconnector:

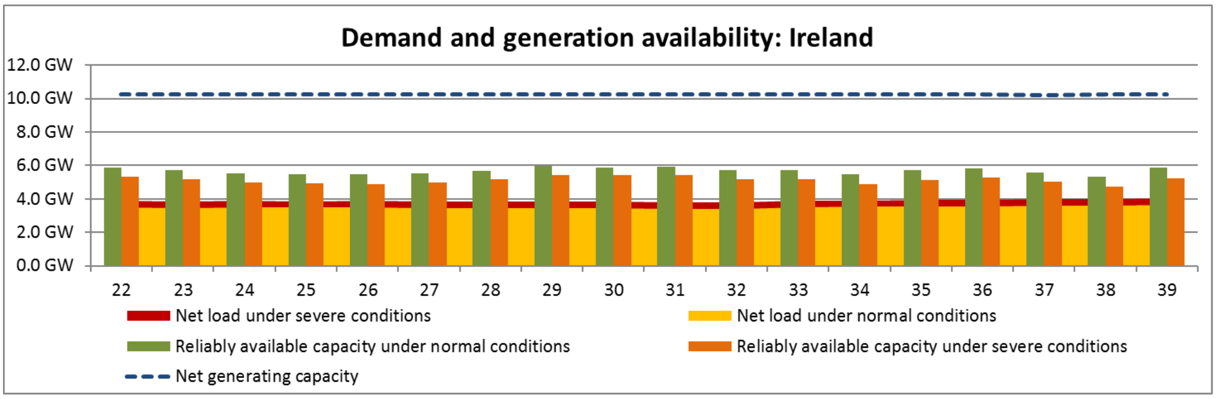
EWIC flows do not exceed an import of 504 MW to Ireland and an export of 526 MW to Great Britain (values taken from Portan). This is required to ensure that the limits are respected. The current restriction is to mitigate against the impact of a high frequency event on the island in the event of a trip on EWIC.

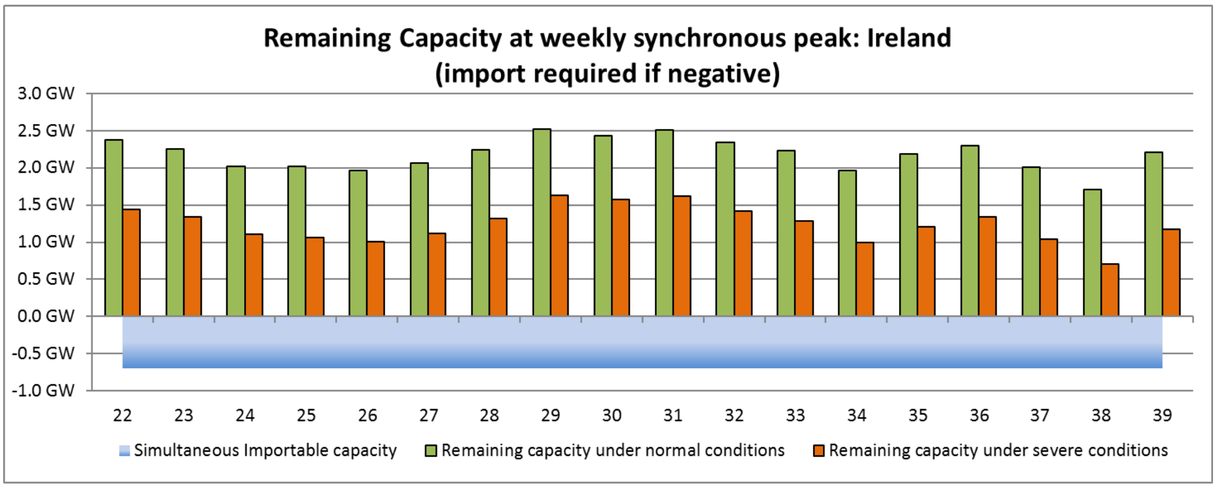
Energy Constraints for Hydro based systems:

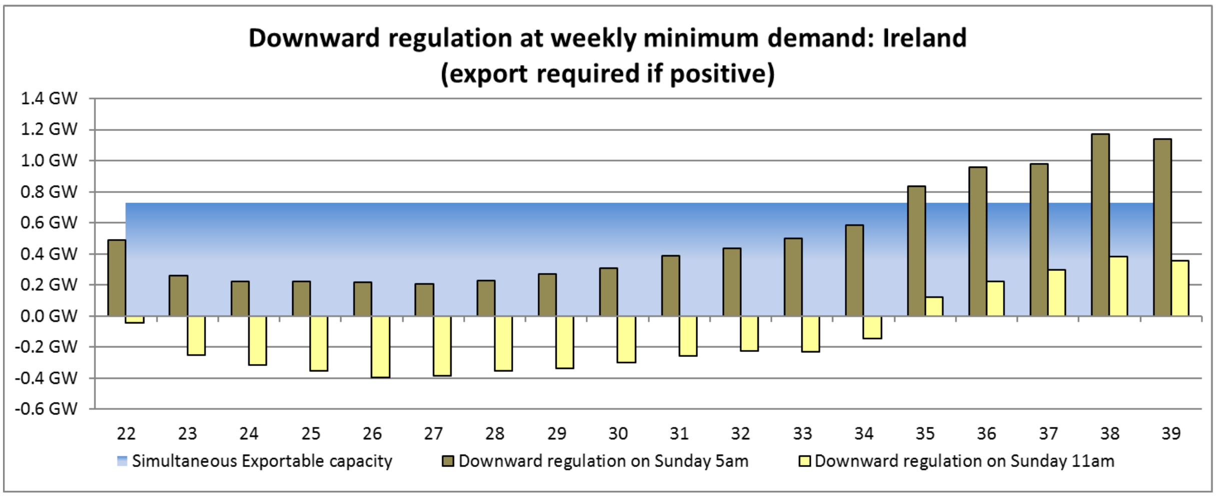
The Ireland system has a 65% System Non-Synchronous Penetration level (i.e. SNSP (%) = (Non-Synchronous Generation + Net Imports/ (Demand + Net Exports) × 100). Over the spring and early summer period, as the water temperature in the rivers and lakes change, the hydro stations in Erne and Lee have to be dispatched in a very specific way to allow fish to move safely.

Potential critical periods and foreseen countermeasures

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







Ireland: Winter Review 2017/2018

Climatic Conditions over Winter Period:

Storm 'Ophelia': On 16 October 2017 hurricane 'Ophelia' brought violent storm force winds to the Southern region of Ireland. The month's highest wind speeds reported at Roches Point, Co. Cork 16 October were the highest on record with a highest gust of 155.6 km/h and a highest 10-minute mean wind speed of 114.8 km/h. Wind generation was utilised in a controlled manner which resulted in a controlled curtailment of wind generation to ensure system security as the storm passed through Ireland. ‘Opheila’ damaged vast amounts of distribution equipment, deferring non-priority transmission works for a number of weeks to allow for ‘post-Ophelia’ distribution repairs.

Storm ‘Emma’: An exceptionally cold Polar Continental easterly airstream covered Ireland from the beginning of March 2018 for the duration of the month. Whole month mean temperatures were 2°C or 3°C below average. The month’s lowest air minimum temperature was recorded on the 1 March at Cork Airport at -7°C, the lowest minimum for March since 1962. Due to advanced knowledge of the storm, sufficient time was available to allow prudent measures to be taken, to ensure the system was largely intact and robust in advance of the storm hitting. Six transmission planned outages had to be cancelled due to the inaccessibility of sites and a number of maintenance outages had to be recalled early. There were 5 forced outages of transmission plants over the course of Storm ‘Emma’, with only one circuit remaining on forced outage for the entire month. The ‘post-Emma’ recovery period was a lot shorter as the damage to the distribution network was much less (than Storm Ophelia), allowing ESBN crews to be available for transmission and distribution works in the immediate aftermath.

Specific events which occurred during the last period and unexpected situations:

Generation Conditions: September 2017 was presented with an extreme increase of Generation Forced Outages. The 14 September saw 1.365 MW of Generation Forced Outages with full generation station outages such as Poolbeg, Turlough Hill and Tynagh.

On the 28 September 1.780 MW of forced generator outages was recorded. Poolbeg and Turlough Hill remained forced out and on the 27 September Whitegate, another major station in Ireland (444 MW) was forced out. On the 28 September, Aghada 2 forced out with a capacity loss of 431 MW to the system. Most of the generation forced outages were cleared by mid-November.

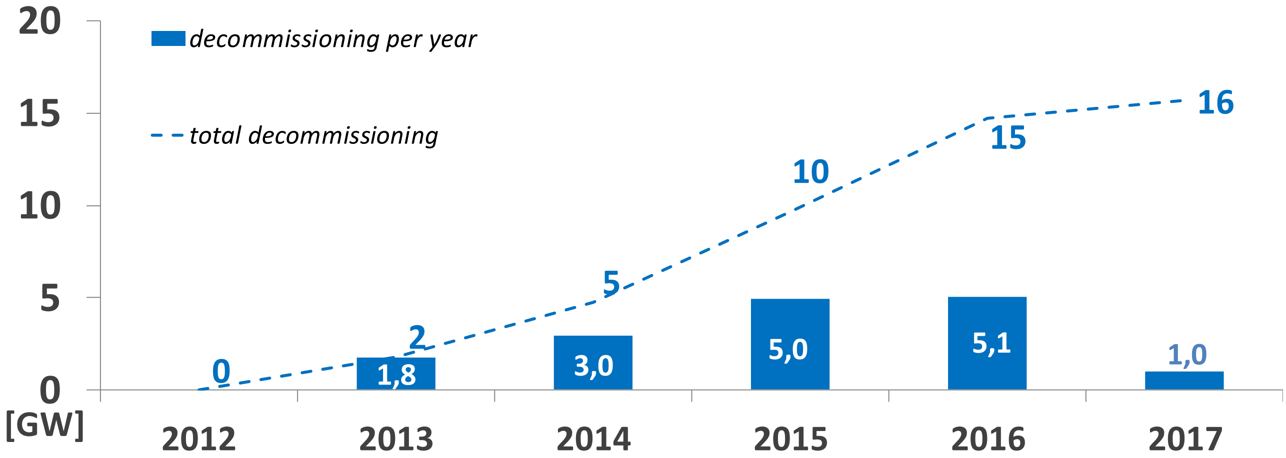
Wind Conditions: For the winter 2017, there was a dramatic increase in installed wind capacity from 2016 by 426 MW. This along with high wind levels resulted in high levels of wind generation but with it, greater difficulty in wind generation prediction.

Interconnector Capacity: EWIC Interconnector Forced Outage - On the 28 February, the EWIC Interconnector forced out due to a tripping at Shotton. This resulted in the interconnector being unavailable for the duration of the outage. EWIC returned to commercial service on 29 March.

Italy: Summer Outlook 2018

Generation capacity in Italy

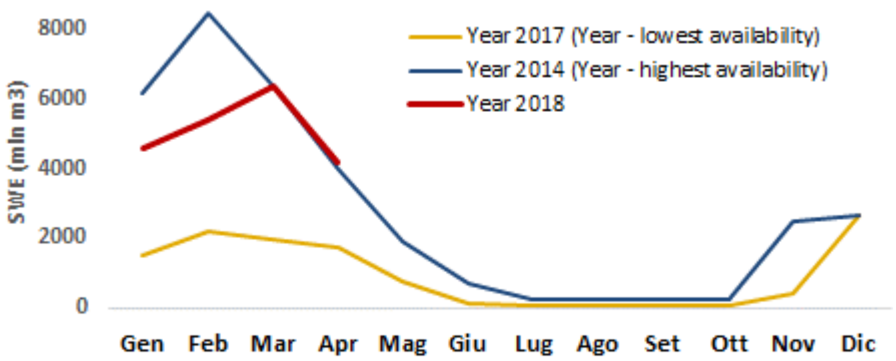
In recent years, the Italian Power System has faced a significant reduction of the conventional (thermoelectric) power fleet. The growth of variable (e.g. wind and PV) generation, together with a demand decrease, is putting commercial pressure onto traditional generators, leading to the decommissioning of the oldest power plants. Between 2012 and 2017, the following phenomena affected the power system operation and adequacy in Italy: about 16 GW installed generation was phased out. The total amount of available capacity in the market conventional power plants fell from 77 GW down to 61 GW and additional 3.1 GW conventional power capacity is not available due to environmental-legal constraints and mothballing. This trend can be observed in the figure below. This phenomenon affects the power system adequacy in Italy and some important warning signals in terms of adequacy on the national level scarcity were already registered in the past: in summer 2015 and in winter 2016/2017.



Nevertheless, for the first time since 2011, the decrease of the available generation capacity is not observed compared to the previous year (Summer Outlook 2017). In fact, even though the decommissioning trend has not yet stopped, some important thermoelectric plants came back from their previous mothballing condition (around 1.2 GW). Grid reinforcements, developed by the Italian TSO in recent years, helped to smooth out some effects caused by the power plants decommission (especially in the main islands).

Available capacity considered in the Summer Outlook 2018 study does not consider the possible unavailability of a large coal power plant in the Southern part of Italy due to authorisation risk. In case this risk materialises, the available capacity will decrease by 2.5 GW, increasing the probability of incurring in scarcity situations.

Hydro availability for the upcoming summer period in Italy is expected to be high: the Snow Water Equivalent index (SWE),[17] which expresses the amount of water stored in the form of snow on the Italian side of the Alps, shows hydro storages level close to the maximum historical values.



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 IT02 and IT03), no problem regarding system adequacy is expected for the Italian Power System.

Under severe conditions:

Under severe conditions, the excess of capacity in the Southern Italy Bidding Zones cannot be fully transferred to the Northern Italian Bidding Zones (where the available generation capacity is expected to be lower than the demand) due to internal grid constraints. Nevertheless, available imports from neighbouring countries is expected to be sufficient to cover the needs of this Northern area (generally composed by Bidding Zones IT01 and IT02). Hence, for the upcoming summer, adequacy problems can be expected only in case of reduced available transmission capacity (e.g. forced outages of grid elements) or unexpected lack of generation capacity (e.g. forced outages of generation units inside or outside the country).

High renewables production (wind and solar) during low load periods, taking into account the level of other inflexible generation, could lead to a reduced downward regulating capacity, especially in the bidding zones in the south at the beginning and the end of season.

[17] Snow Water Equivalent (SWE) is a common snowpack measurement. It is the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously.

Most critical periods for maintaining adequacy margins and countermeasures

Under normal conditions, no problem regarding system adequacy is expected, and the most constrained period is expected to be July.

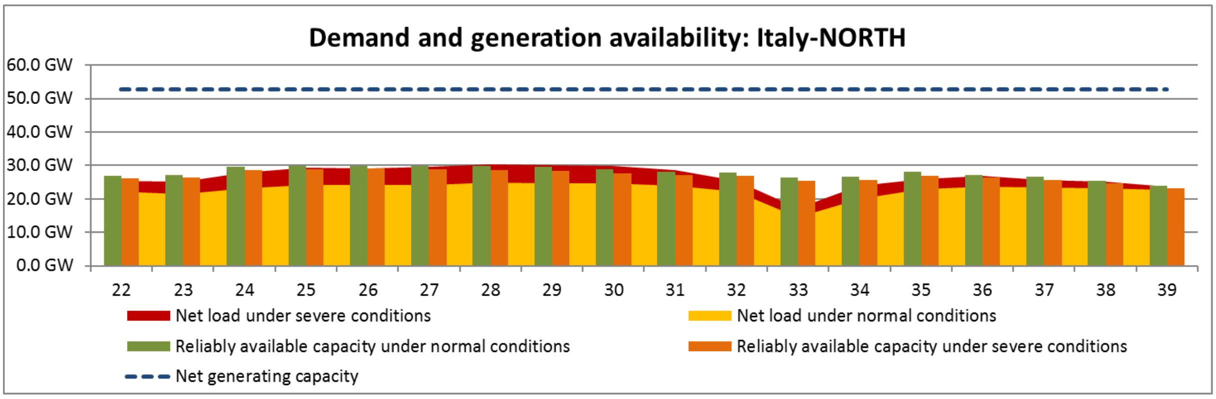
Under severe conditions, the situation for the summer could lead to the need for imports for several weeks from June until end of September (excluding the mid-August).

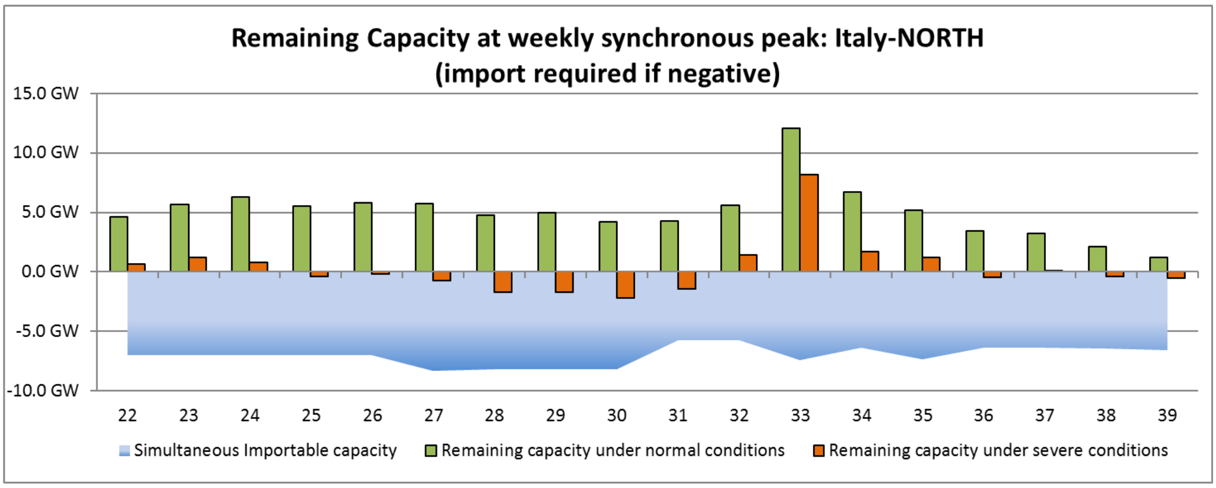
Appropriate planning (and coordination) of grid and generation maintenance schedules have been performed, but in case of need, postponement and/or cancellation of maintenance could be necessary.

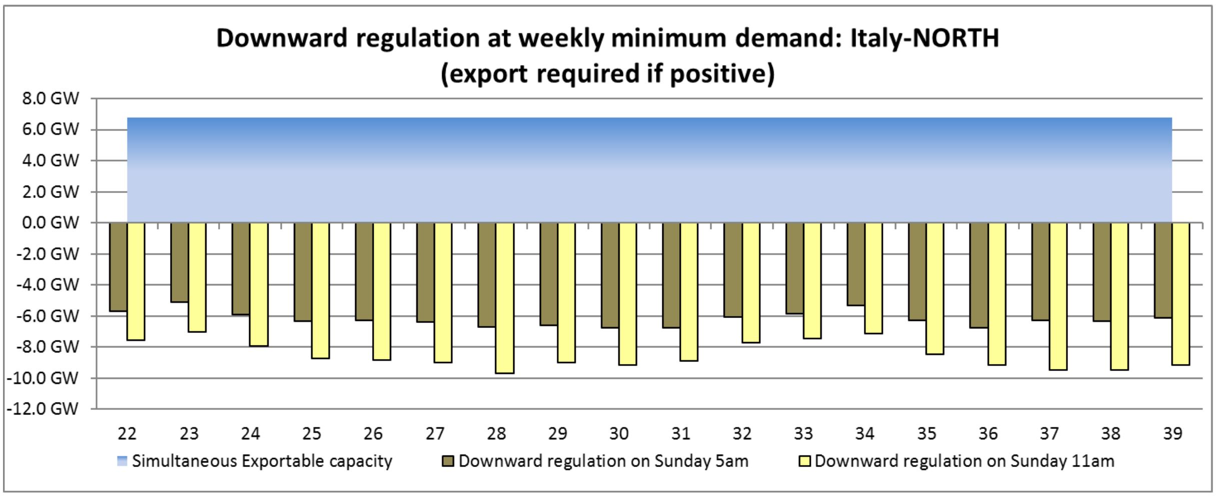
Regional weekly adequacy assessment, together with regional coordination processes coordinated by RSC, will support the definition of proper and efficient countermeasures in case the risk of incurring in critical situations is detected in the short-term horizon.

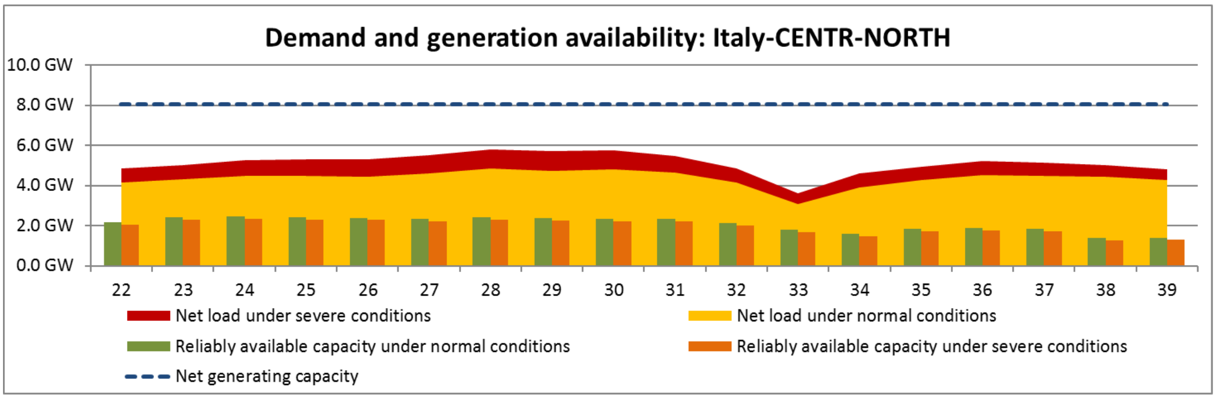
Most critical periods for downward regulation and countermeasures

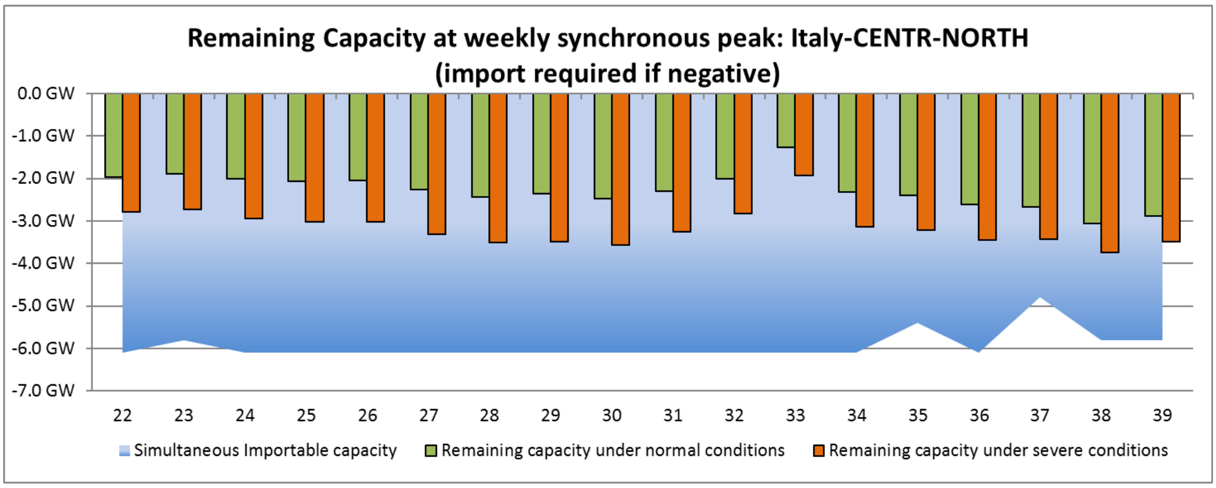
The worst periods for downward regulation are expected to be mid-August, and the start and end of the summer period (June and September). In order to cope with this risk, the Italian TSO (Terna) has prepared preliminary action and emergency plans and, in case of need, will adopt the appropriate countermeasures. 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 Net Transfer Capacity (NTC) reductions, could be planned in cooperation with neighbouring TSOs.

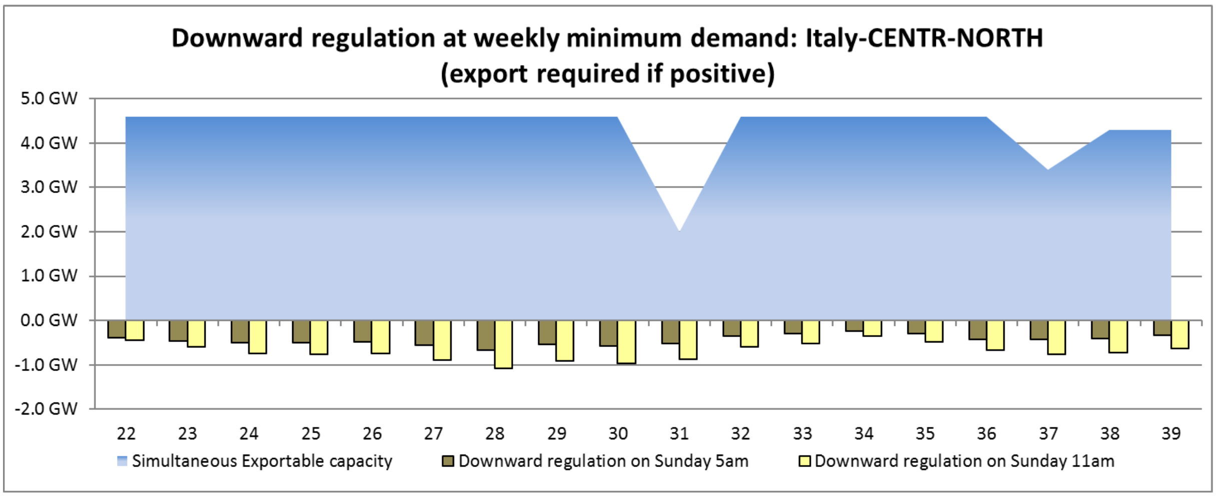

Demand and generation availability: Italy-NORTH
60.0 GW
50.0 GW
40.0 GW
30.0 GW
20.0 GW
10.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity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

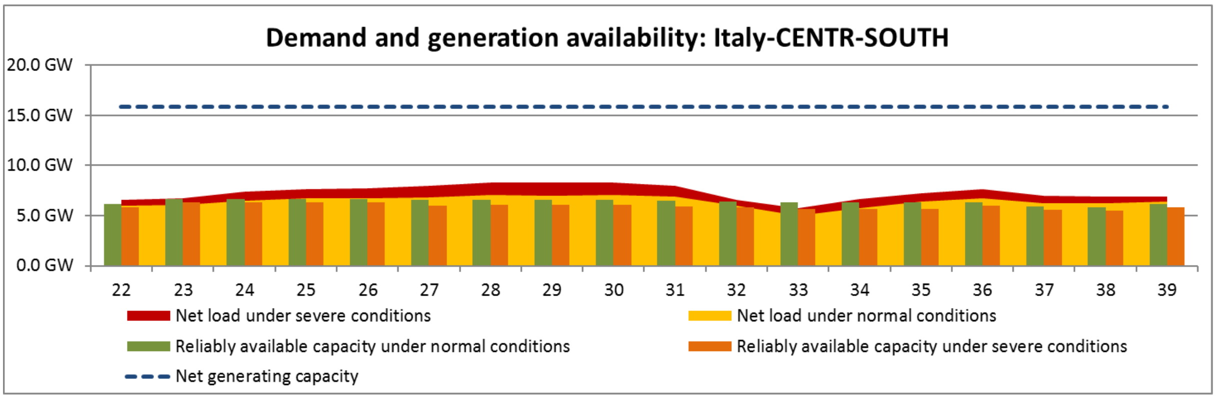

Remaining Capacity at weekly synchronous peak: Italy-NORTH
(import required if negative)
15.0 GW
10.0 GW
5.0 GW
0.0 GW
-5.0 GW
-10.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions

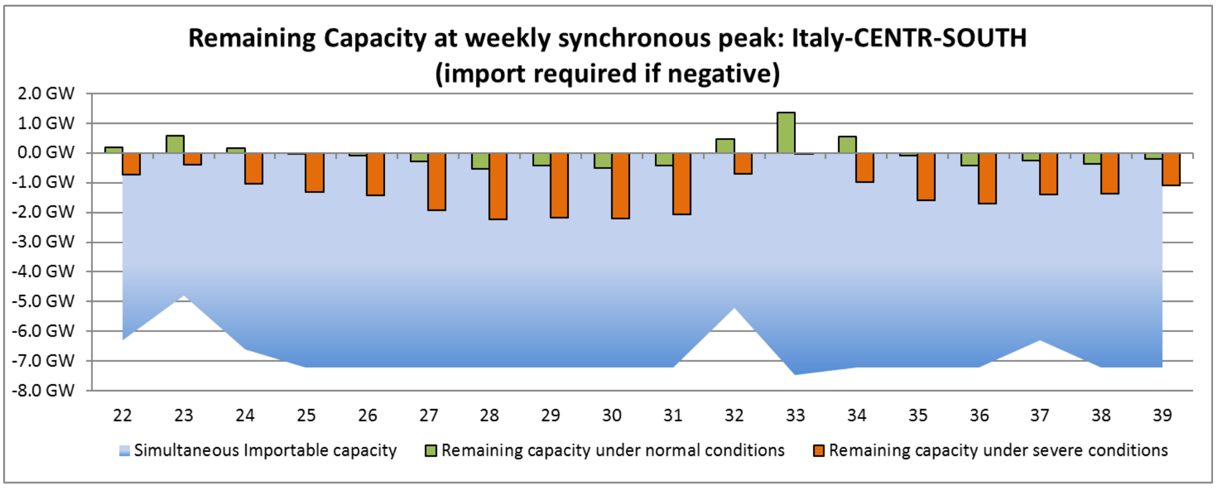

Downward regulation at weekly minimum demand: Italy-NORTH
(export required if positive)
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
-2.0 GW
-4.0 GW
-6.0 GW
-8.0 GW
-10.0 GW
-12.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward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

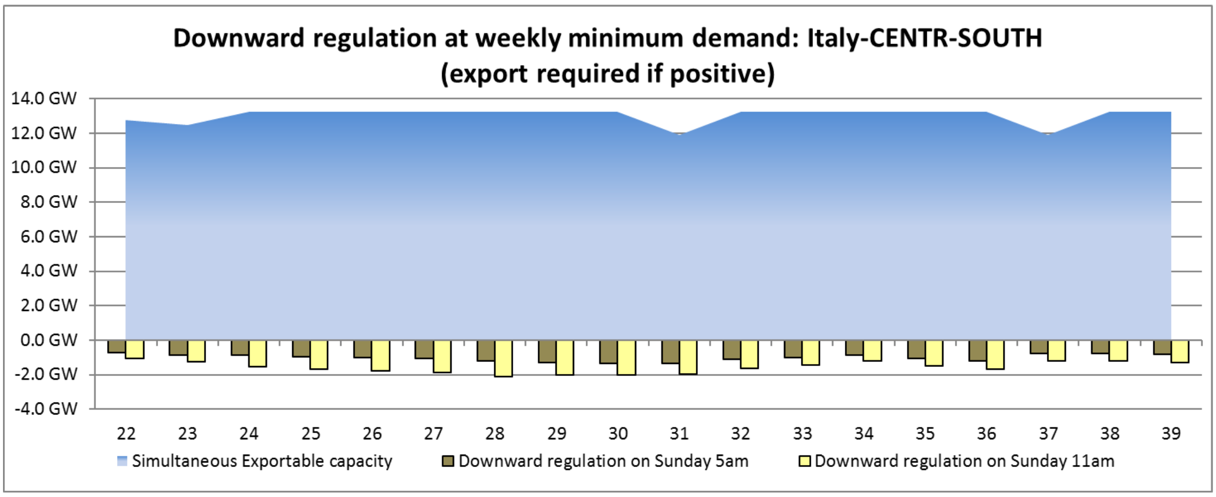

Demand and generation availability: Italy-CENTR-NORTH
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under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

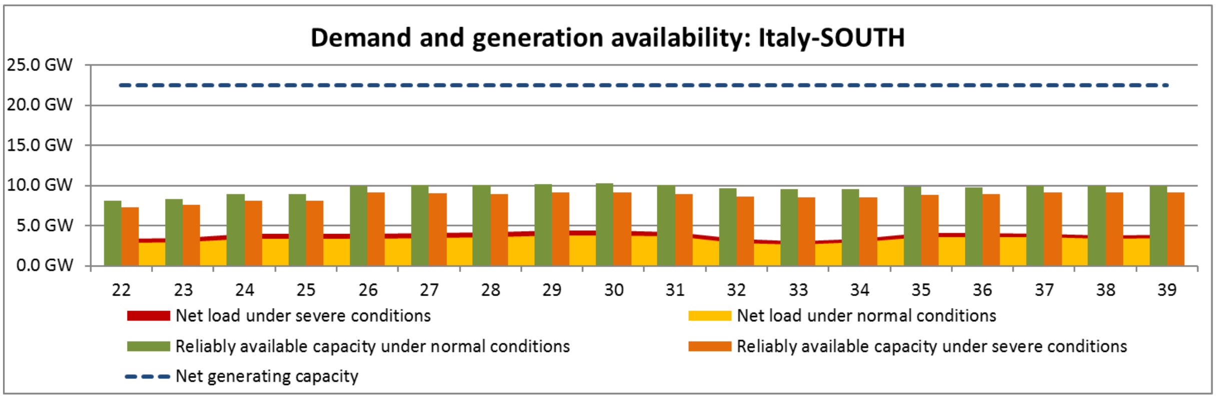

Remaining Capacity at weekly synchronous peak: Italy-CENTR-NORTH
(import required if negative)
0.0 GW
-1.0 GW
-2.0 GW
-3.0 GW
-4.0 GW
-5.0 GW
-6.0 GW
-7.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity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

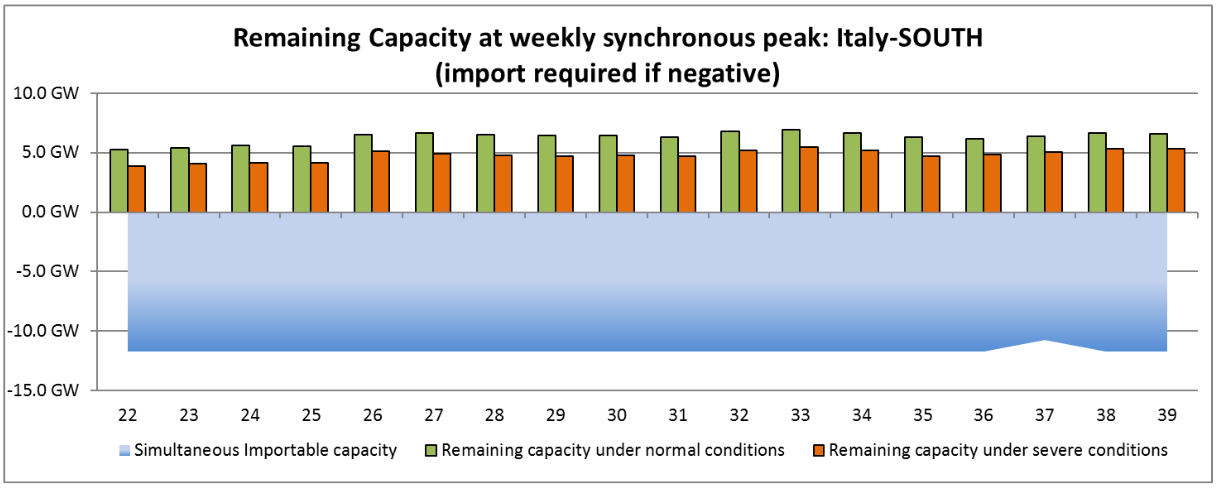

Downward regulation at weekly minimum demand: Italy-CENTR-NORTH
(export required if positive)
5.0 GW
4.0 GW
3.0 GW
2.0 GW
1.0 GW
0.0 GW
-1.0 GW
-2.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday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

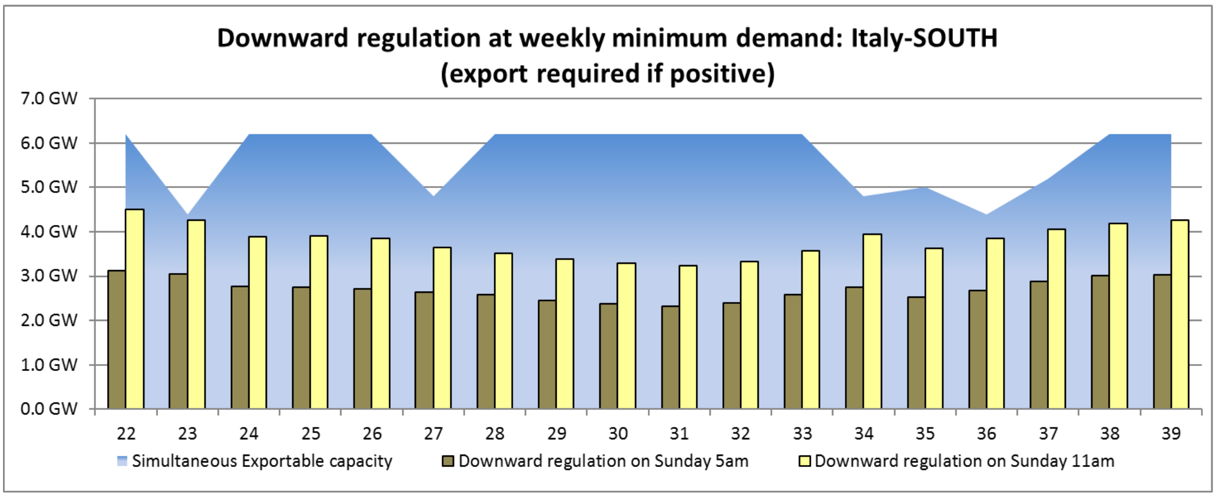

Demand and generation availability: Italy-CENTR-SOUTH
20.0 GW
15.0 GW
10.0 GW
5.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe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

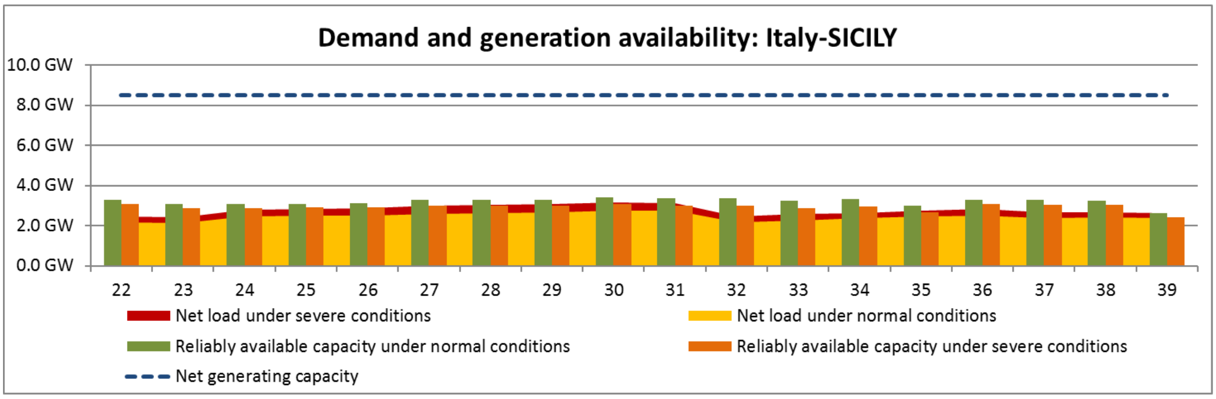

Remaining Capacity at weekly synchronous peak: Italy-CENTR-SOUTH
(import required if negative)
2.0 GW
1.0 GW
0.0 GW
-1.0 GW
-2.0 GW
-3.0 GW
-4.0 GW
-5.0 GW
-6.0 GW
-7.0 GW
-8.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
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

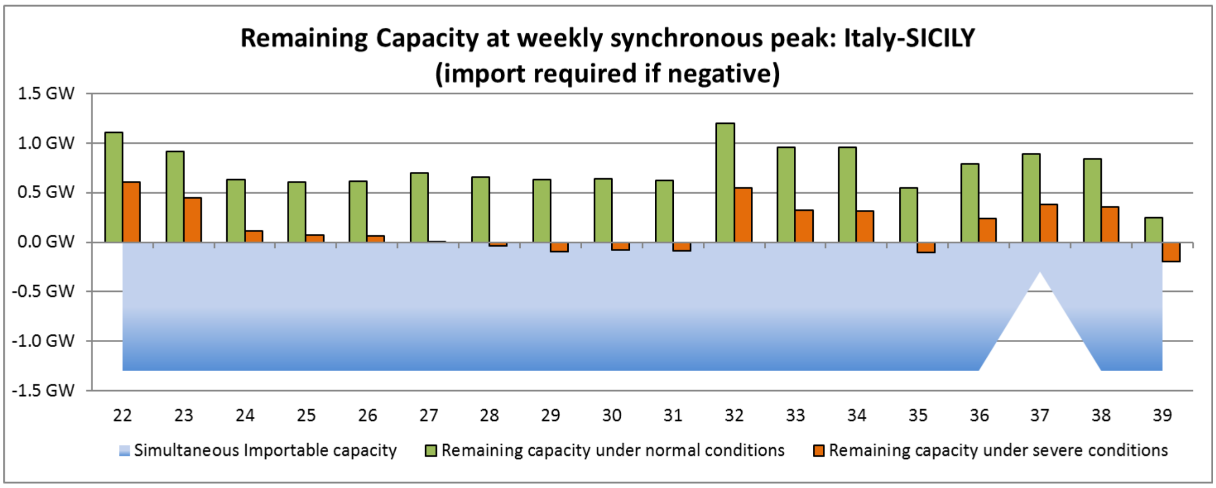

Demand and generation availability: Italy-SOUTH
25.0 GW
20.0 GW
15.0 GW
10.0 GW
5.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe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


Remaining Capacity at weekly synchronous peak: Italy-SOUTH
(import required if negative)
10.0 GW
5.0 GW
0.0 GW
-5.0 GW
-10.0 GW
-15.0 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

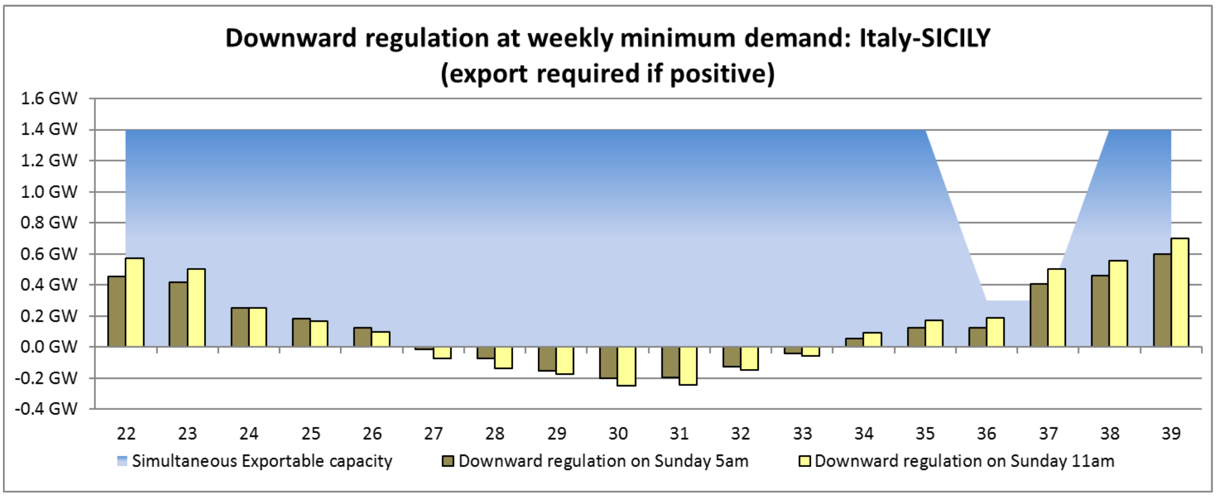

Downward regulation at weekly minimum demand: Italy-SOUTH
(export required if positive)
7.0 GW
6.0 GW
5.0 GW
4.0 GW
3.0 GW
2.0 GW
1.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Exportable capacity
Downward regulation on Sunday 5am
Downward regulation on Sunday 11am



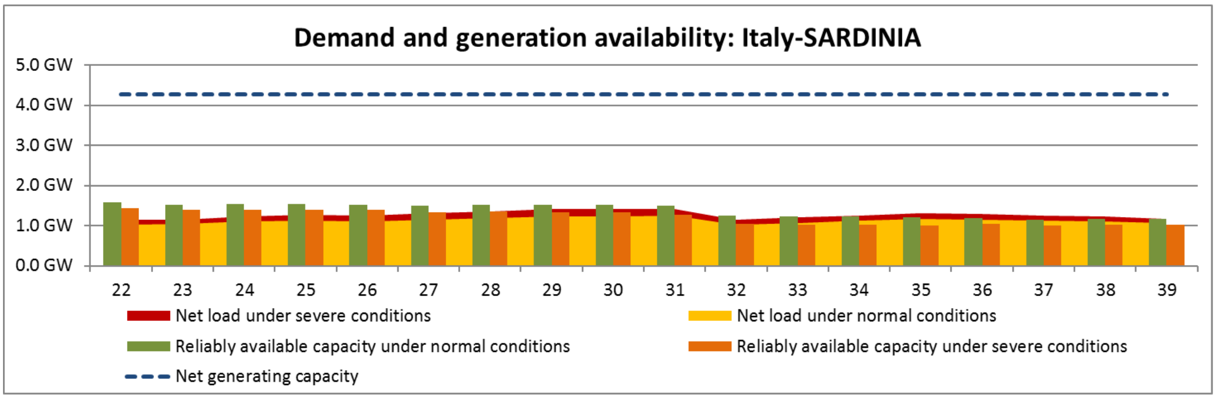
Demand and generation availability: Italy-SICILY
10.0 GW
8.0 GW
6.0 GW
4.0 GW
2.0 GW
0.0 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Net load under severe conditions
Net load under normal conditions
Reliably available capacity under normal conditions
Reliably available capacity under severe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

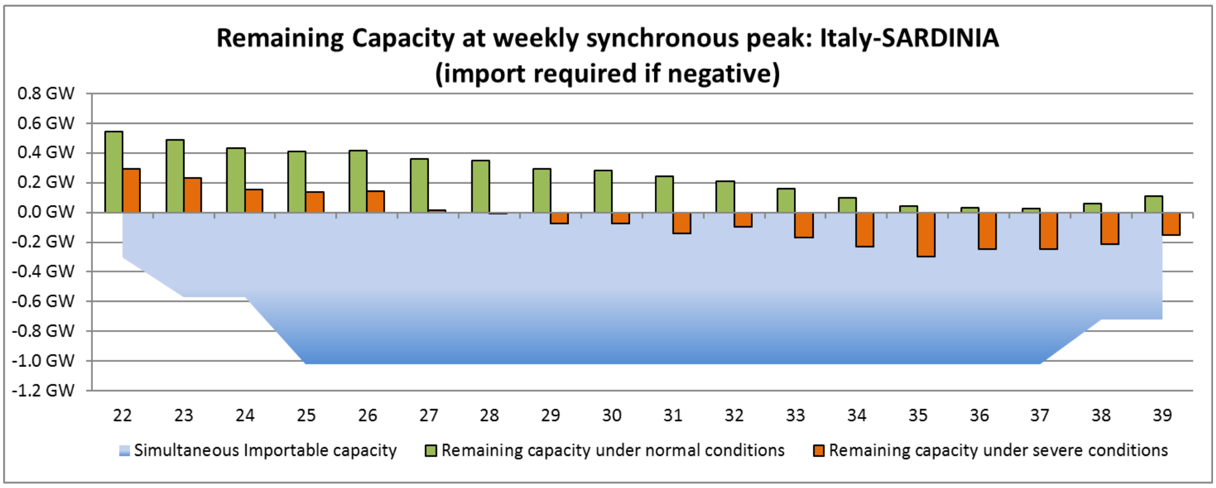


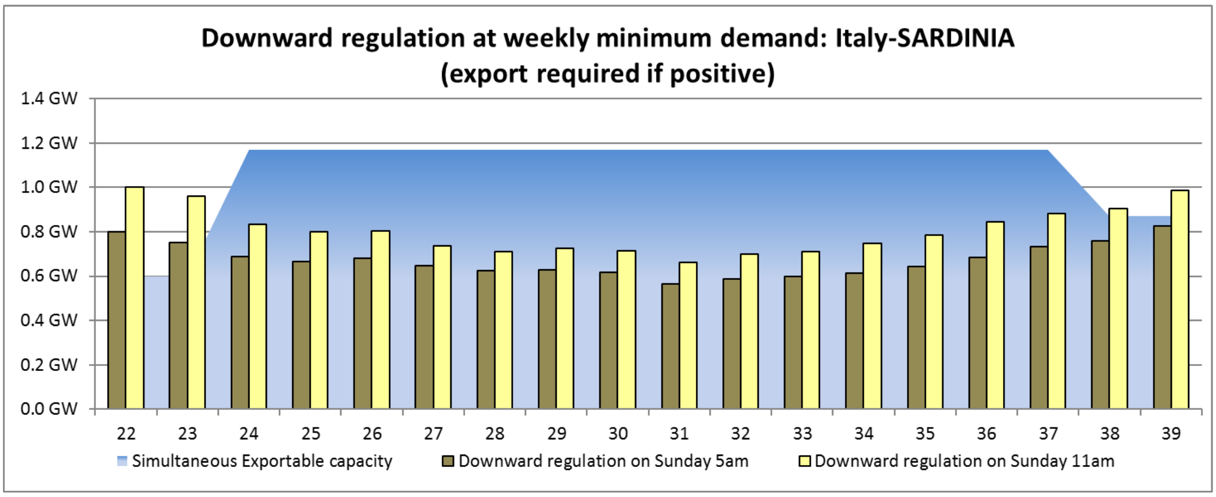
Remaining Capacity at weekly synchronous peak: Italy-SICILY
(import required if negative)
1.5 GW
1.0 GW
0.5 GW
0.0 GW
-0.5 GW
-1.0 GW
-1.5 GW
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Simultaneous Importable capacity
Remaining capacity under normal conditions
Remaining capacity under severe conditions



Downward regulation at weekly minimum demand: Italy-SICILY
(export required if positive)
1.6 GW
1.4 GW
1.2 GW
1.0 GW
0.8 GW
0.6 GW
0.4 GW
0.2 GW
0.0 GW
-0.2 GW
-0.4 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 2017/2018

General comments on past winter conditions

The winter 2017/2018 was characterised by average temperatures lower than those of the previous year (-0.4 °C) with a decrease also in the maximum values (-1.09°C average).

All this contributed to a slight increase in the electricity demand (from December 2017 to March 2018), equal to about + 1.7% compared to the same period of the previous year, especially between the second week of February and the first of March.

In more detail, after a very mild and dry January, the month of February was characterised by many days with rainfall. In addition, a cold wave was recorded, from 25 February until 2 March which caused a significant temperatures drop (about 7 degrees less than the average temperature value of the same period of the last year)

In addition, the month of March turned out to be a little cooler and rainier than the average.

During winter, the Italian system did not experience significant problems of adequacy in the electricity system, due to the effective and intensive coordination which took place with neighbouring TSOs.

Latvia: Summer Outlook 2018

The installed capacity in power plants in area of Latvia during the whole summer period is around 2.93 GW. In the first part of summer, one unit of Riga CHP2 is in maintenance and generation capacity is reduced by approximately 419 MW. The production capacity is limited by water inflow and maintenance schedule on Daugavas Hydro Power Plants (HPPs) as well. The production capacity due to the maintenance schedule is reduced from around 141 MW to 438 MW but this does not have a significant influence on generation adequacy because water inflow is the main limiting factor for hydro generation.

Under normal conditions, it is assumed that there is no production reduction on gas power plants. The gas supply is unlimited and gas generation is available at full net capacity. The reduction of capacity relates to Biomass and Biogas power plants (around 30 MW in total) and HPPs on Daugava river which are dependent on water inflow in the river. It is assumed that in normal conditions the available capacity in HPPs on Daugava river is around 300 MW. Under severe conditions the generation from gas power plants is reduced by 100 MW. It is further 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 production in Biomass and Biogas power plants is reduced by 50 MW. The production in HPPs on Daugava river is assumed as 200 MW to cover peak demand.

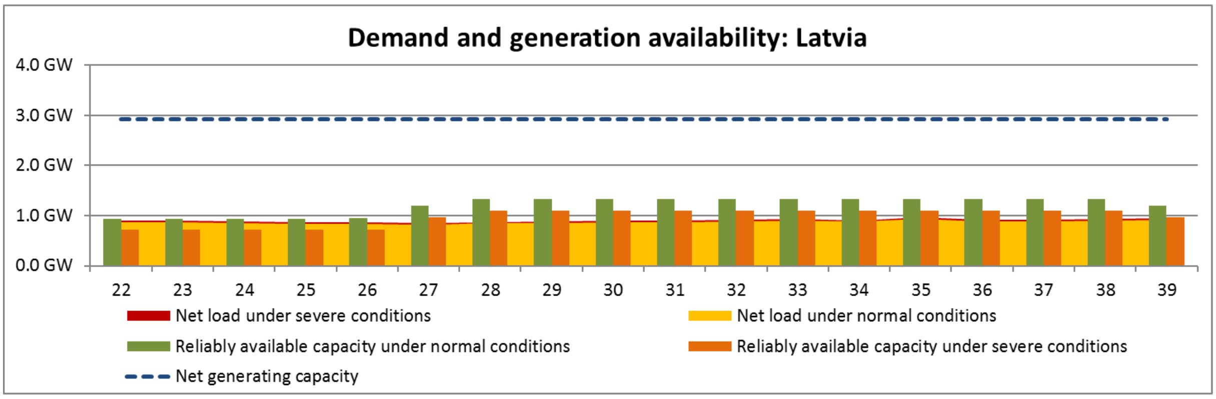
The system service reserve is 100 MW during the whole year according to the BRELL agreement.

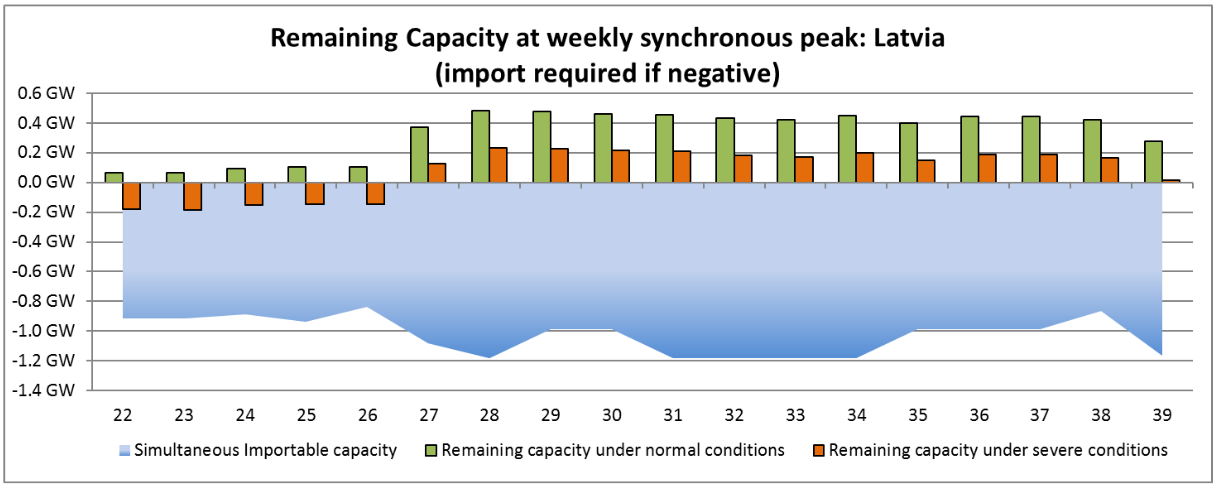
The peak demand under normal conditions is considered to be 1.5%, whereas under severe conditions it is 5% higher compared with peak demand in the previous year. The expected average peak demand increase in 2018 is around 1.9%. The minimum load during the night minimum is assumed as post-factum values from the previous year.

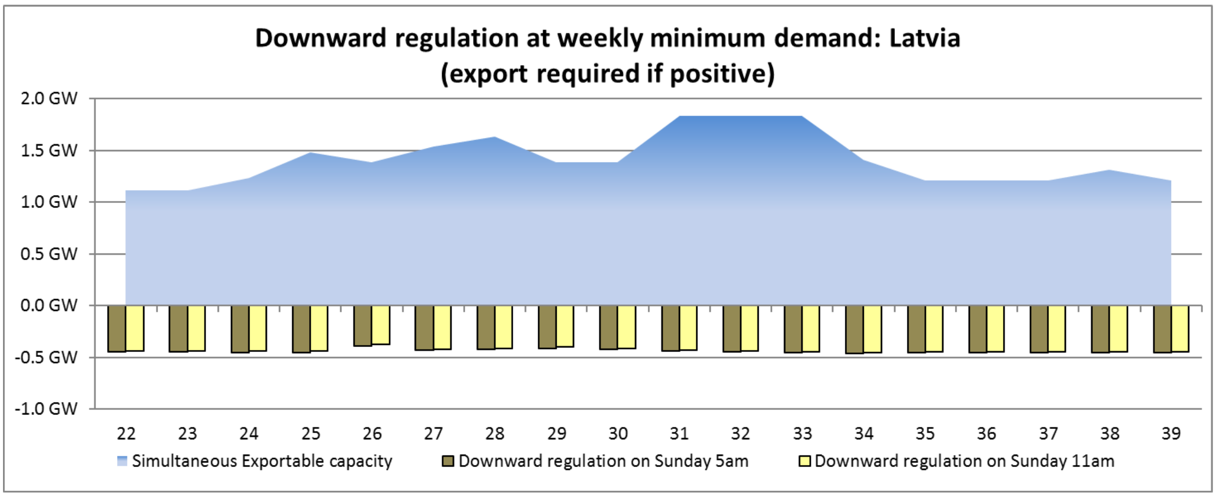
Potential critical periods and foreseen countermeasures

The most critical weeks for the Latvian power system in normal conditions are weeks 22, 23, 24, 25 and 26 when the available generation is very close to peak demand but still covers the peak demand. Under severe conditions, the Latvian power system has problems covering the peak load in the first part of summer when one unit of Riga CHP2 is in maintenance (capacity reduced by 419 MW). During the rest of summer, the reliable available capacity can cover the demand in normal and severe conditions. In the first part of summer, the Latvian TSO will rely on neighbouring power systems or run system service reserve.

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







Latvia: Winter Review 2017/2018

The average temperature in Latvia in November and December was higher than normal. The statistical data for the temperature at the beginning of 2018 is not available yet.

The forecasted peak demand was very close to actual peak demand and significant deviations were not observed. The forecasted peak demand in severe conditions was not exceeded.

The water inflow in Daugava river during the analysed time frame was higher than expected and hydro generation for almost the whole winter was above 500 MW (on average 879 MW). The year 2017 was very wet and hydro generation dominated in the area of Latvia. The actual figures of import cross-border capacities between Latvia and Lithuania were higher than the forecasted, except for December values. The import cross-border capacities between Estonia and Latvia were higher than the forecast. During the whole winter period, the Latvian TSO could rely on electricity imports from neighbouring countries. Regarding the export cross-border capacities between Latvia and Estonia, for almost the whole winter period post-factum values were higher than planned, whereas a similar situation has been observed on cross-border Latvia – Lithuania. The other RES has generated the same amount of energy as the previous summer period on average. These deviations to the plan do not cause any problems for the security of supply in the area of Latvia and the updated capacities were used for power exchange within Baltic States.

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

Lithuania: Summer Outlook 2018

The demand estimation for normal conditions was based on 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 2% higher, with a maximum (under normal conditions) of 1690 MWh at the end of September.

Since the last summer season, net generating capacity has increased by 92 MW and currently is equal to 3380 MW.

Total volume of frequency restoration reserves and replacement reserves for summer season will not change significantly and will be equal to 883 MW during the whole season which represents 26% of NGC. The maintenance schedule will not be intensive, the largest (7% of NGC) generation unavailability due to maintenance will be on 22 and 23 weeks of 2018 when generating units of Kruonis Pumped Storage Plant and Kaunas Hydroelectric Power Plant (23 week) will not be available.

Regarding the capacity of Lithuanian power system interconnections, the most significant transmission constraints are foreseen between Lithuania and Sweden. Starting from week 31 and during the rest of the summer period, NordBalt HVDC link will be disconnected due to the planned replacement of the underground cable joints.

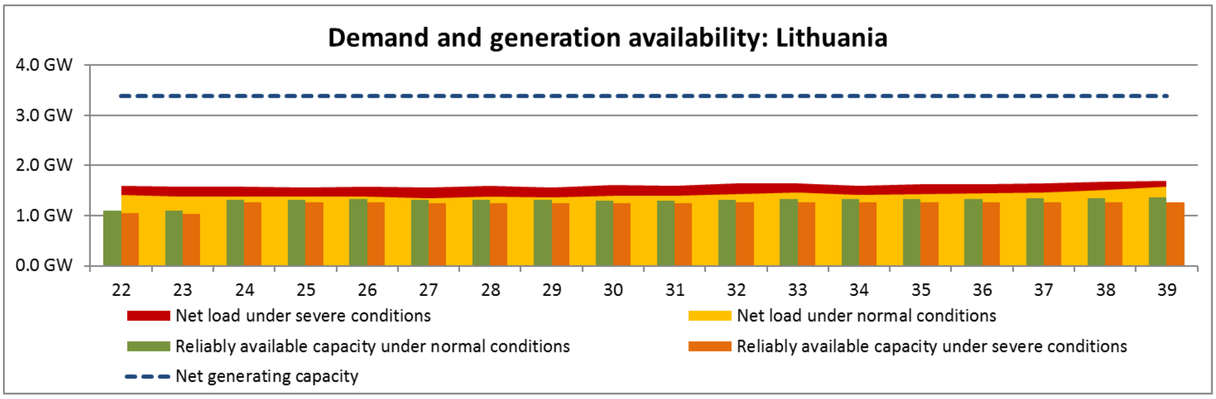
All import volume from third countries (Russia, Belarus) based on power flow calculations and allocated at Lithuania-Belarus interconnection highly depends on the Estonia-Latvia interconnection capacity, which is reduced during the summer period because of higher the ambient temperature and planned maintenance activities on the interconnection lines. This causes significant import restrictions from third countries to the Lithuanian power system for the whole summer period.

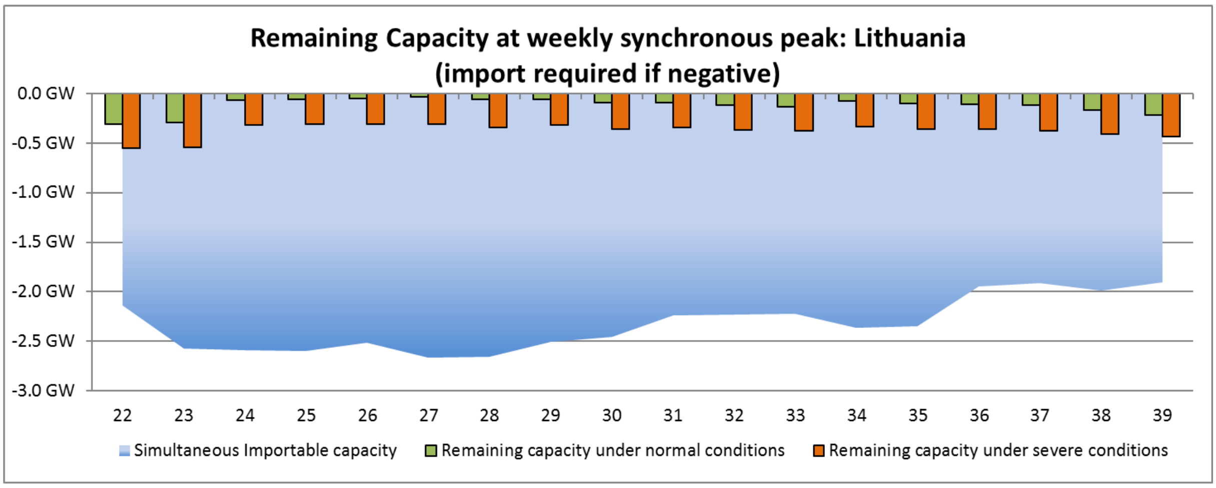
Moreover, due to limited generation capabilities in the Kaliningrad region during peak demand hours, decreased import capacities are expected on the Lithuania-Russia cross-border interconnection. Highest import constraint is foreseen in weeks 22 and 39 because of the planned maintenance activities of Kaliningrad Thermal Power Plant.

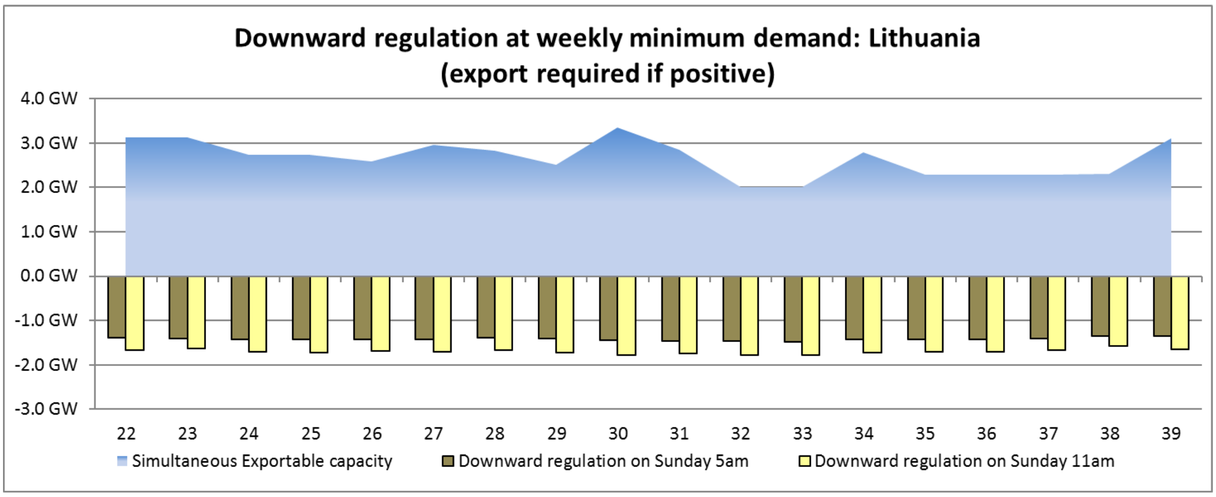
The average adequacy level of the Lithuanian power system during the upcoming summer season is forecast to be negative. Nevertheless, the cross-border interconnection capacity is expected to be sufficient for maintaining system adequacy.

Potential critical periods and foreseen countermeasures

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







Lithuania: Winter Review 2017/2018

In the previous winter, national consumption was 3% higher than in winter before. The highest increase was recorded in February (6%) when the average monthly temperature was -6°C. Maximum load (1999 MW) was reached at the end of January (24 January 2018), when the average temperature of this particular day was -12°C.

In general, the winter balance portfolio consisted of 30% local generation and 70% imports from neighbouring countries. During the winter of 2017/2018, total generation was 9% lower compared with winter 2016/2017. There are three main reasons that explain the generation decrease. First, growth in the allocated capacity of Lithuania – Sweden HVDC interconnection that led to a larger amount of imported energy. Second, the 33% (95 GWh) lower fossil fuel generation that can be explained by the higher price of generation using this type of fuel. Third, wind net generation from December 2017 until the end of February 2018 was 15% (61 GWh) lower than the year before. On the other hand, hydro net generation during this winter season was 21% (30 GWh) higher than the year before. Balancing reserve capacity was sufficient to compensate for actual imbalances.

The largest part of imported electricity was from Latvia (42%) and from Russia (34%). DC interconnections with Poland (LitPol Link) and Sweden (NordBalt) covered 17% of imports.

During the winter period, import and export capacities of the Lithuania power system had no significant deviations from yearly plans.

Most of the time, capacities from third countries were limited due to the congested Estonia-Latvia cross-border interconnection, except in January and February, when limitations were also caused by the Latvia-Lithuania interconnection (due to the high surplus generation of the Latvian power system).

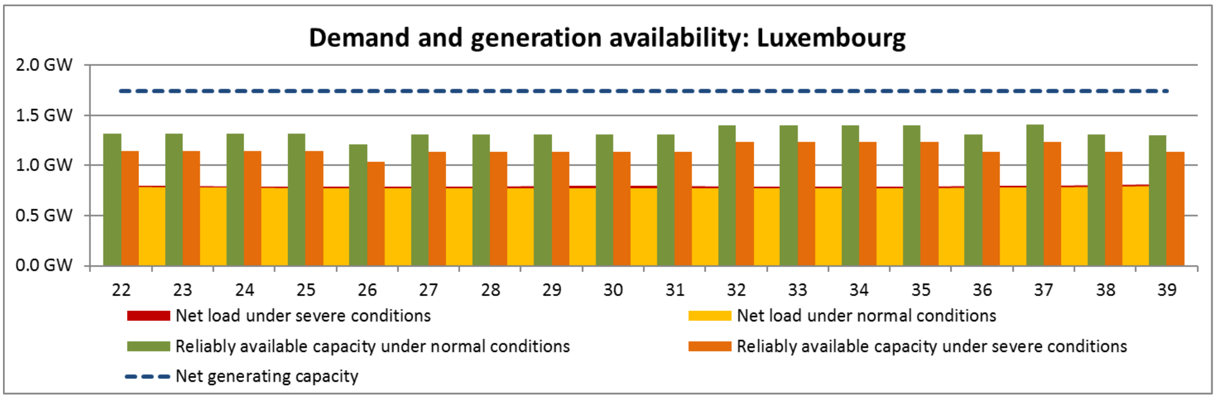
Furthermore, capacities between Lithuania and Sweden were reduced by unplanned outages of NordBalt HVDC interconnection in week 48 2017 and week 3 2018.

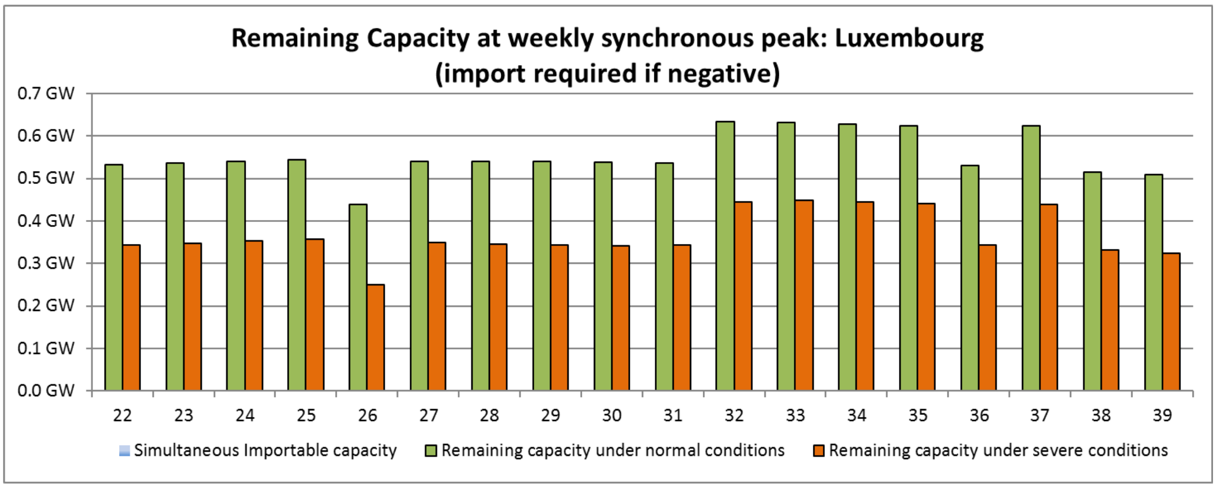
Adequacy was ensured due to sufficient transmission capacities of the interconnections.

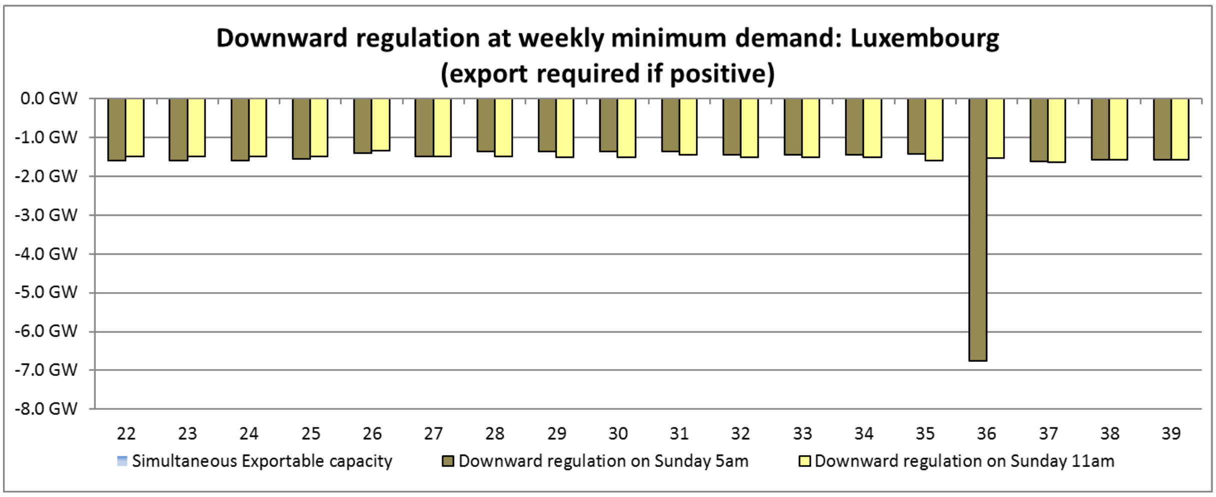
Luxembourg: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







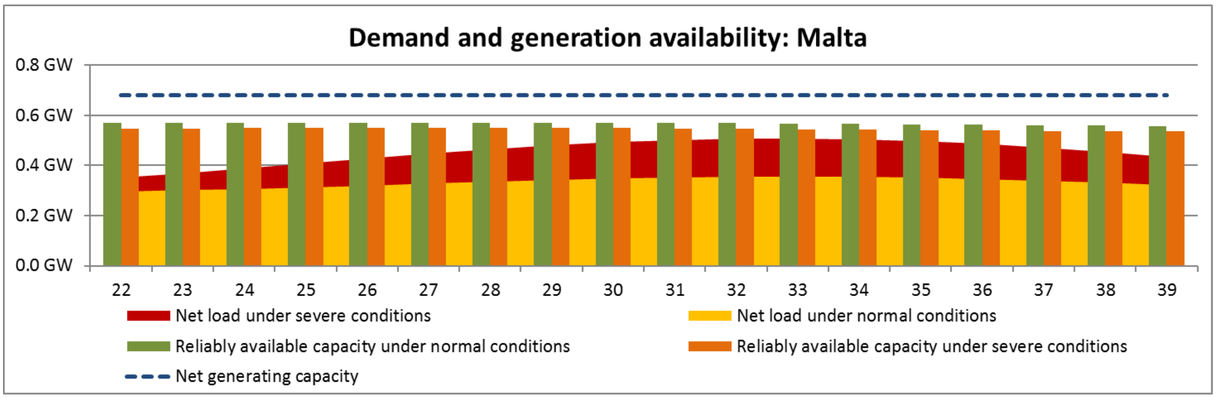
Luxembourg: Winter Review 2017/2018

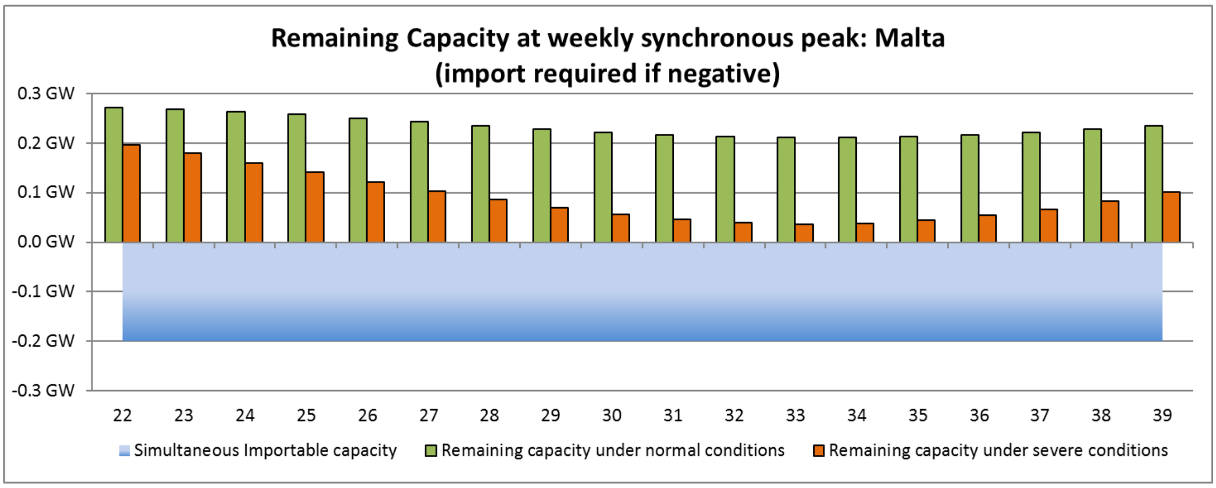
No adequacy or downward regulation issues were identified during past season.

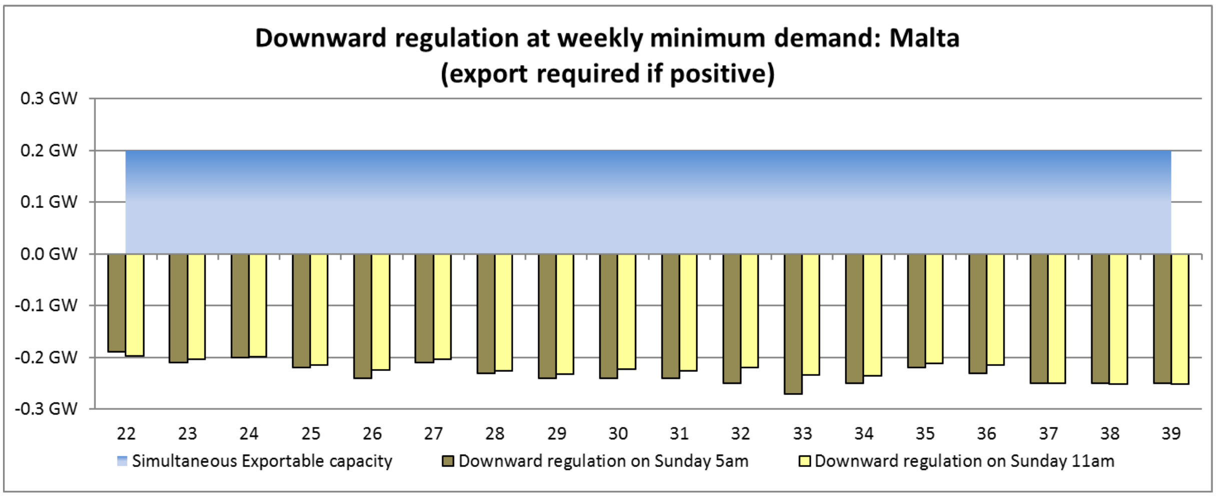
Malta: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







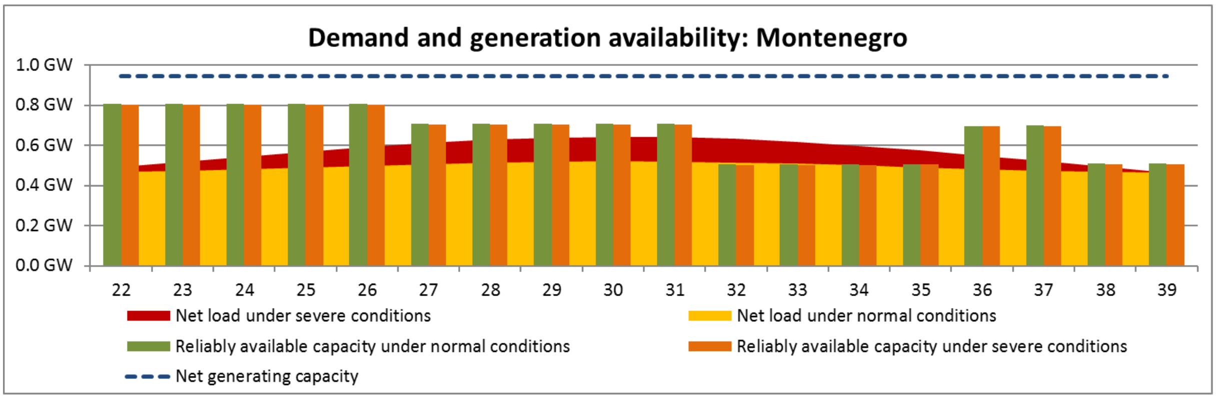
Malta: Winter Review 2017/2018

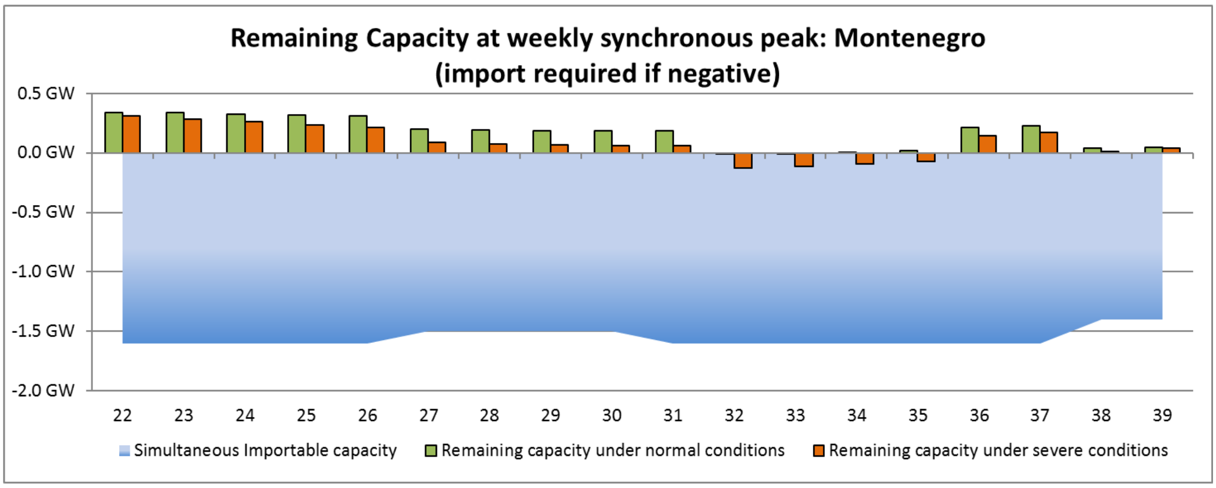
No adequacy or downward regulation issues were identified during past season.

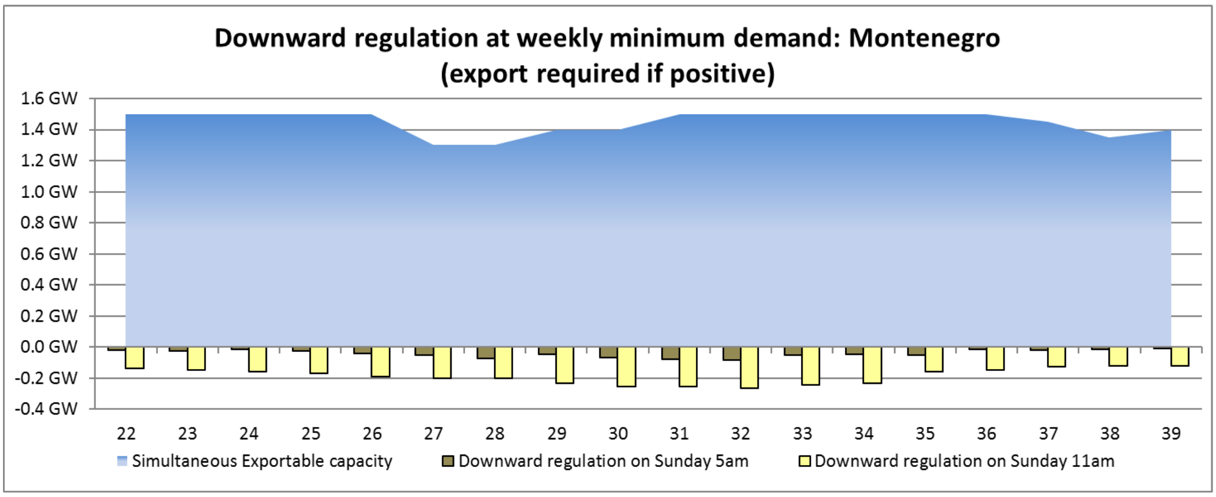
Montenegro: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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





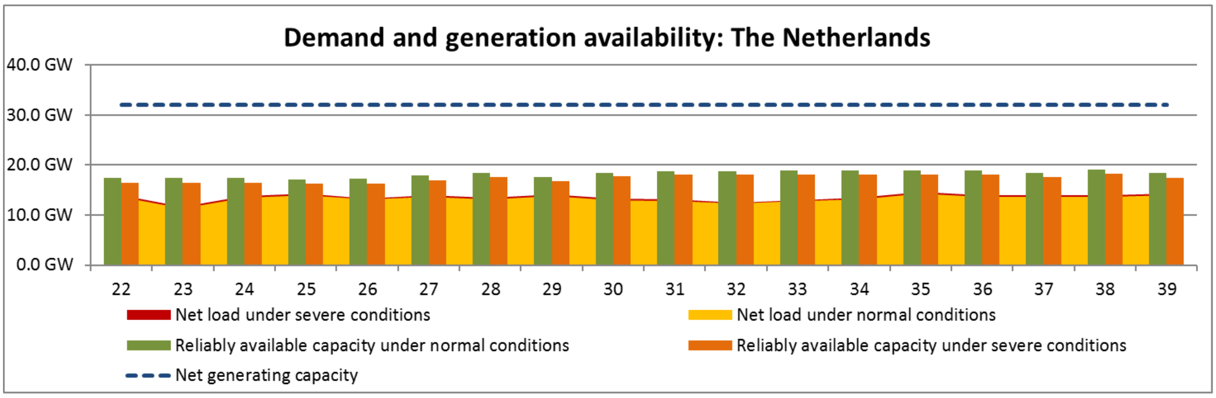


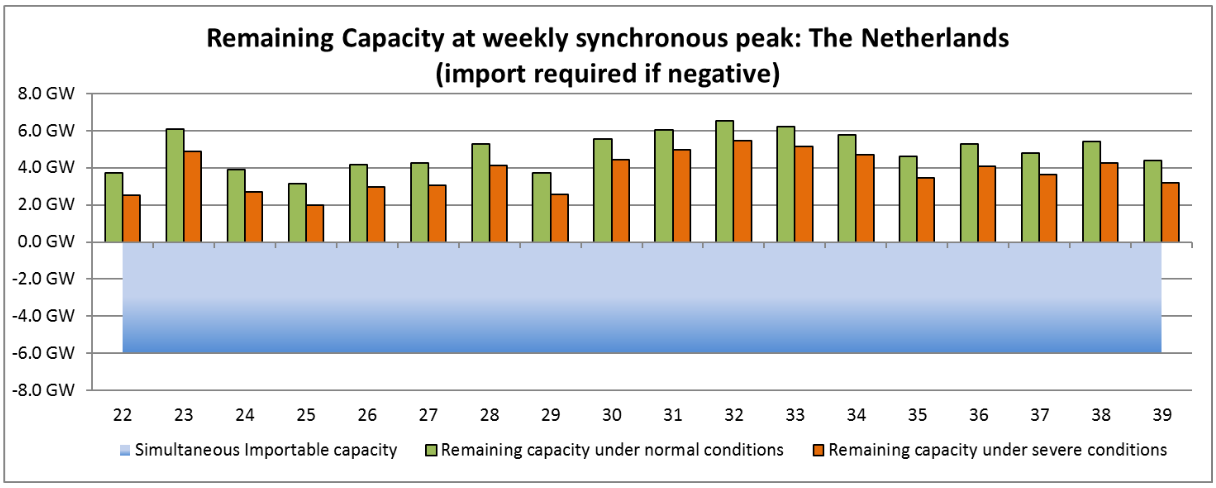
Montenegro: Winter Review 2017/2018

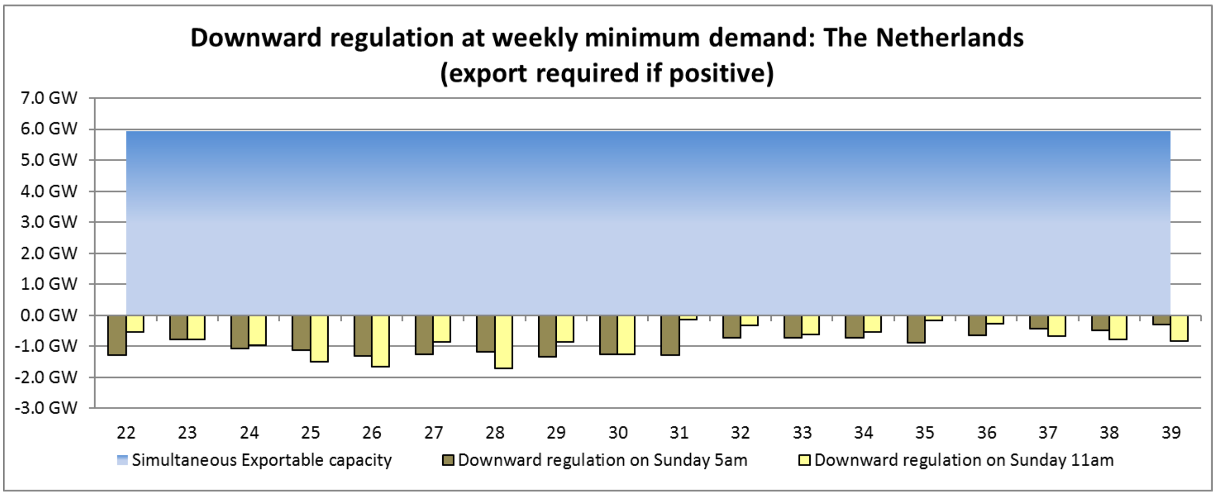
No adequacy or downward regulation issues were identified during past season.

Netherlands: Summer Outlook 2018

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







Netherlands: Winter Review 2017/2018

In the previous winter period (2017/2018), national consumption was on average 0.25% higher than in the winter 2016/2017. The highest increase of 2% was recorded in December 2017 (in comparison to the same month in the previous year).

The coldest month was February 2018 with an average temperature of 0.7°C. The coldest day was recorded on 28 February -8.5°C.

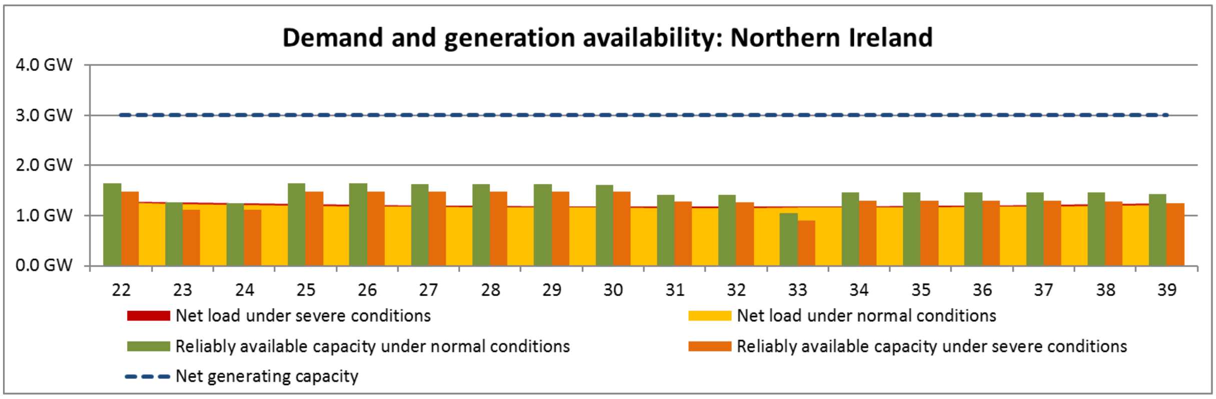
The highest demand was recorded on 13 December reaching 18 620 MW at 17 and 18 o'clock.

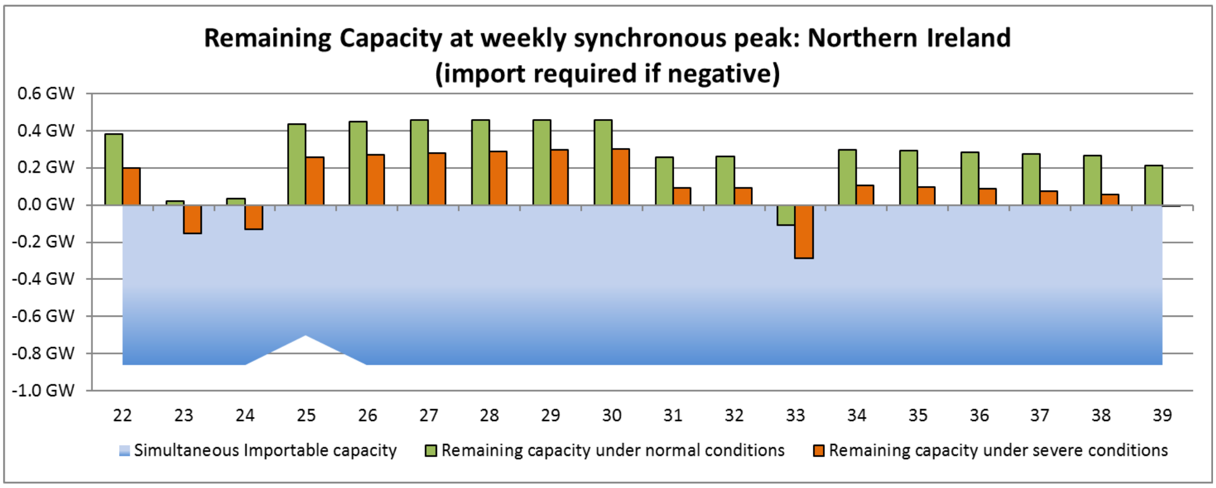
No adequacy or downward regulation issues were identified during the past season.

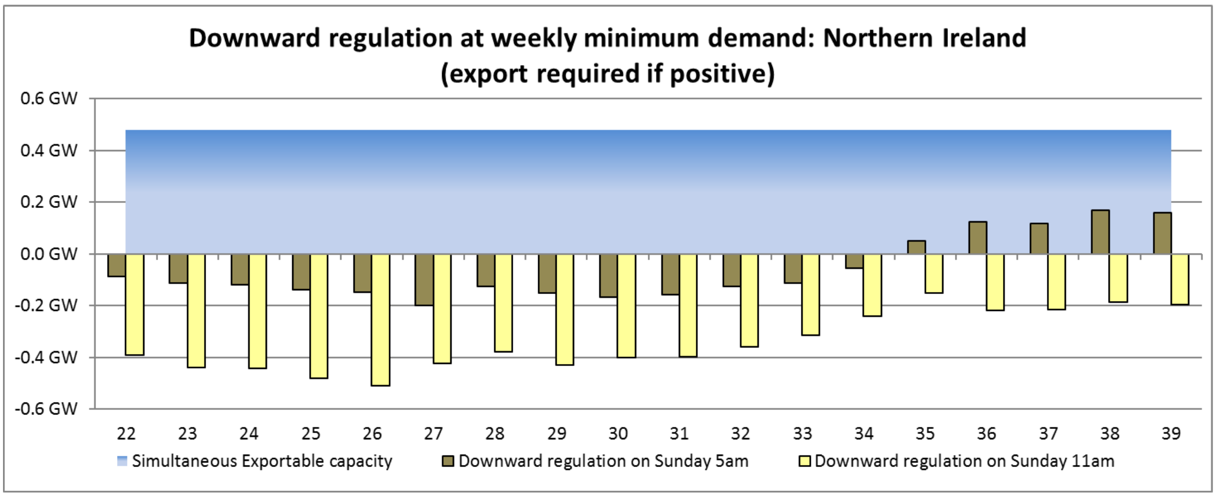
Northern Ireland: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







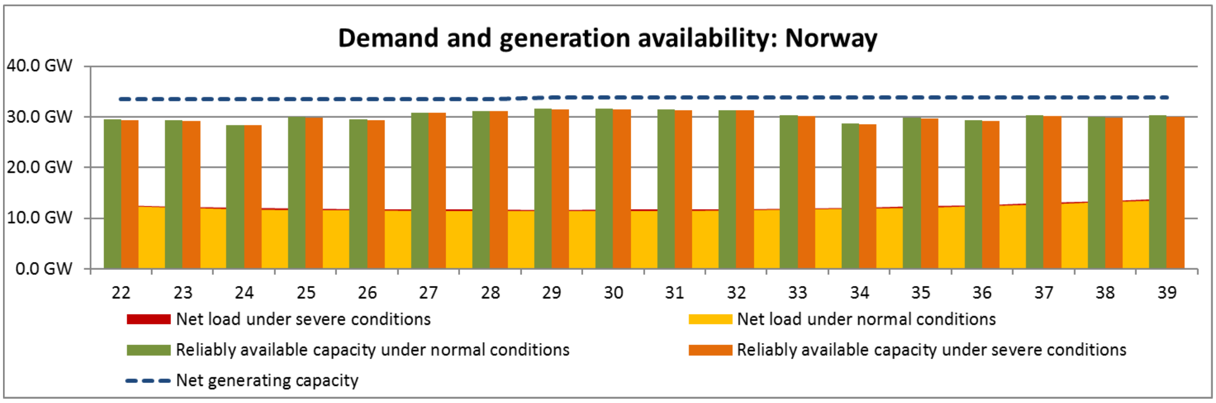
Northern Ireland: Winter Review 2017/2018

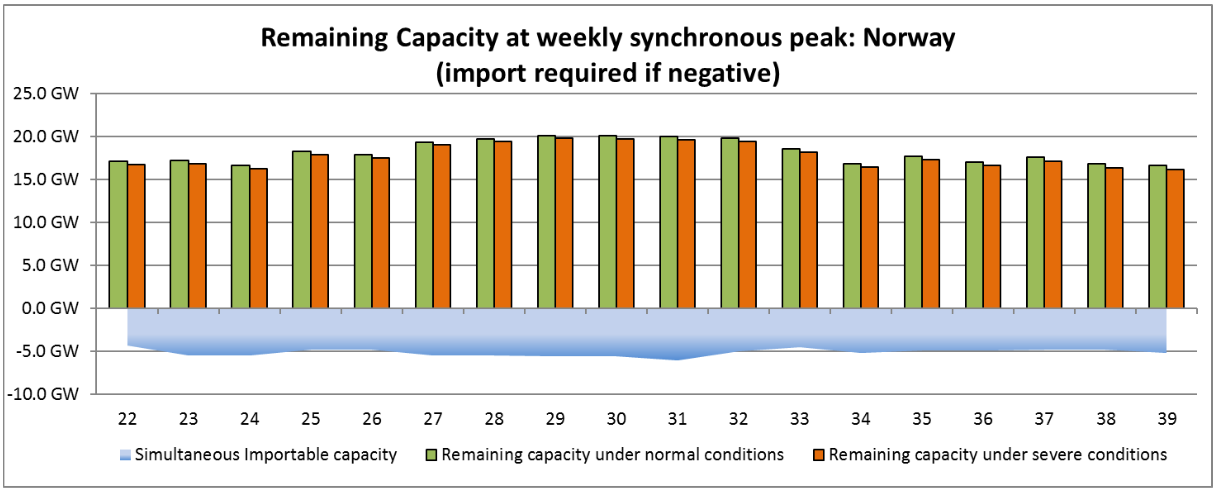
No adequacy or downward regulation issues were identified during past season.

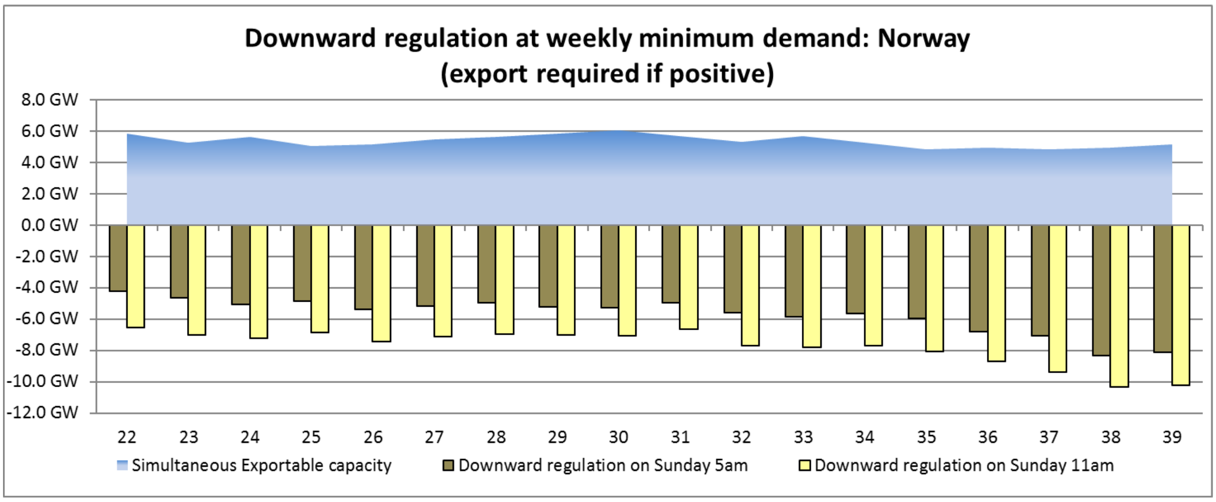
Norway: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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





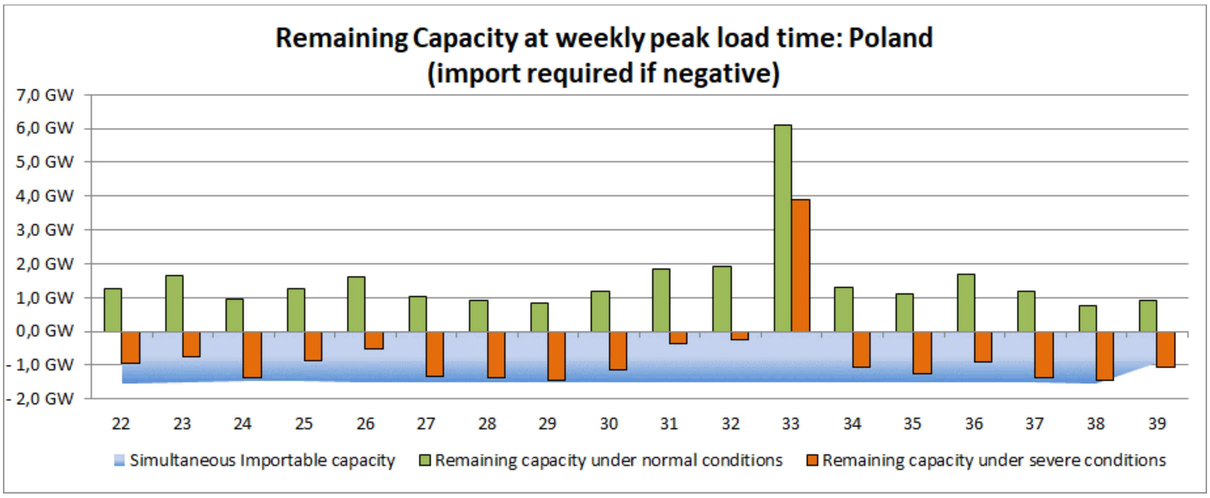


Norway: Winter Review 2017/2018

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

Poland: Summer Outlook 2018

One year ago, the time of the European synchronous peak reference point was shifted to 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 and 14:00 CEST, the adequacy results for 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 2018 power balance results are a bit better compared with previous Summer Outlook ones. In both normal and severe conditions, PSE expects to be able to balance the system, however under severe conditions import via interconnections may be a key issue. In particular, import capacity forecasts on synchronous profile with Germany, Czech Republic and Slovakia are significantly limited by unscheduled flows through the Polish power system (the issue is described at length in the previous Outlooks report). Therefore, a situation may occur, when there would be enough available solar generation in Germany at midday to support adequacy in Polish power system, while interconnections (in the direction to Poland) might be congested. On the other hand, it is expected that 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.

At present, adequacy under Poland peak demand moment is being closely investigated in national studies as well as by RSCs in week ahead adequacy studies. Meanwhile, PSE acknowledges the efforts to enhance the Seasonal Outlook adequacy study methodology to hourly granularity.

Potential critical periods and foreseen countermeasures

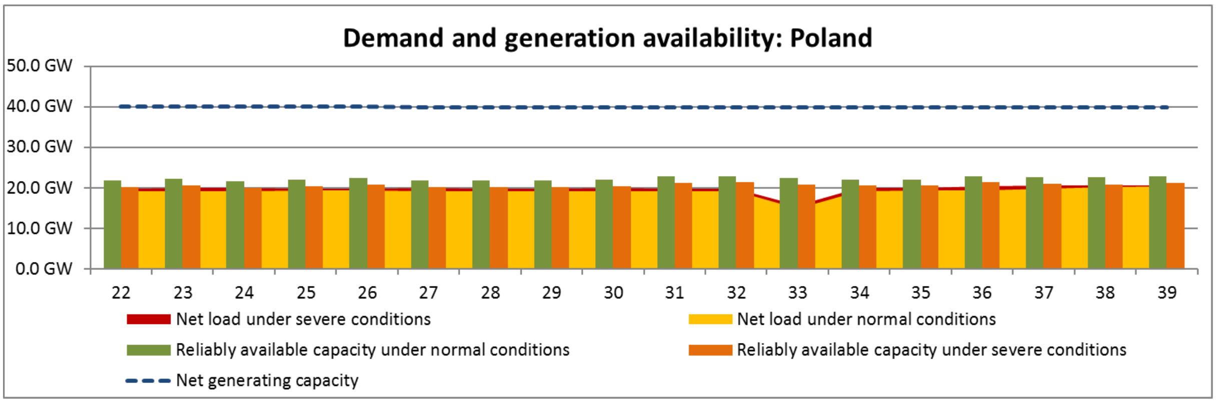
Extremely severe balancing conditions in the summer period may take place in case of long lasting heat waves leading to a significant deterioration in the Polish power system. This causes an increase of demand with a simultaneous decrease of generating capacities due to a higher forced outage rate of generators and the increase of non-usable capacity, e.g. hydrological constraints (low level of water in rivers used to cool some thermal power plants).

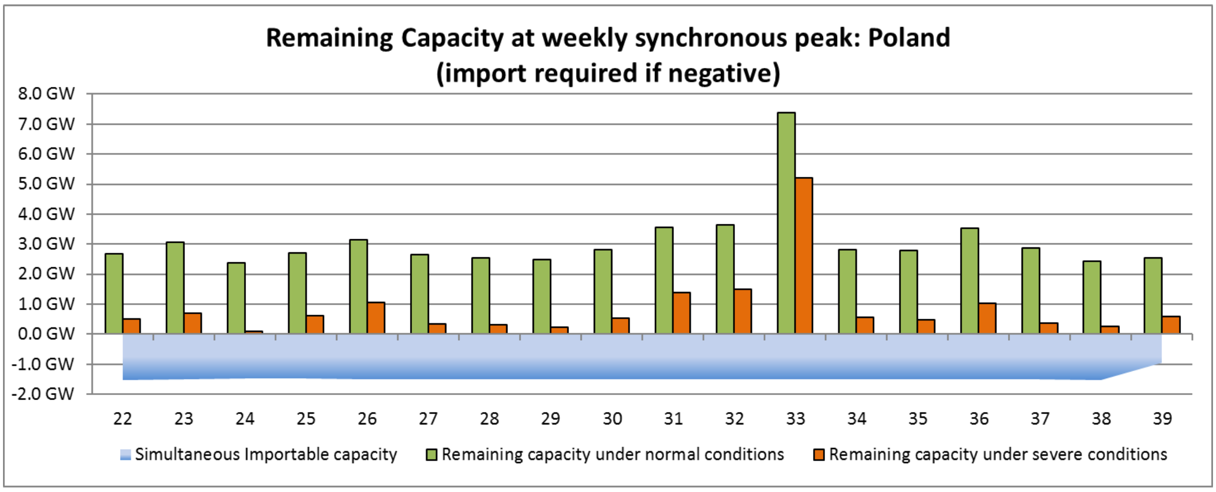
The risk of high unscheduled flows through the Polish system (from the west to the south) during such weather conditions is high as a result of development of solar generation in Germany and high volume of market transactions. In such a situation, if necessary from a power balance point of view (to recover minimum generating capacity reserve margin required), additional import on synchronous profile towards the Polish system can be realized under the condition of simultaneous multilateral re-dispatch action, MRA (with source and sink respectively south and west of Poland) taken at the same time to limit the unscheduled transit flows through the Polish system. It is estimated that ca 300 MW of such a re-dispatch (assuming source in Austria and sink in Germany) is necessary to allow 100 MW of import to Poland from Germany. It is important to underline that even this combined action cannot be treated as a certainty because it depends on the availability of up regulation power in the TSOs Security Coordination (TSC) area and the possibility of decreasing generation in 50Hertz. Such a situation occurred on 15 September 2015 and was described precisely in the Summer Review 2015 as part of the Winter Outlook 2015/2016 report. On the other hand, usage of mentioned above measure is more probable than before summer 2016 due to implementation of special topology measure on PL-DE border described in the Summer Outlook 2016 report.

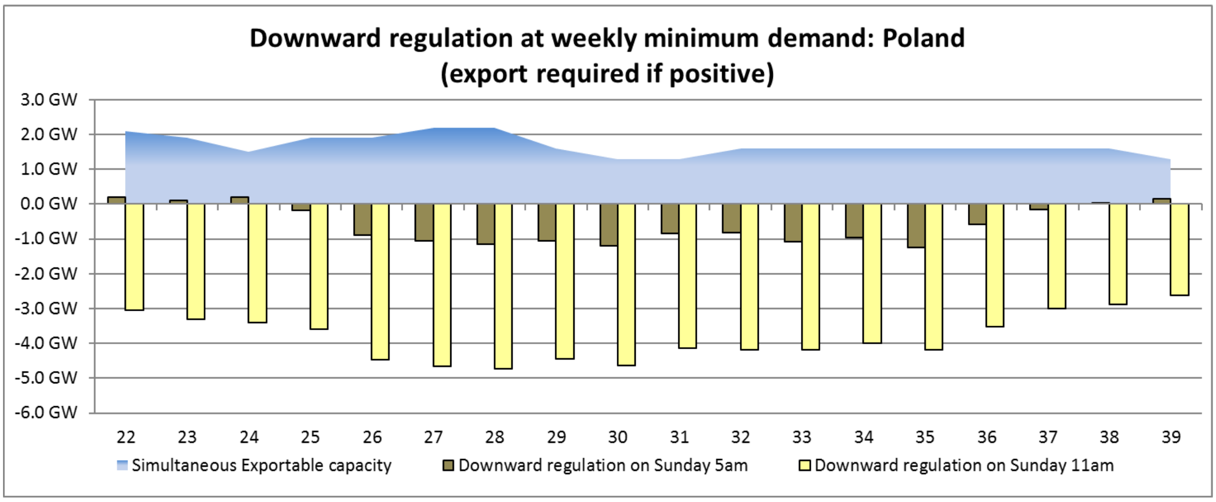
In addition, PSE has contracted 361 MW of DSR at the moment, which may be activated in case of inadequacy. PSE expects the increase of DSR from 1 July 2018 up to 500 MW. Nevertheless, the previously mentioned DSR potential was not considered in the Summer Outlook 2017/2018 study as this DSR is procured to be used as a remedial measure and is out-of-market.

During the last Wednesday in September, import needs will exceed the forecasted level of NTC, mainly due to the planned maintenance of the Poland-Sweden HVDC cable. Nevertheless, the situation in September, when peak demand is very short and is taking place in the evening, is less stressed than peak demand in the main summer season occurring at midday.

PSE does not expect problems with the renewable infeed at 5:00 and 11:00 CEST on Sundays. Solar generation (which is c.a. 0.3 GW) is still negligible in the Polish power system.



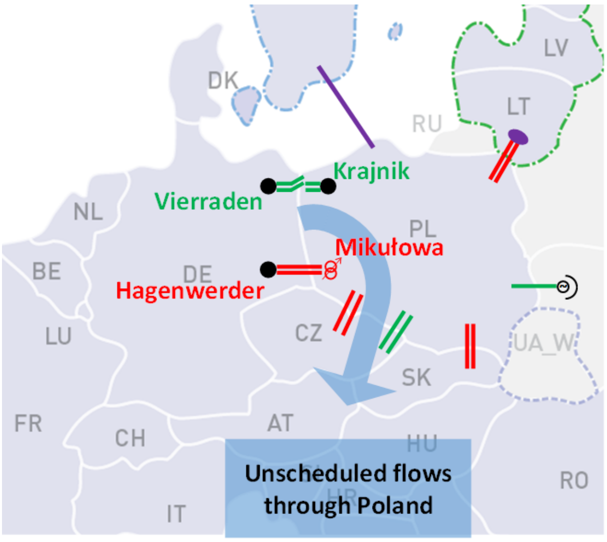




Operational conditions

As usual, operational conditions for the forthcoming summer strongly depend on the level of unscheduled flows through the Polish system (from the west to the south). Indeed, the problem of unscheduled flows through Poland has not been solved, but since June 2016 these flows can be partially reduced by special, temporary measures referred to the reconfiguration on the PL-DE border. This reconfiguration consisted of the utilisation of Phase Shifter Transformers

(PSTs) in one of two double circuit tie-lines with a simultaneous disconnection of the second double circuit tie-line:



Polish interconnections as of 30 April 2018.

More details can be found on page 100 of Summer Outlook 2016.

An upgrade to voltage 380/400 kV of Krajnik-Vierraden double circuit line has been completed during the last two years and two (from four planned) PSTs have been installed in Vierraden substation. These changes allow the Krajnik-Vierraden line to be reconnected and operated in parallel with a second connection on the PL-DE border, 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 not forecasted before 2020.

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

Based on the Polish TSO experience from recent seasons, PSE still assesses that it will be possible to offer some commercial transmission capacities in the direction towards Poland to the market. Nevertheless, such capacity might be offered only in day ahead and intraday horizon. For the report, 250 MW of import capacity was assessed, however the real level will depend on operational conditions[18]. It is important to underline that installation of PSTs is a kind of non-costly remedial action, which can only decrease the negative impact of unscheduled flows, but does not solve the origin of the unscheduled flows problem. The sustainable solution is the implementation of an adequate coordination of capacity calculation and allocation in the meshed centre of the Continent, i.e. a flow-based approach in the proper region, which means Continental Europe East, West and South with properly configured bidding zones. More details referring to unscheduled flows problem can be found in the previous Outlooks reports.

Poland: Winter Review 2017/2018

Despite a cold spell at the end of February 2018, no adequacy issues occurred last winter. Nevertheless, new peak demand registered on 28 February, at 18:30. It amounted to 24.8 GW.

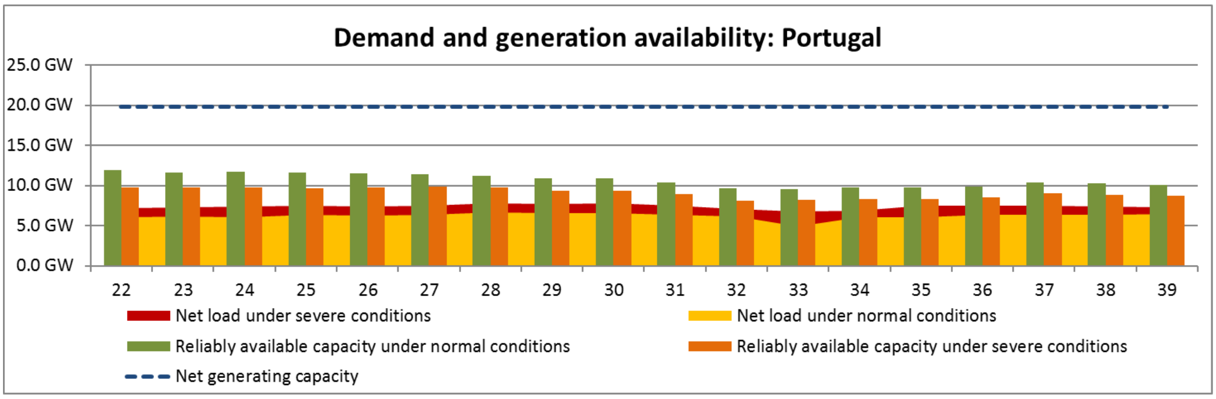
Operational conditions were favourable last winter.

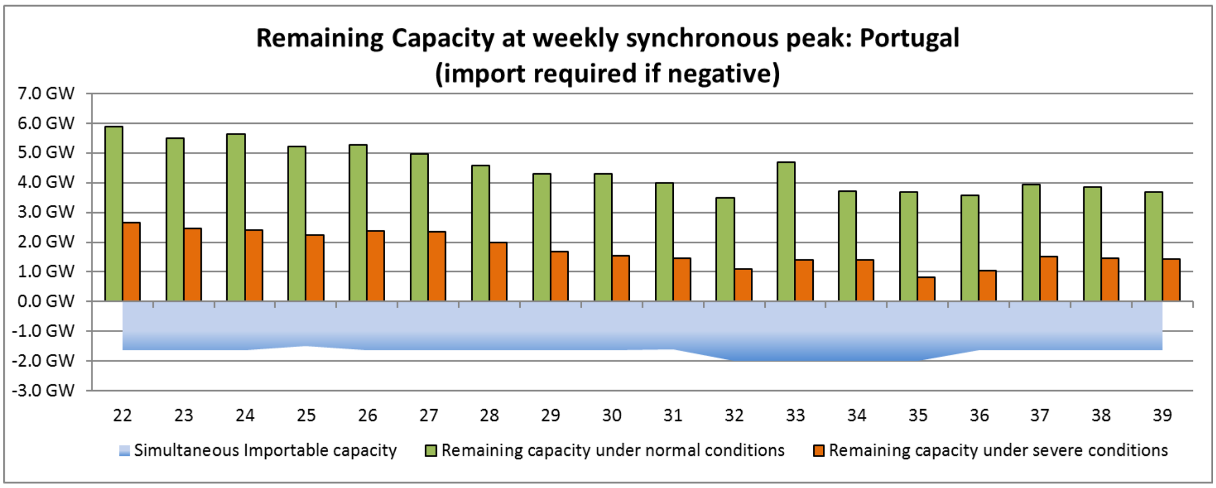
[18] The remark about the dependency of capacity possible offered to the market and operational conditions refers also to the best estimate of NTC provided in the report in the direction PL->LT and PL->SE.

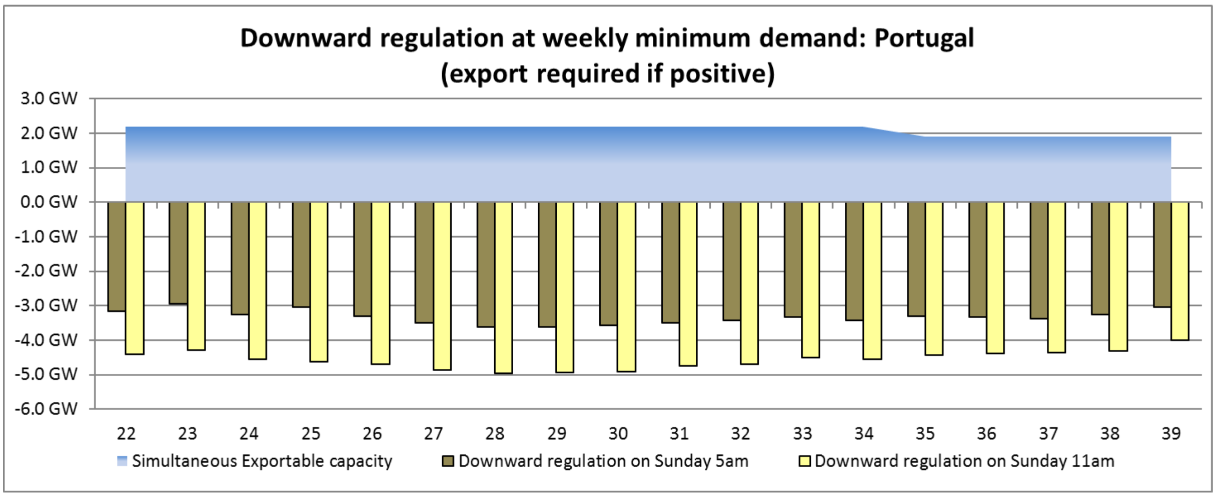
Portugal: Summer Outlook 2018

REN's outlook for the 2018 summer season is positive, as conditions are more favourable to system adequacy than in the previous year. In mid-April, hydro storage is in 84% of its maximum capacity, and thermal generating capacity is expected to be fully available from the beginning of July until the end of the period under analysis.

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







Portugal: Winter Review 2017/2018

This winter was atypical, with the low temperatures and high rainfalls coming only at the end of the season.

Although until the end of February hydro conditions were significantly difficult, the scene has changed since then and, in March, monthly generation from renewable plants exceeded the national monthly demand for the first time in history. The hydro generation reached an all-time high of 5689 MW.

On 7 March 2018, REN registered a new maximum in national electricity production of 12043 MW. On that day, power demand was 8417 MW and the system was exporting about 3600 MW. The exports exceeded the 4000 MW level for the first time on 26 February, however national power demand record (9403 MW) from 2010 was not reached.

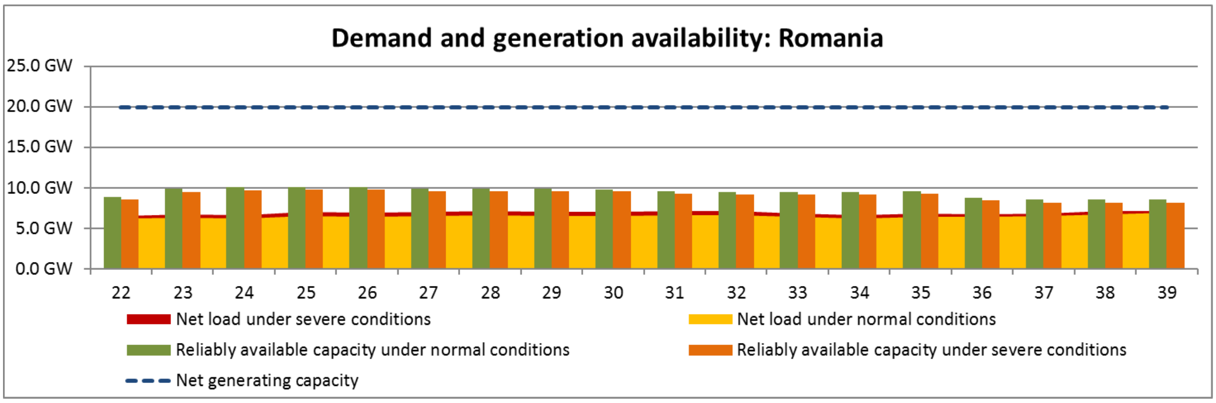
In any condition, the situation has posed adequacy and downward regulation risks.

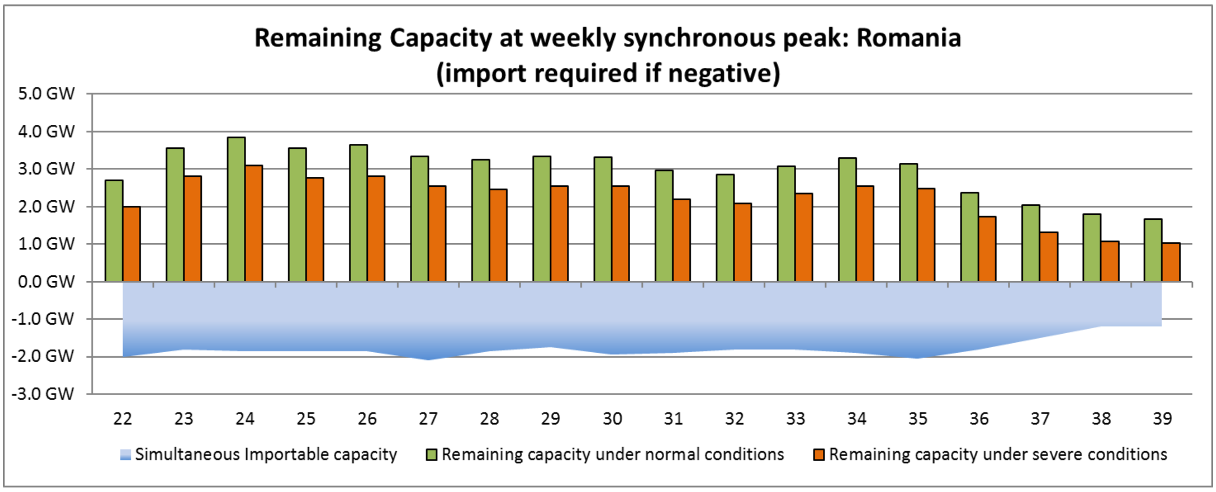
Romania: Summer Outlook 2018

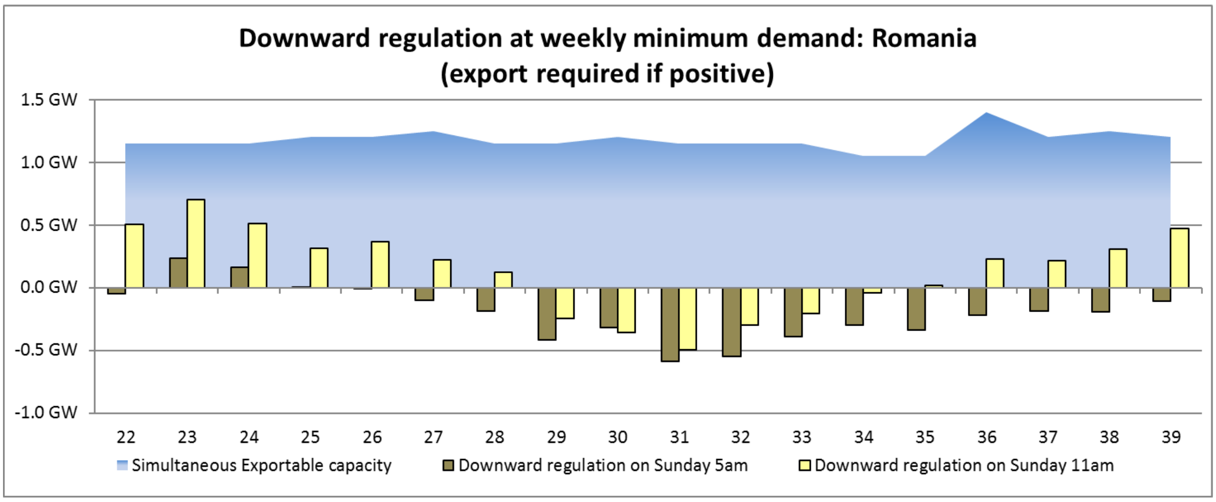
Potential critical periods and foreseen countermeasures

The balance forecast for the coming summer 2018 does not indicate any problem which could affect the Romanian Power System adequacy for both normal and severe conditions.

When the downward regulation has a positive value during the minimum demand, the NTC export level is sufficient to allow the export of the RES over generation. However, if the export net position is lower than the export NTC value and the downward regulation has a positive value, then it is possible to apply market rules to reduce the renewable generation (hydro, wind and solar) in order to keep the balance for those hours.







Romania: Winter Review 2017/2018

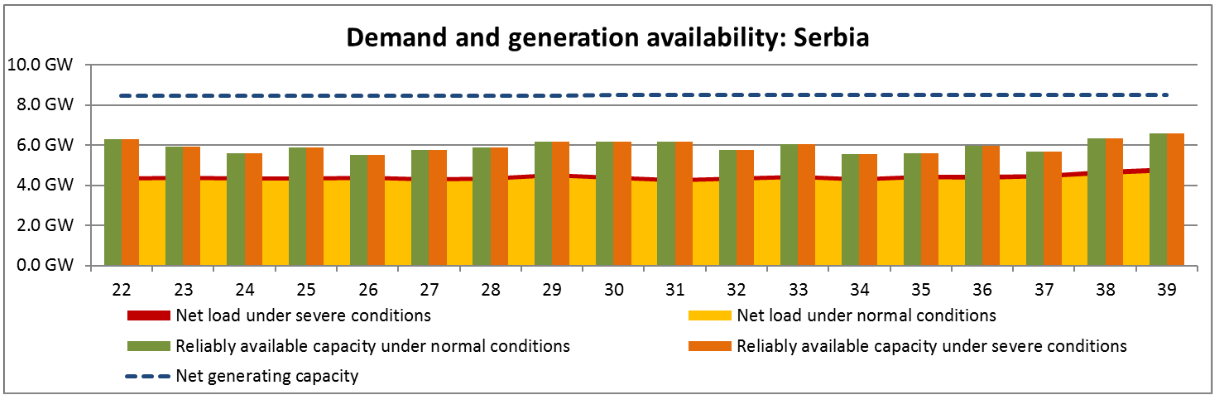
The main part of the winter 2017/2018 interval was characterised by normal or higher than normal temperature values. During January and February, for short time intervals of a few days or up to a week, low temperatures were recorded reaching a limit of frosting.

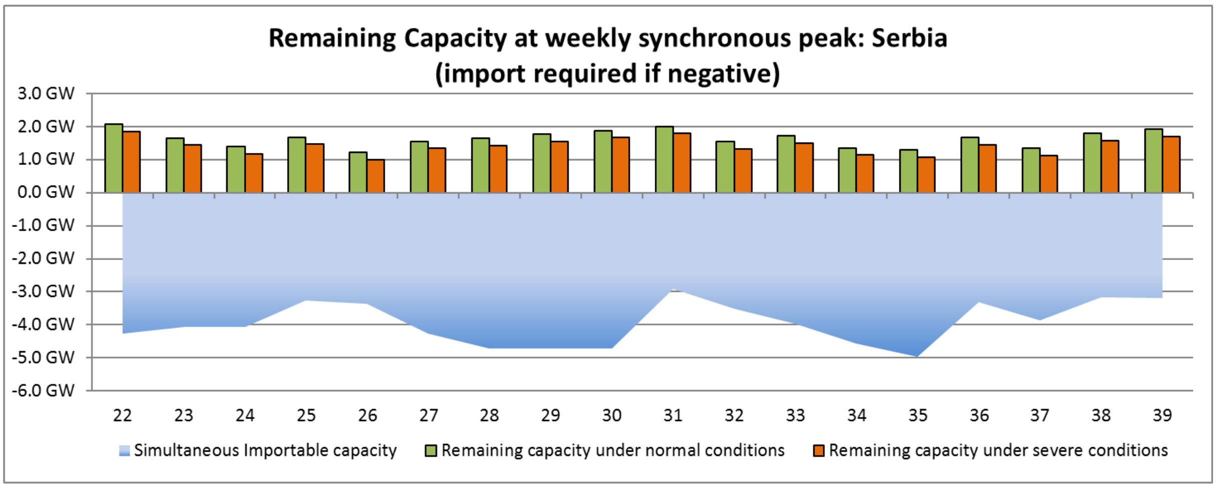
On 20 March 2018 in the hourly interval 06:50 – 11:40 (CET) in the European Alarm System (EAS), the ’Alert‘ state was set by Transelectrica with the message ’Lack of Reserve‘, after the full use of the restoration reserve, which was in the amount of 1500 MW. Significant deviations from the schedule were recorded by wind farms, whose turbines were stopped due to ice deposits on blades and anemometers, leading to the beforementioned imbalance. For the replacement of the restoration reserve the start – up of certain thermal units were ordered. There were no deviations of the Area Control Error (ACE) during that time interval.

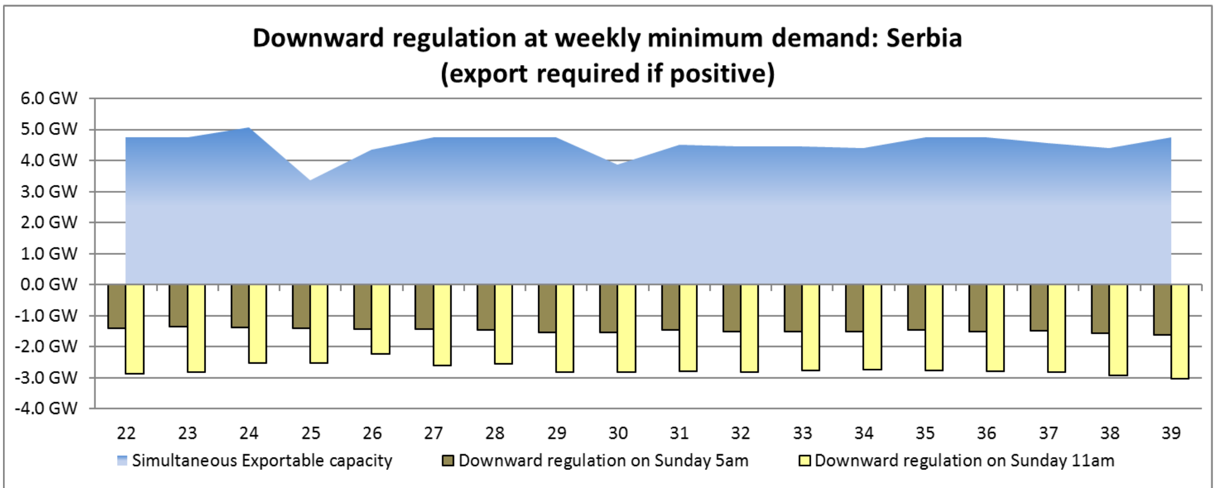
Serbia: Summer Outlook 2018

For the upcoming summer, we do not expect problems to cover demand. The hydro reservoir levels are high and the levels of maintenance are 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. This might lead to a reduction of planned export of energy, or even to the energy import to cover the demand.







Serbia: Winter Review 2017/2018

Apart from the event described in the next paragraph, the last winter passed without major problems. Some energy import was realised in December during the period with colder temperatures but weather conditions were generally as expected during the whole winter.

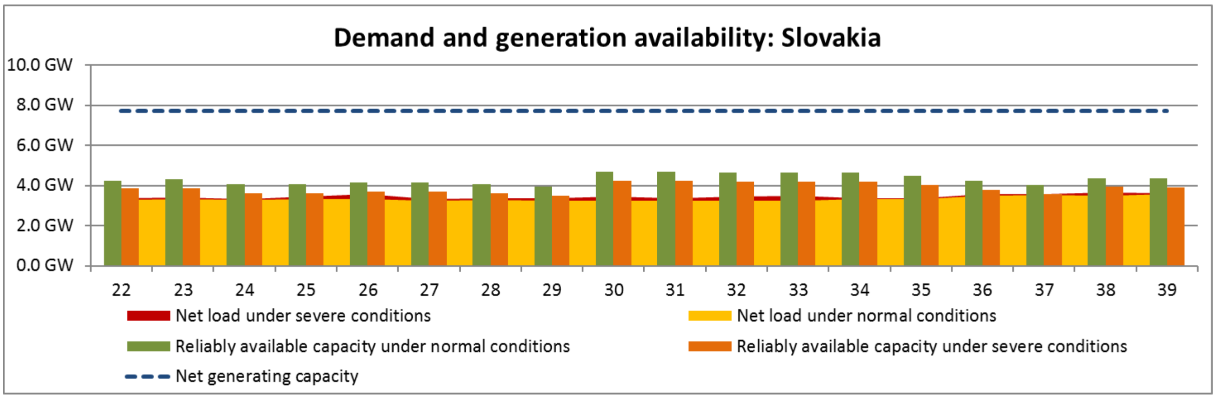
The lack of sufficient amount of energy in sub-area KOSTT which operates within EMS control area led to a disturbance of the generation-demand balance of the entire EMS control area. This energy imbalance, which continuously lasted from mid-January to mid-March, caused the lack of energy in the Continental Europe synchronous area and caused frequency deviation resulting in a 6 minute synchronous time delay.

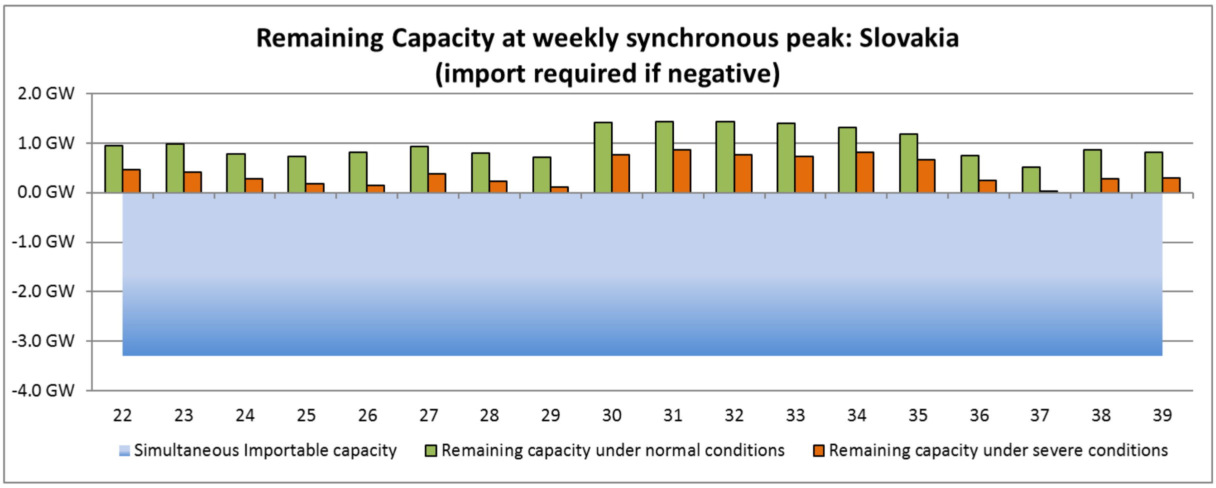
Slovakia: Summer Outlook 2018

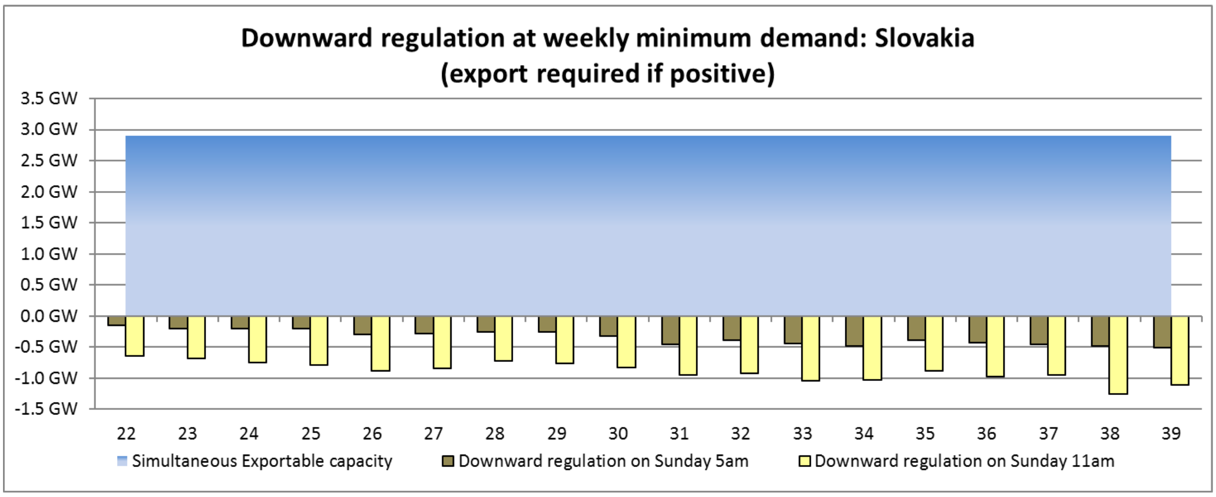
No adequacy risk is foreseen in the summer outlook 2018 in Slovakia. Expected generation capacity will be sufficient to meet foreseen peak demands this summer and to ensure the appropriate level of security of supply under normal conditions. Forecasted peaks for the coming summer are expected mainly in September. The peak demands in the previous summer 2017 were in June (3854 MW) and in September (3844 MW). The maximum weekly peak demand in summer 2018 under severe conditions is expected 3840 MW in September.

Considering the severe condition scenario, the remaining generation capacity is sufficient, except for the second week of September. The scheduled maintenance of generation units is at the same level as it used to be. The most important scheduled maintenance relates to nuclear units (500 MW) in the beginning and the end of summer.

The ancillary services are at the same level as in the previous year; no critical periods for lack of ancillary services are foreseen in summer 2018.







Slovakia: Winter Review 2017/2018

In winter 2017/2018 there were different weather conditions compared to the previous winter. Average temperature during the winter months was 1.2°C (in the previous winter it was 0.7°C). December 2017 and especially January 2018 were much warmer months than the previous winter. The average temperature in December was 1.3°C (-1.4°C in 2016) and in January 2.0°C (-6.7°C in 2017). In contrast, the end of winter was much colder than in 2017. The average temperature in February was -1.1°C (2.5°C in 2017) and in March 2018 it was 2.7°C (8.2°C in 2017).

Numbers in the articles below are preliminary and can be slightly changed after receiving updated data in future. Analyses of the winter period refers to December, January, February and March.

Total production of electricity in Slovakia during the winter period increased (index 102.6 %). The warm weather from December to the mid-February mainly impacted the production of hydro power plants that increased significantly in December (110.5%), February (112.7%) and above all in January (189.2%); in March, hydro production decreased (73.3%) because of poor snow conditions during the winter.

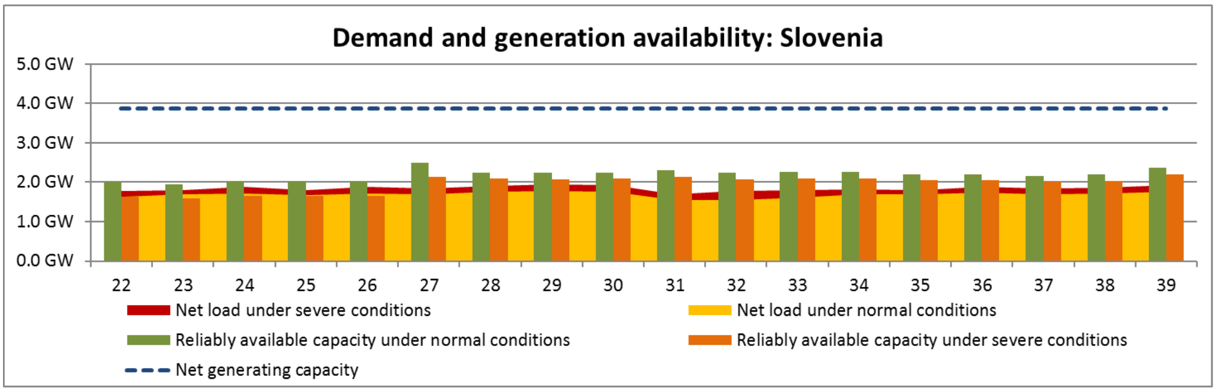
Total electricity consumption of Slovakia was almost the same as the previous winter (index 99.8 %). The high variations of consumption were in January (93.6%) and in March (106.0%) compared with previous winter months. The winter peak demand 4506 MW was on 27 February 2018 at 9:00; in the previous winter it was 4550 MW (11 January 2017 at 19:00). This peak demand, influenced by cold weather and by economic growth, was also very high. In the past peak demand did not exceed 4500 MW.

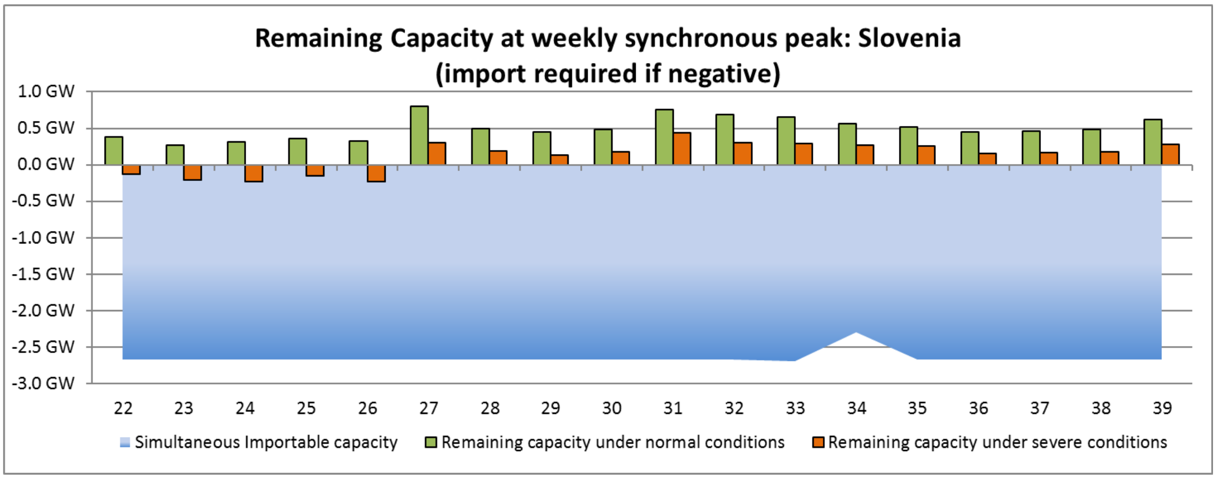
The consumption of Slovakia was partially covered by the import of electricity during winter. However, the total import of electricity for consumption coverage decreased significantly (75.5%). The share of imported electricity for consumption decreased to 7.6% (compared with 10.1% in winter 2016/2017).

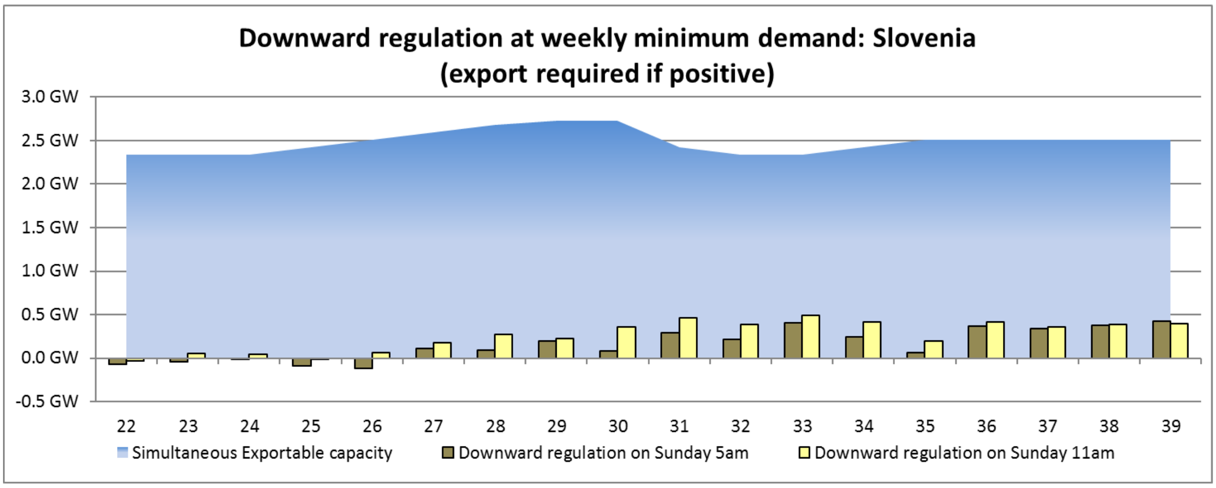
Metered cross-border flows of electricity decreased substantially in winter 2017/2018. Total imports decreased to 61.3% and total exports decreased to 64.1% compared with the electricity exchanges of the previous winter.

Slovenia: Summer Outlook 2018

No adequacy issues are expected this summer in Slovenia. The second biggest power unit of installed capacity 553 MW will be under maintenance between weeks 22 and 26. Only during this period and only in the case of severe conditions do we assume Slovenia might face a negative remaining capacity and require an import of maximum 200 MW.







Slovenia: Winter Review 2017/2018

Slovenia did not experience any adequacy related issues this winter. Considering the last 30 years, winter temperatures in Slovenia were slightly above the average, but there were fewer sunny days. Hydrological conditions were good, so the hydro power plants were able to produce more energy than in the last few years.

A new power unit was connected to the grid in the Brestanica Gas Thermal Power Plant. Its installed capacity is 52 MW.

Spain: Summer Outlook 2018

From the point of view of upward adequacy, no risk is detected in the Spanish peninsular system for the upcoming summer. Good adequacy situation can be expected regardless of available imports from neighbouring countries. If average conditions are considered, remaining capacity around the hour considered for the Summer Outlook (19h) will be over 18 GW. In the case of severe conditions, assessed remaining capacity is still over 15 GW.

In Spain, peak summer demand takes usually place around 12-14h. 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 approaching the historical average values, as they have sharply increased from the beginning of March, after very drought conditions from mid-2016.

Assumptions

It is expected that the total demand in 2018 will slightly increase, continuing the trend of the last 3 years. For peak values -mainly in severe conditions- the sensitivity of the load to the temperature is a key factor which is considered together with the trend values.

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

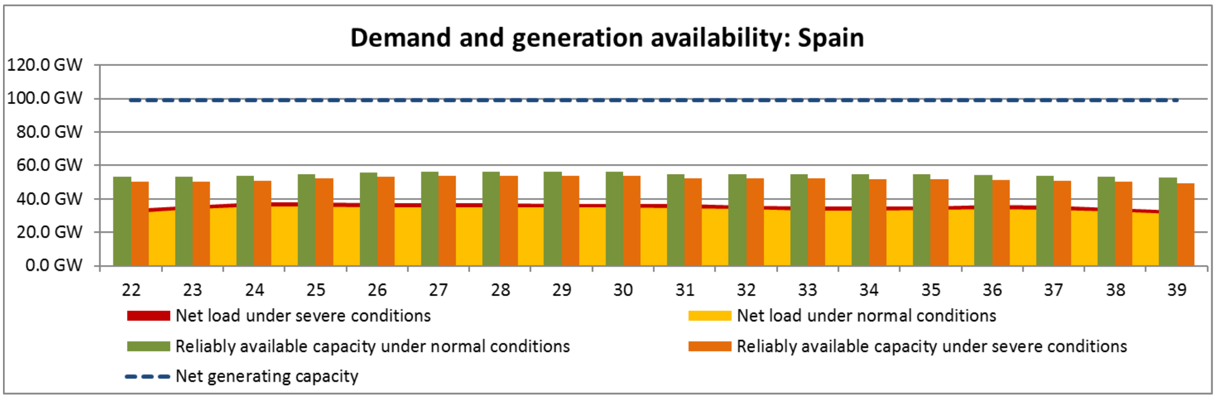
The NTC values are calculated considering forecast scenarios that are shared with neighbouring countries, with different time scopes. Weekly values are calculated considering planned outages and overhauls in the system.

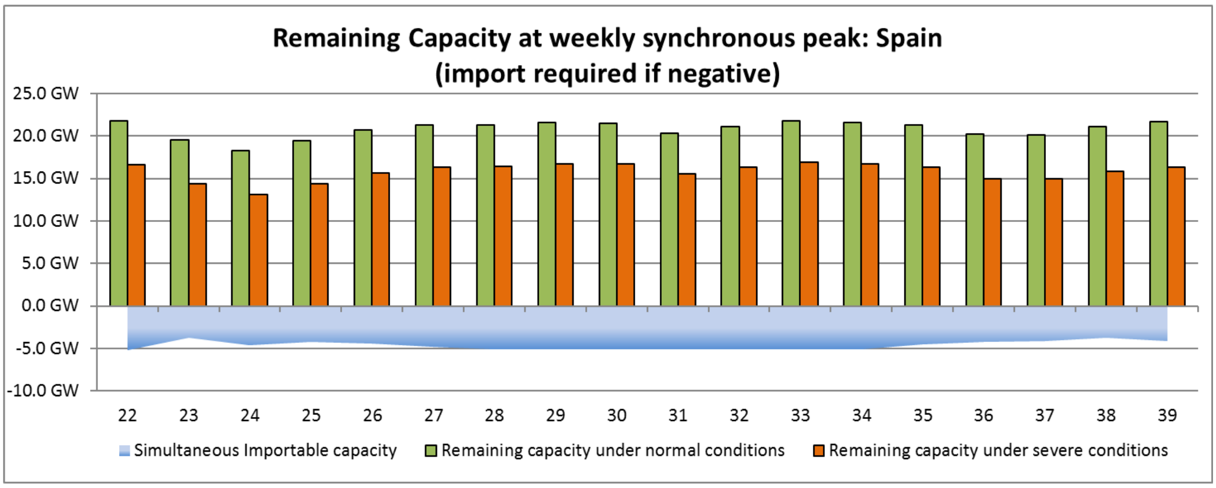
Potential critical periods and foreseen countermeasures

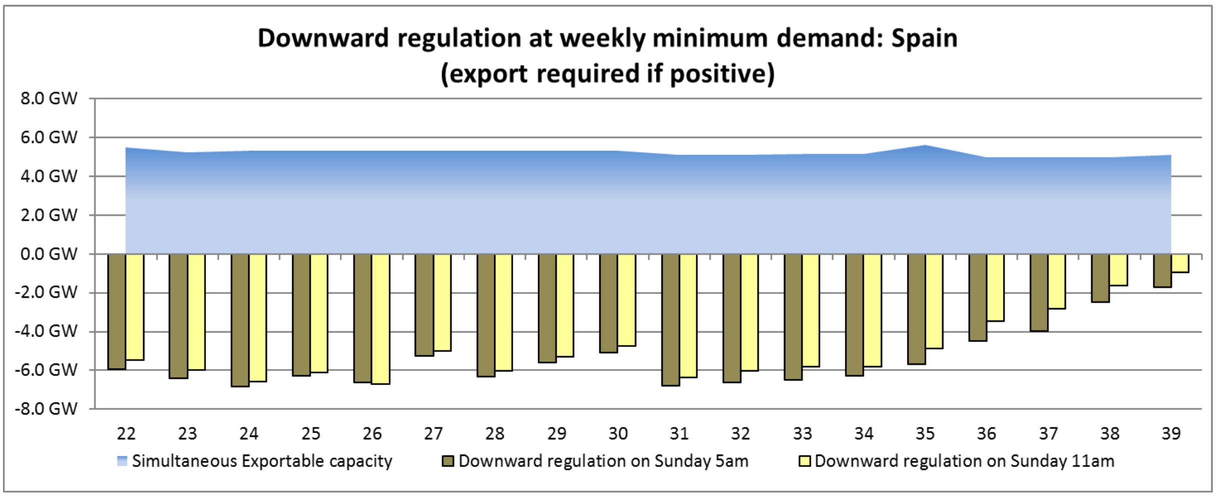
No upward adequacy issues are expected for the coming season.

With the RES percentiles used for the calculation of downward regulation, there are no periods with significant risk of RES spillage. Nevertheless, with higher levels of wind power production downward margins could decrease.

The export capacity of interconnectors is a key factor in order to avoid spilling the renewable energy, mainly wind power. Another point worth mentioning is the importance of energy storage - mainly pump storage plants - in order to properly manage the excess of inflexible power. The installed capacity of hydro pump storage plants in Spain is currently around 6000 MW.







Spain: Winter Review 2017/2018

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

Temperatures were slightly lower than average during December, February and March. The average January temperature was slightly higher than average. During February, some extremely low temperatures were reached.

Highest peak demand was reached in February and was near 41 GW, similar to the peak demand reached in 2017 (January).

Water inflows were very low until the end of 2017, and reservoir levels nearly reached their minimum historical values. However, inflows have increased sharply from the beginning of 2018 and the reserves level is currently approaching its historical average value.

Sweden: Summer Outlook 2018

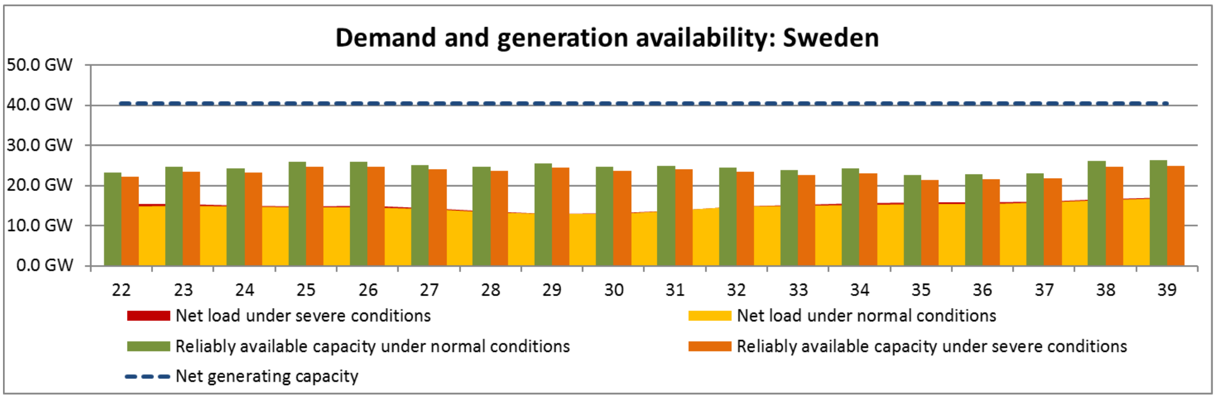
Potential critical periods and foreseen countermeasures

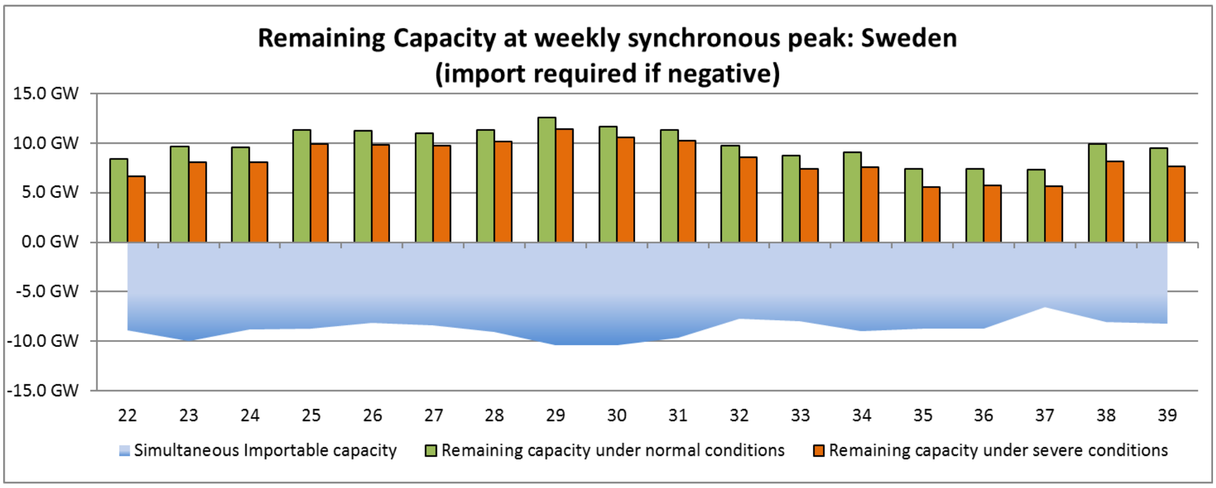
During summer time, adequacy problems are not expected in Sweden since electricity demand is strongly dependent on temperatures and peak demand occurs at times with cold weather. However, there is less generation capacity available during summer due to maintenance allocation at this period. In addition, all the remaining capacity should not be assumed to be available for export since internal congestions are not accounted for in the analysis. At the end of August and beginning of September, large parts of the installed nuclear power capacity are undergoing maintenance, which increases the need for import to the south of Sweden.

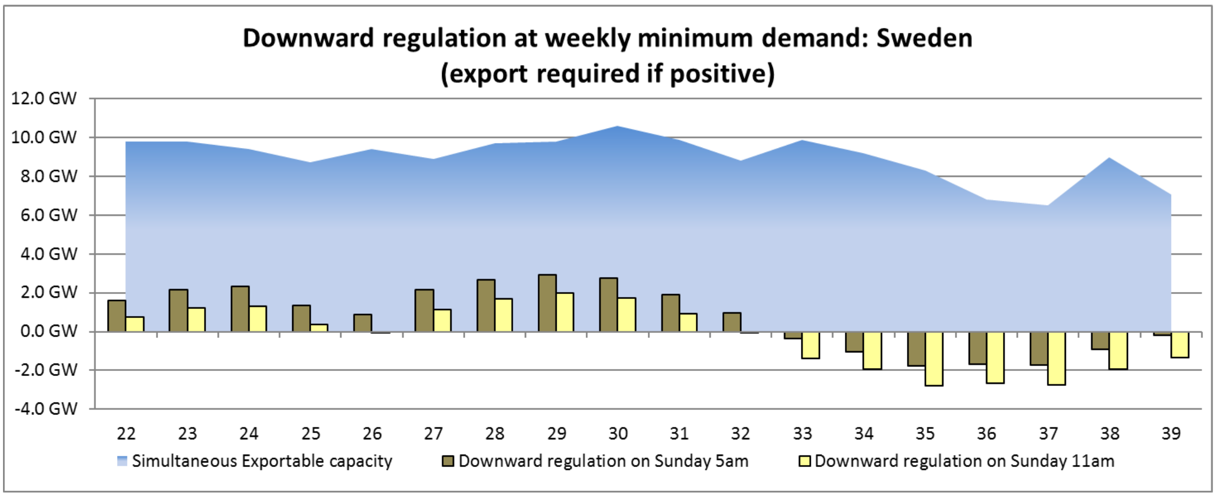
There is a risk of not meeting the requirements for frequency stability as a result of a large power imbalance occurring in a low inertia situation. The risk is higher during the summer when less conventional power plants – main source of inertia – are operating. New countermeasures may have to be activated.

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 with as much as 3 GW is expected for some hours in order to handle the excess of inflexible generation. During June and July 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.

To handle the bottleneck called the West Coast Corridor, limitations on import and export capacity is expected, especially during summer time at conditions with low demand and high nuclear power generation.







Sweden: Winter Review 2017/2018

Overall, the past winter was mild but not as mild as the previous four winters. At the end of February, when the peak demand occurred, the temperatures were lower than normal throughout the country.

Low temperatures and high consumption resulted in a strained power balance in the end of February and beginning of March. At the Swedish peak demand hour, the consumption was about 26700 MWh, which is more than the expected peak demand during a normal winter. In order to secure a sufficient margin for the power balance, the activation time of Swedish peak load reserve (strategic reserve mechanism in Sweden) was reduced. Reduction was applied only to the production part of Swedish peak load reserves. On some occasions, a part of the peak load reserve was set on minimum generation to be able to ramp-up immediately if necessary, but no further activation was needed.

Svenska kraftnät has identified stronger internal transmission flows in SE4 than usual following situations with import from the west and export to the east, together with lower nuclear and thermal power generation in the south-eastern part of Sweden. On some occasions, supportive power has been agreed upon to handle these situations.

Switzerland: Summer Outlook 2018

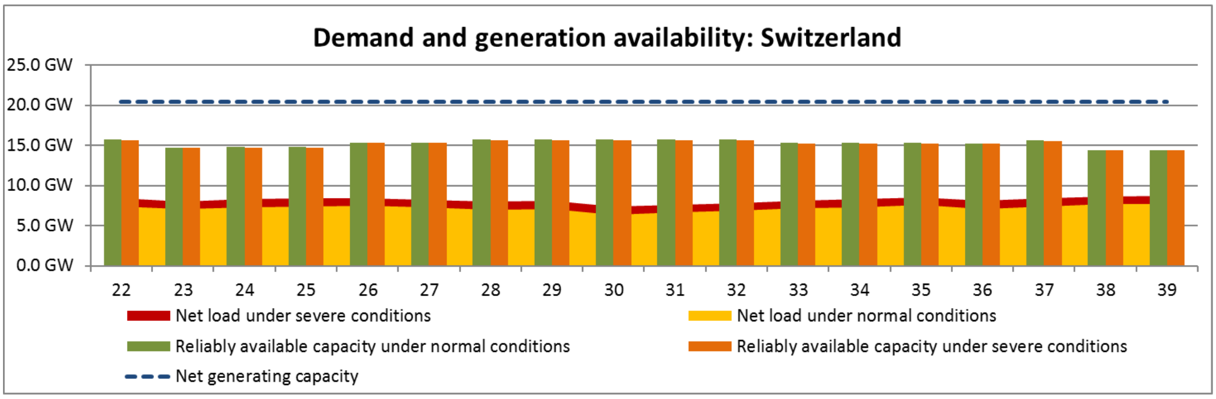
Using the current adequacy methodology, no special problems are detected.

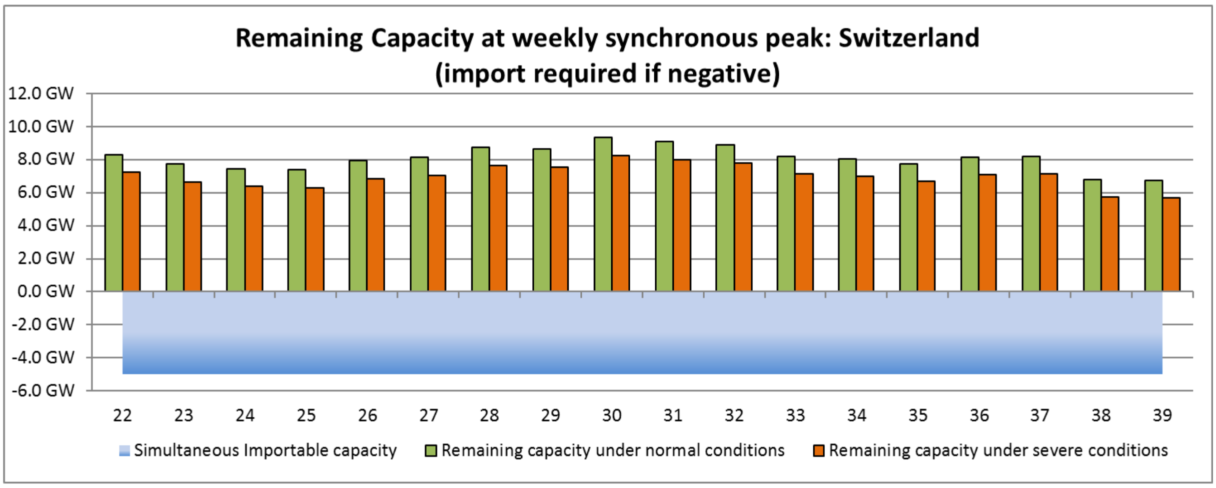
Deterministic capacity-based assessments [MW] cannot reveal potential problems faced by hydro-dominant countries like Switzerland. In particular, for Switzerland it is very important to also consider energy constraints [MWh].

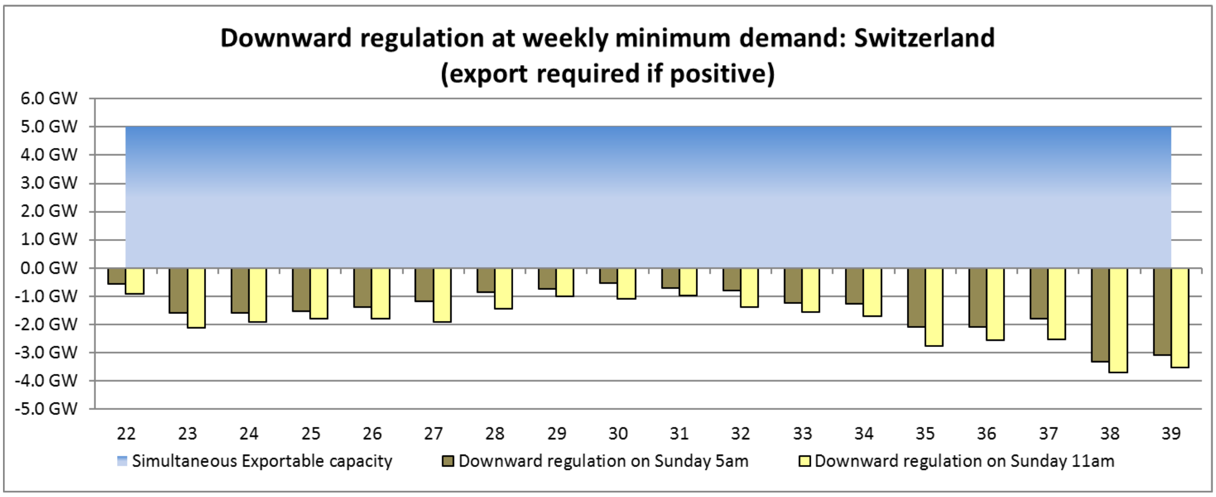
This methodology does not aim to provide insights on possible overloads and voltage problems which might occur.

In other terms, 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). Swissgrid is currently trying to adapt the current methodology in order to take the aforementioned energy constraints into account.

Despite low reservoir indication in Switzerland, there are historical high levels of snow in the alps which will generate substantial inflows to the lakes. Thus, the situation is not as risky as it seems.



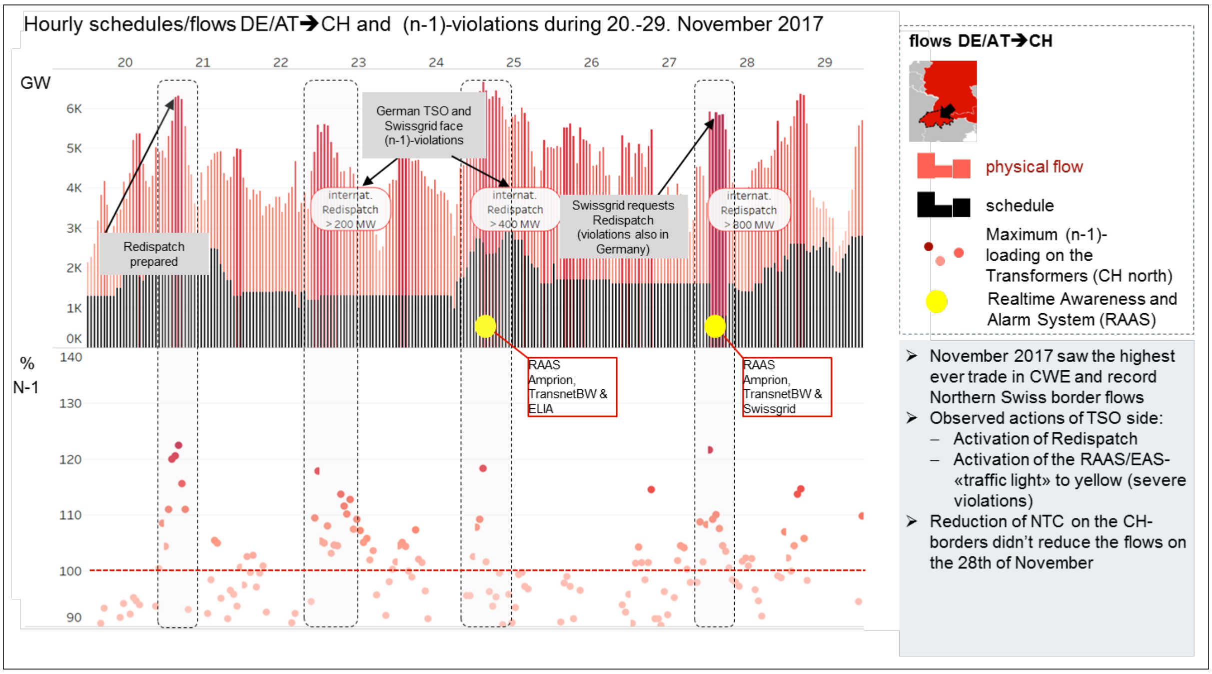




Switzerland: Winter Review 2017/2018

During the winter 2017/2018, the temperatures were within the norms, there was heavy snowfall and there were relatively short periods of sunshine, especially in February 2018.

In November and December 2017, Swissgrid observed high physical flows at the German-Swiss border from Germany to Switzerland, part of these flows originated from trading between the neighbouring countries in the CWE region under Flow-Based Market Coupling. The reduction of NTC on the Swiss borders and the activation of redispatch measures were not sufficient to remove the n-1 violations in the Swiss network. In addition, please refer to the following overview for details:



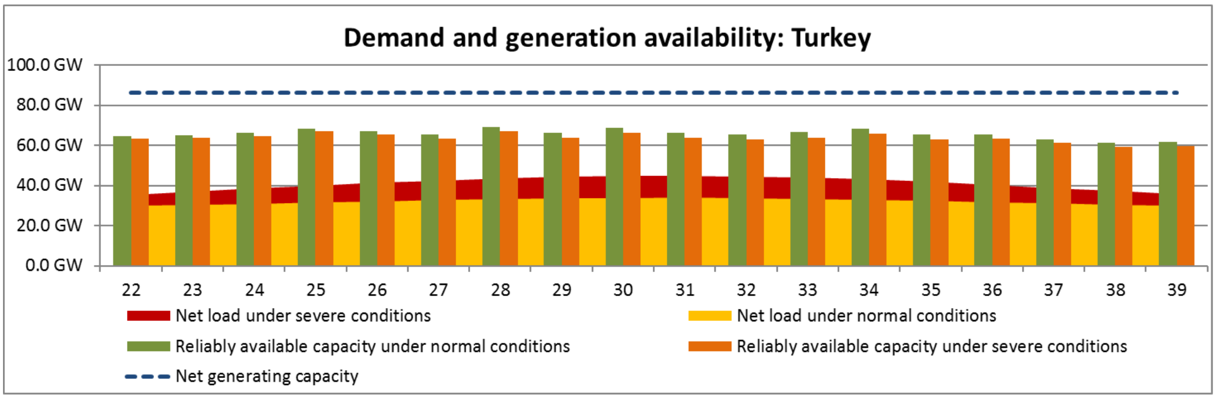
During 80-90% of the winter, Switzerland was a net importer. Despite the extreme weather conditions (snow, wind, ice) there were very few incidents in the transmission grid.

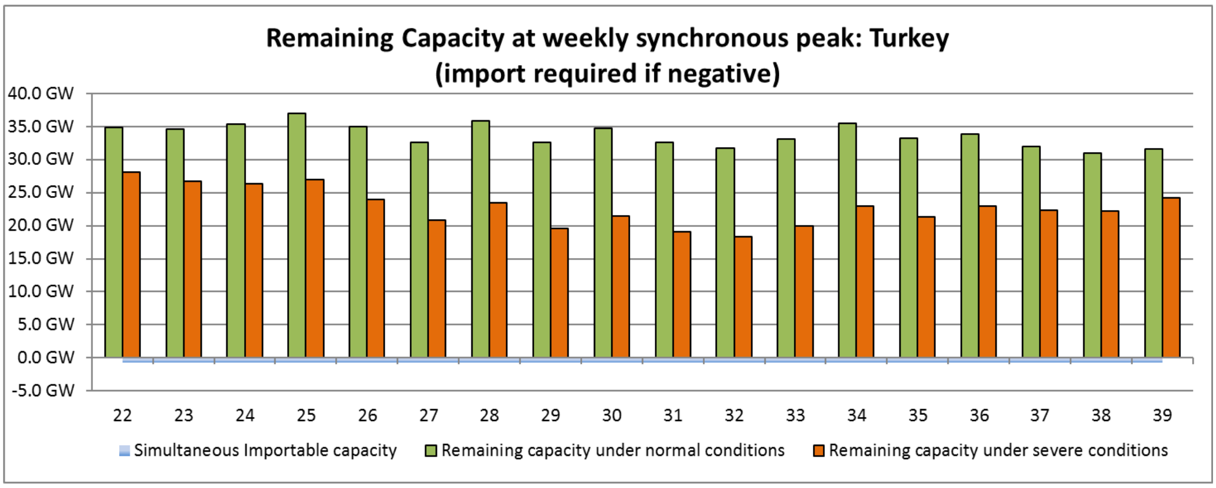
Within the current scope of the questionnaire, no adequacy or downward regulation issues were identified during the past season.

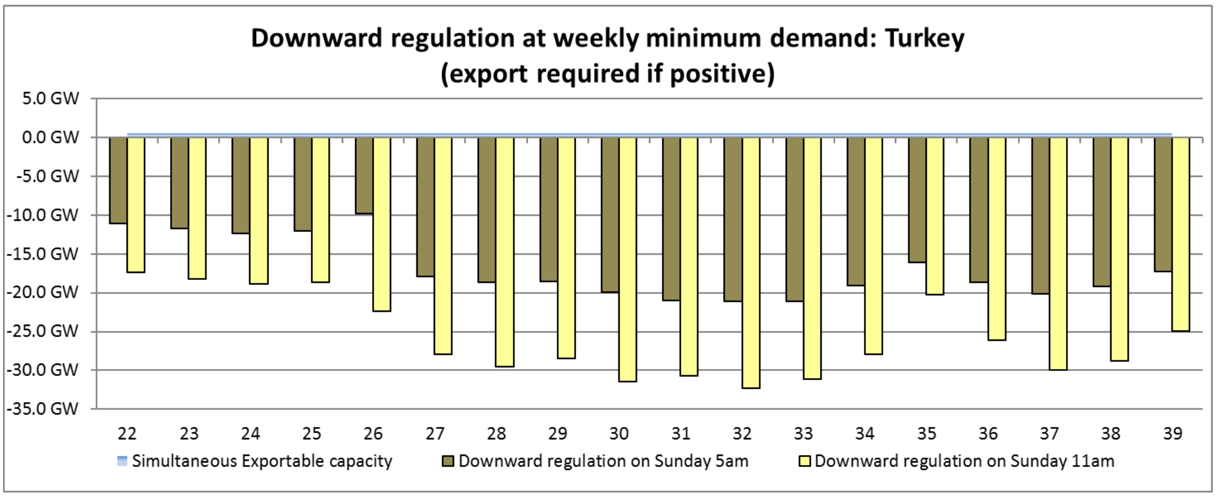
Turkey: Summer Outlook 2018

Potential critical periods and foreseen countermeasures

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







Turkey: Winter Review 2017/2018

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

Appendix 2: Continuously Improving Methodology Based on TSO Expertise

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

ENTSO-E, supported by committed stakeholders, is continuously improving its existing adequacy assessment methodology with a special emphasis on harmonised inputs, system flexibility and interconnection assessments. The target agreed by the stakeholders and published by ENTSO-E is the *Target Methodology for Adequacy Assessment.*[19]

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

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

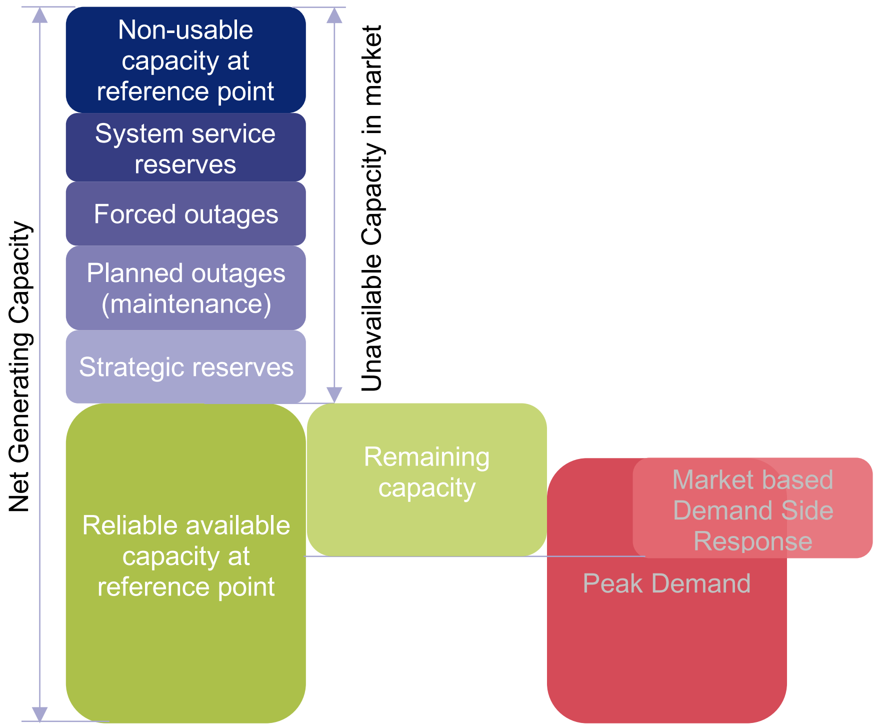
1. Upward Adequacy and Downward Regulation Definitions

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

- '**Normal conditions'** correspond to average weather conditions resulting in 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 at a rate of less than 1 in 20 years.

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

The analysis is the same under normal or severe conditions, and it is schematically depicted in the figure below:[20]



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.

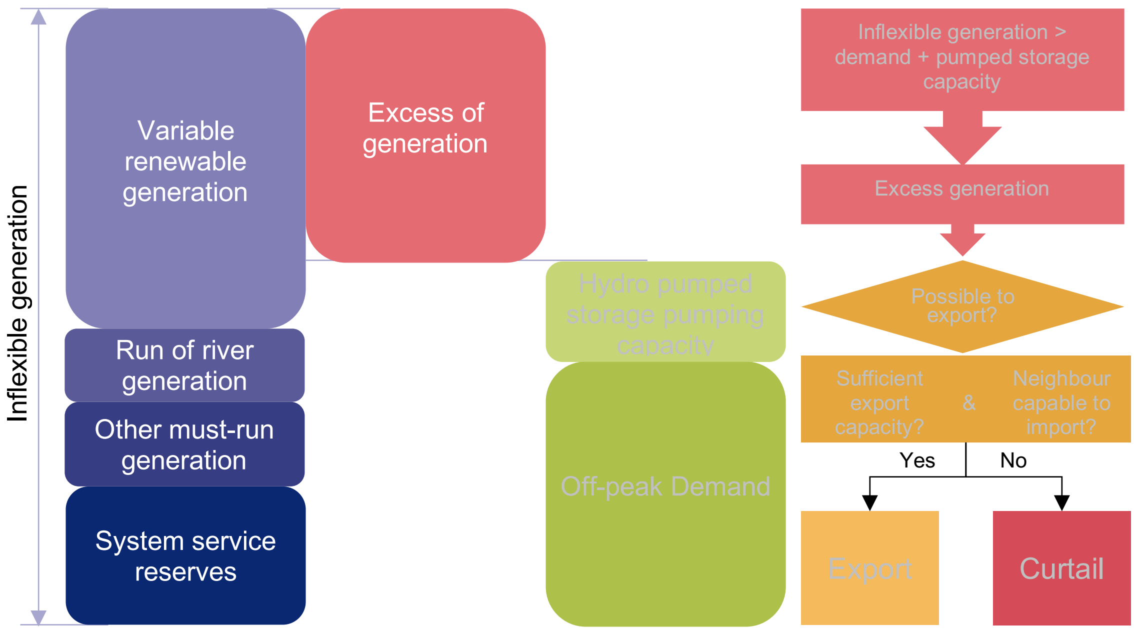
It is important to emphasise that the scenarios evaluated in the assessment represent conditions that are significant and realistic for the European system as a whole. Therefore, they may differ from the scenarios evaluated in each individual country-perspective analysis, which correspond to significant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

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

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

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

The analysis is schematically depicted in the figure below:



Downward adequacy methodology.

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

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

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

2. Upward Adequacy and Downward Regulation Methodology

2.1 Pan-European analysis

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

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

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

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

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

- The balance (RC) of these systems was set at 0 MW; and

- A best estimate of the minimum NTC comes from neighbouring systems belonging to ENTSO-E.

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

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

1. Solar,
2. Onshore wind,
3. Offshore wind,
4. Other renewable sources (including run of river),
5. Nuclear,
6. Coal,
7. Gas,
8. Other non-renewable sources,
9. Hydro-pumped storage,
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[21] is used to run numerous simulations. The following high-level methodology is applied to build each one of those simulations:

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

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

3. Data Processing

3.1 Renewable Infeed Data

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

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

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

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

6,902 records (34 years x 29 days x 7 hours) per reference time point. However, considering 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. renewable infeed in all countries is simultaneously assumed to be equal to the 5th percentile). This scenario can then be used to detect regional adequacy issues that can consequently be investigated in more detail and with a more realistic (and therefore less severe) renewable infeed scenario if necessary.

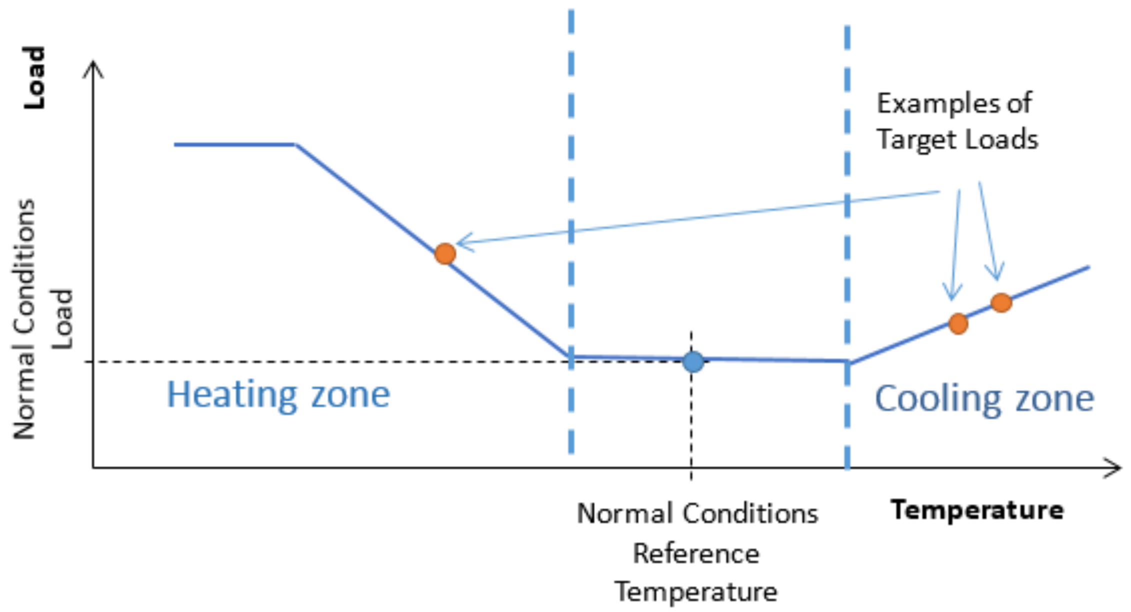
Regarding the downward adequacy analysis, the same approach is used, but using the 95th percentile value (that is exceeded only by 5% of records in collection).

3.2 Load Scaling

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

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

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



Load-temperature sensitivity.

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

3.3 Import/export Capacity

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

4. Future Expected Improvements

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

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

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, ...)

---

[22] *The source of data for the number of the countries and the corresponding cities population is www.citypopulation.de*

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

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

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

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

ND_{imonth}- number of days of month j

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

to the dates corresponding to the middle of each month:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

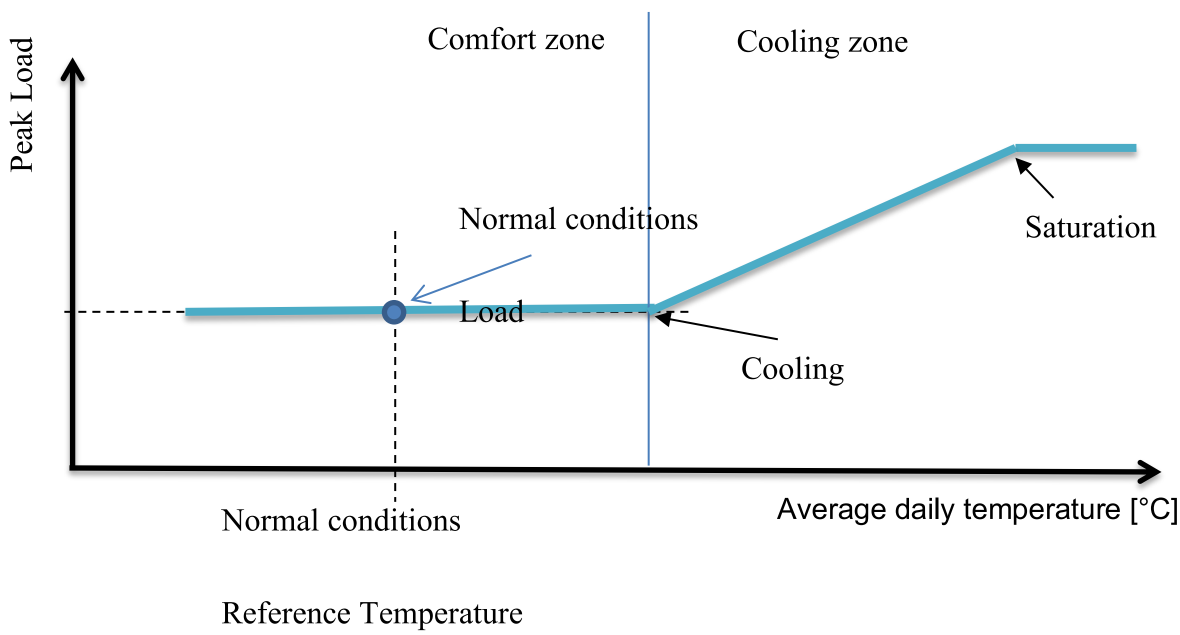
5. Model the relationship between the peak load and the daily average temperature in the range **T_{start} - T_{satur}** by simple linear regression:

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

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

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

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



Appendix 4: Questionnaires Used to Gather Country Comments

1. Seasonal Outlook Questionnaire Template

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

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

2. Seasonal Review questionnaire template

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

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

Appendix 5: Glossary

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

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

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

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

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

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

Downward regulation margin (also **Downward regulation capability):** Indicator of the system 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; power stations with output power limitation due to environmental and ambient constraints.

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

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

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

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

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

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

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

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

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